Original Research Article

Correlation of glenohumeral instability with rotator cuff injuries based on conventional MRI and CT

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Abstract

Background: Rotator cuff forms a dynamic as well as static component of glenohumeral joint stability. Glenohumeral instability can lead to rotator cuff tears and rotator cuff injuries may predispose to glenohumeral instability. In this article, we discuss the imaging features of glenohumeral instability and correlation of rotator cuff injuries in association with glenohumeral instability. **Aim:** To study imaging features of glenohumeral instability and its correlation with rotator cuff tears. **Material and Methods:** During the period of January 2018 to January 2019, patients with clinically suspected glenohumeral instability with chronic complaints for more than 3 months and/ past history of dislocation were evaluated. Patients with acute dislocating injuries were excluded. MR imaging was done using 1.5 Tesla Magnetic Resonance Imaging system (Magnetom Essenza, Siemens health care, Germany) and CT was done using Dual source 16 slice Computed tomography scanner (Bright speed, GE health care, UK). To find the significance/association in categorical data, the Chi square test was used with probability value (P value) 0.05 considered as significant. **Results:** 20 cases were of shoulder instability, of which 90% were of anterior shoulder instability with 5% of posterior and multidirectional instability each. Significant association of anterior instability and Hill-Sach's lesion with Chi-square value of 18 and p-value <0.05 was noted. Significant association was noted between anterior stability and Bankart's lesions with Chi-square value of 5.54 and p-value < 0.05 at degree of freedom 1. Significant association was noted between glenohumeral instability and rotator cuff injuries with Chi-square value of 5 and p-value <0.05 at degree of freedom with subscapularis involved in majority of cases. **Conclusion:** It is essential to correlate the findings of glenohumeral instability and rotator cuff tears and approach these conditions in tandem, to achieve better patient management.

Key Words: Shoulder instability, anterior instability, Hill Sach's, Bankart's, Rotator cuff tears, MRI.

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INTRODUCTION

Glenohumeral joint instability is an important cause of shoulder pain. Rotator cuff muscles are considered the dynamic stabilisers of shoulder joint along with many other factors. In this article, we discuss MRI features of glenohumeral instability and involvement of rotator cuff tears in glenohumeral instability.

AIMS AND OBJECTIVES

1. Evaluate various types of glenohumeral instabilities and its imaging features using conventional MRI and CT.
2. Evaluate rotator cuff tears in cases of glenohumeral instability using conventional MRI.

MATERIALS AND METHODS

- Selection: During the period of January 2018 to January 2019, 100 patients with complaints of chronic shoulder pain at least for period of 3 months were selected.
- Out of these, patients with clinically suspected glenohumeral instability and/ history of dislocation underwent MR imaging.

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Inclusion criteria:

- All patients registered in the institution.
- All patients with clinically suspected glenohumeral stability.
- Age greater than 15 years.

Exclusion criteria:

- Claustrophobia.
- Acute/recent dislocating injuries.

Equipment: MR imaging was done using 1.5 Tesla Magnetic Resonance Imaging system (Magnetom Essenza, Siemens health care, Germany) and CT was done using Dual source 16 slice Computed tomography scanner (Bright speed, GE health care, UK).

Method: In this study, 20 patients with clinically suspected glenohumeral instability underwent MRI evaluation with few cases undergoing CT evaluation.

- Following MR sequences were used i) Axial T1WI, T2WI, PD fat-sat; ii) Coronal PD fat sat and STIR; iii) Sagittal PD fat sat.
- Following scanning parameters were used for CT imaging: i) Helical, thin, overlapping slice, ii) 0.625 mm thick; iii) 200 mA; 120kV; iv) "Bone Plus" and "Standard" algorithms.
- Following parameters were evaluated in all cases using conventional MRI: 1) Osseous lesions related to instability; 2) Labral lesions related to instability and 3) Rotator cuff tears using conventional MR imaging.
- CT imaging was used in few cases for osseous lesions.

Statistics: To describe about the data descriptive statistics, frequency analysis and percentage analysis were used. To find the significance/association in categorical data, the Chi square test was used. In the above statistical tools, the probability value (P value) 0.05 is considered as significant level.

Ethics

This study was carried out after clearance and approval of institutional ethics committee. A written and informed consent was obtained from all the subjects.

RESULTS

Out of 20 cases (Table 1) of shoulder instability, 90% were of anterior shoulder instability with 5% of posterior and multidirectional instability each (Table 2). This was consistent with literature by Gregory VandenBerghe *et al* [1] which states that anterior instability/dislocation is most common of all shoulder instabilities accounting for 90-95% cases. Hill-Sach's lesion is commonly associated with the anterior shoulder instability. Our study showed positive association of anterior instability and Hill-Sach's lesion with Chi-square value of 18 and p-value <0.05 at degree of freedom 1 (Table 3). Our study showed 100 % cases of anterior stability had Hill-Sach's lesion. Study by Antonio *et al* [2] showed 71% cases of anterior instability had Hill-Sach's lesion. In our study, positive association was noted between anterior stability and Bankart's lesions with Chi-square value of 5.54 and p-value < 0.05 at degree of freedom 1 (Table 4). Our study showed 75% cases of anterior instability with Bankart's lesions. This was in correlation with study by Rowe *et al* [3] which stated 64% cases of anterior shoulder dislocation showed Bankart's lesion. Out of the 12 Bankart's lesions, 9 were classical soft tissue Bankart's lesions, 1 was Perthe's lesion and 2 were osseous Bankart's lesions. In our study, positive correlation was noted between glenohumeral instability and rotator cuff injuries with Chi-square value of 5 and p-value <0.05 at degree of freedom 1 (Table 5). Our study showed 75% cases of shoulder instability showed rotator cuff lesions. This was consistent with study by Ribbans *et al* [4] which concluded that incidence of 61% for rotator cuff lesions in shoulder instability.

Our study showed that subscapularis tendon injury was with highest frequency among the shoulder instability cases, followed by supraspinatus and infraspinatus (Table 6).

TABLE 1: DETAILS OF CASES WITH GLENOHUMERAL INSTABILITY [N=20]

Case No.	Age	Sex	Side	BONY LESION	LABRAL LESION	ROTATOR CUFF INVOLVED
1	30	M	Right	Hill Sach's	-	Subscapularis
2	25	M	Right	Hill Sach's	-	Subscapularis
3	24	M	Right	Reverse Hill Sach's	-	Subscapularis
4	18	M	Left	Hill Sach's	-	Supraspinatus
5	31	M	Right	Hill Sach's	-	Supraspinatus
6	27	M	Right	Hill Sach's	Bankart's	-
7	55	F	Left	Hill Sach's	Bankart's	Subscapularis
8	20	M	Left	Hill Sach's	Bankart's	-
9	50	M	Right	Hill Sach's	Bony Bankart's	Subscapularis and supraspinatus
10	28	M	Left	Hill Sach's	Perth's lesion	-
11	55	F	Right	Hill Sach's	Bony Bankart's	Subscapularis
12	25	M	Right	Hill Sach's	-	Supraspinatus and infraspinatus
13	28	M	Right	Hill Sach's	Bankart's	Subscapularis, supraspinatus and infraspinatus
14	28	F	Left	Hill Sach's	Bankart's	Subscapularis

15	27	M	Right	Hill Sach's	Bankart's	-
16	66	M	Right	Hill Sach's	Bankart's	Subscapularis, infraspinatus
17	20	M	Right	Hill Sach's	Bankart's	Subscapularis
18	25	M	Right	Hill Sach's	Bankart's	Subscapularis, supraspinatus
19	24	M	Right	Hill Sach's	Bankart's	Subscapularis
20	60	M	Right	Hill Sach's	Bankart's	Subscapularis

TABLE 2: CLASSIFICATION OF GLENO-HUMERAL JOINT INSTABILITY [N=20]

INSTABILITY	NO. OF PATIENTS	PERCENTAGE
ANTERIOR	18	90%
MULTIDIRECTIONAL	1	5%
POSTERIOR	1	5%
TOTAL	**20**	**100%**

N- Sample size

TABLE 3: ANTERIOR INSTABILITY AND HILL-SACH'S LESIONS [N=18]

ANTERIOR INSTABILITY	HILL-SACHS LESION			
	POSITIVE	%	NEGATIVE	%
PRESENT (18)	18	100%	0	0%

N- Sample size

TABLE 4: ANTERIOR INSTABILITY AND BANKART'S LESIONS [N=18]

ANTERIOR INSTABILITY	BANKART'S LESION (SOFT TISSUE + BONY BANKART'S)			
	POSITIVE	%	NEGATIVE	%
PRESENT (18)	14	77%	4	23%

N- Sample size

TABLE 5: GLENO-HUMERAL JOINT INSTABILITY AND ROTATOR CUFF INJURIES [N=20]

SHOULDER INSTABILITY	ROTATOR CUFF TENDON INJURIES			
	PRESENT	%	ABSENT	%
PRESENT (20)	15	75%	5	25%

N- Sample size

TABLE 6: GLENO-HUMERAL JOINT INSTABILITY AND ROTATOR CUFF INJURIES [N=20]

ROTATOR CUFF TENDON INVOLVED	FREQUENCY
SUBSCAPULARIS	13
SUPRASPINATUS	6
INFRASPINATUS	3

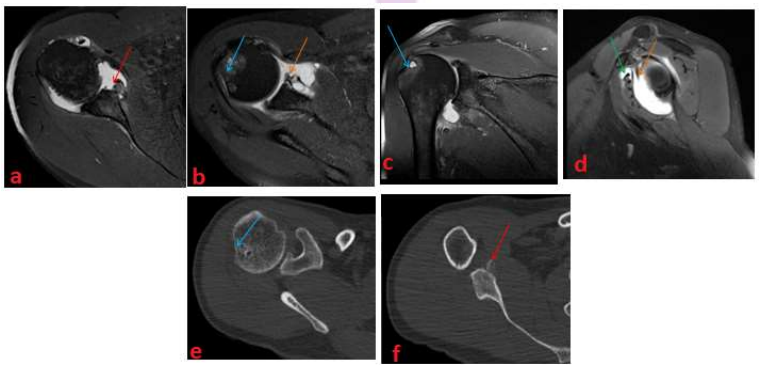

Figure 1: representing case no. 9: Hill Sach's Lesion with Bony Bankart's Lesion with Superior Extension (Slap V Tear) [Multidirectional Instability]

50-year-old male patient with right shoulder pain since 6 months;[a, b, c, d] Proton-density fat-suppressed MR images of shoulder show Hill-Sach's lesion (blue arrow) and bony Bankart's lesion (red arrow) with superior extension of labral tear (orange arrow) and tear involving subscapularis (green arrow); [e ,f] CT images of shoulder showing Bony Bankart's lesion(yellow arrows) along with Hill Sach's lesion (red arrows).

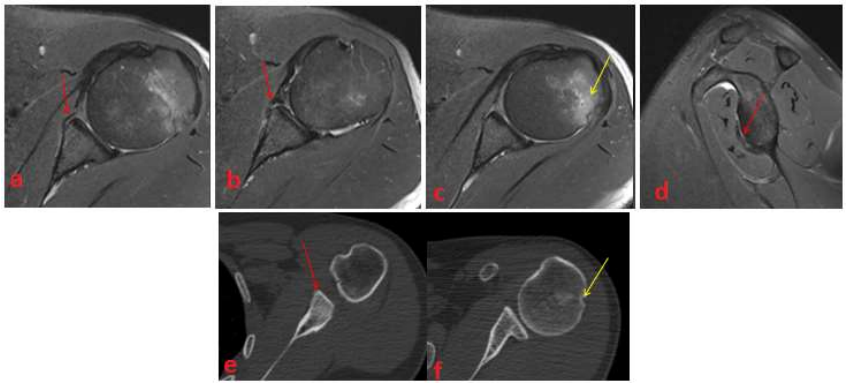

Figure 2: representing case no.10: Perthe's Lesion (Anterior Instability); 28-year-old male patient with left shoulder pain since 5 months; [a, b, c, d] MR Proton-density fat-suppressed images of shoulder show detachment of the antero-inferior labrum (3-6 o'clock) with medially stripped but intact periosteum – Perthe's injury (red arrows) associated with Hill Sach's lesion (yellow arrow) involving postero-lateral aspect of left humeral head; [e, f] CT images of shoulder region show stripped/irregular periosteum (red arrow) over antero-inferior bony glenoid rim. Hill-Sach's lesion shown by yellow arrow

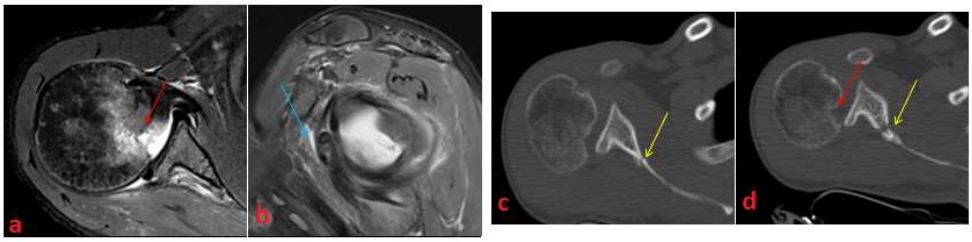

Figure 3: representing case no.3: Reverse Hill Sach's Lesion (Posterior Instability) Associated with Scapular Fracture; 24-year-old male patient with right shoulder pain;
[a, b] Proton-density fat-suppressed MR images of shoulder show posterior dislocation of shoulder with reverse Hill Sach's lesion (red arrow), partial tear of subscapularis muscle (blue arrow); [c, d] CT images of shoulder joint show reverse Hill Sach's lesion (red arrow) with posterior dislocation and scapular fracture (yellow arrows)

DISCUSSION

Glenohumeral instability:

Gleno-humeral joint is the most commonly dislocated joint in the human body [5]. It relies on following intra-capsular and peri-capsular structures like joint capsule, labrum, peri-capsular soft tissue and glenohumeral bony apparatus [6]. Rotator cuff also forms a part of the peri-articular stability apparatus.

Causes of instability include- a) acute traumatic dislocation causing disruption of supporting structures; b) chronic repetitive overhead motions with or without acute injury.

Shoulder instability can de classified in many ways; [7]

- Acute versus recurrent
- Anterior, posterior or multidirectional.
- Traumatic versus non traumatic.
- Functional vs. anatomical.

Here, we consider the classification of anterior, posterior and multi-directional. Anterior instability accounts for majority i.e. 95% followed by the posterior 2-3% and multidirectional 2-3% of all shoulder instability cases [8, 9].

Anterior instability-

Anterior instability forms the major bulk of the shoulder dislocations. Anterior dislocation occurs when the extended arm is predisposed to the abduction and the external rotation. Anterior dislocation [10] is more prone to the recurrent subluxations or dislocation. Imaging findings include:-

Osseous lesions- The most common osseous lesion in the anterior stability is the Hill Sach's lesion and the Bankart's lesion. Hill Sach's lesion is seen as contour abnormality or bony defect seen in the posterosuperior aspect of the humeral head [5]. Hill Sach's lesion needs to be differentiated from the normal bon depression in the posterior aspect of the humeral head. Hill Sach's lesion is mostly seen in the superior supracoracoid part of the humeral head; however normal depression in the humeral head is seen in the infracoracoid part. MRI has high sensitivity and specificity for the diagnosis of the Hill Sach's lesion. [11]

Osseous Bankart's lesion is seen in the anteroinferior aspect of the glenoid margin. It involves the separation of the bony fragment in the antero inferior aspect of the

glenoid labrum; the lesion is well demonstrated on the MRI [12]. Another less common lesion in anterior instability is the greater tuberosity fractures [10, 13].

Labro-ligamentous injury- Anterior instability is commonly associated with the injury or the avulsion of Labro-ligamentous complex in the antero-inferior aspect of the glenoid fossa. Injury may involve the ligament capsular part, humeral attachment or the glenoid attachment. The labro-ligamentous injury is evaluated by localizing on the face of the clock. The anterior aspect is labelled from 0 to 6 o'clock position, and posterior labrum is labelled progressively from 6 o'clock to 12 o'clock position. MR arthrography is the imaging method of choice for the evaluation of the labro-ligamentous pathology [5]. Most of the lesions in the anterior instability are the Bankart's lesions or its variants.

The major labral lesions seen in the anterior instability are as follows:

- The classic Bankart's lesion consists of the avulsion of the glenoid labrum and the anteroinferior aspect of the glenoid rim with stripping of the adjacent periosteum. It can be purely cartilaginous or involve the adjacent bone [5].
- Perthe's lesion is a variant of the Bankart's lesion. In Perthe's lesion, tear of the glenoid labrum with intact scapular periosteum is noted. There is minimal displacement of the torn labrum. The lesion is difficult to be diagnosed on the conventional MRI and MR arthrography is more sensitive technique for the diagnosis of this lesion.
- Other variants worth mention are: ALPSA (Anterior labro ligamentous periosteal sleeve avulsion) lesion; GLAD (gleno-labral articular disruption) lesion; Superior labral anterior to inferior (SLAP) type 5; HAGL (Humeral avulsion of glenohumeral ligament) lesions.

Anterior stability is also associated with the rotator cuff tears which are more commonly seen in the elderly patients.

Posterior instability-

Posterior instability is less commonly seen as compared to the anterior instability [8]. It can occur as a component of the multidirectional instability as well as after the trauma. Ligamentous abnormality involving the posterior band of the inferior gleno-humeral ligament can occur in isolation or in association with the posterior labral injury.

The main lesions seen in the posterior instability are as follows:-

- Reverse Bankart's lesion is the posterior counterpart of the anterior Bankart's lesion. It is characterized by the tear of the postero-inferior part of the labrum associated with the stripping of the adjacent scapular periosteum. It is better visualized on MR arthrography.
- POLPSA (Posterior labro-capsular periosteal sleeve avulsion) lesion is posterior counterpart of the Perthe's lesion occurring anteriorly. It is characterized by the detachment of the labrum posteriorly but remains intact with the stripped scapular periosteum. It differs from reverse Bankart's lesion in which there is disruption of the posterior capsule and scapular periosteum together with the labral detachment. MR arthrography is the preferred technique for diagnosis of the POLPSA lesion [14].
- Kim lesion is deep intra-substance detachment of the posterior labrum from the glenoid margin [14].
- Posterior GLAD lesion is the posterior counterpart of the anterior GLAD lesion.
- Humeral avulsion of the posterior glenohumeral ligament results from negative micro-trauma and can be associated with avulsion fracture of the posterior humerus at the insertion of the posterior band of the inferior glenohumeral ligament [15].
- Bony lesion in posterior instability: Reverse Hill-Sach's lesion consists of the antero-medial superior humeral impaction fracture and is often associated with a reverse Bankart's lesion.

Multidirectional instability-

Multidirectional instability is mostly non-traumatic which accounts for 2% of the all cases of shoulder instability [8]. The multidirectional instability involves multiple segment injury of the labrum. The most common finding in the MR arthrography is the multi quadrant labral injury together with capsular distension. The multidirectional instability may not show any lesion in many cases. Other set of the labral injuries commonly associated with the multidirectional instability is the superior labrum anterior to posterior instability. SLAP lesions have been classified into multiple subtypes. Snyder *et al* [16] (1990) initially classified SLAP lesion into 4 types:

- Type 1: superior labral fraying and degeneration. The labrum remains attached to the glenoid.
- Type 2: superior labral fraying with stripping of the labrum and biceps tendon from the glenoid cartilage. It is the most common lesion occurring in 41-55% of all the SLAP lesions [17].
- Type 3: bucket handle tear with intact biceps.
- Type 4: bucket handle tear with the biceps extension.

Maffet *et al* [18] (1995) further revised the SLAP lesion with 3 additional subtypes:

Type 5: this represents either a Bankart's lesion with superior extension or a SLAP lesion with antero-inferior extension. It is associated with anterior instability.
Type 6: this represents type 4 or type 3 lesion with tear of the bucket handle component.
Type 7: this includes SLAP lesion with extension into the middle glenohumeral ligament.
However, identifying these lesions using conventional MR techniques is quite difficult. It may be possible if effusion is present in glenohumeral joint space.

Rotator cuff tears and glenohumeral instability: -

Rotator cuff provides static and dynamic stability to the glenohumeral joint [19]. Rotator cuff tears may occur after the shoulder dislocations. They are associated with young athletes or old patients with tendon degeneration.
Single dislocating injury or trivial injury in old patients that may lead to rotator cuff tear in an already weak rotator tendon, further predisposing to shoulder instability. Anterior dislocation of the shoulder may be associated with rotator cuff tears, which, if undetected, may be the cause of recurrent anterior instability [20]. These untreated cases may develop chronic shoulder pain and poor prognosis. Thus, appropriate and timely evaluation helps in proper treatment that is necessary for the best clinical outcome.

CONCLUSION

Diagnosing glenohumeral instability requires thorough knowledge of what imaging findings to look for and to detect them accurately. It is also essential to look for rotator cuff tears in patients with glenohumeral instability. Emphasizing on the thorough evaluation of glenohumeral instability with respect to rotator cuff muscles is an important aspect in timely management of both entities leads to better clinical outcome.

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