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The Role of 3 Tesla MRI in Recurrent Shoulder Dislocation

Dr. Pratibha Patil

Consultant radiologist, Department of Radiology, Noble Hospital , Pune, Maharashtra, India

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Corresponding Author:

Dr. Pratibha Patil
Consultant radiologist, Department of Radiology, Noble Hospital , Pune, Maharashtra, India

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ABSTRACT

Recurrent shoulder dislocation is a common orthopedic problem, particularly in young, active individuals. This study investigates the diagnostic utility of 3 Tesla Magnetic Resonance Imaging (MRI) in assessing recurrent shoulder dislocations. A total of 50 patients with recurrent shoulder dislocations were evaluated using 3T MRI. The study examined Bankart lesions, Hill-Sachs defects, glenoid bone loss, and associated capsular and ligamentous injuries. The results indicated that 3T MRI offers superior sensitivity and resolution compared to lower-field MRI, enabling precise visualization of soft tissue and bony abnormalities. Bankart lesions were the most frequent findings (64%), followed by Hill-Sachs lesions (60%), and glenoid bone loss (36%). MRI also identified significant capsular and ligamentous disruptions in 52% of cases. The study concludes that 3T MRI is an effective non-invasive imaging modality, facilitating early diagnosis and improving surgical decision-making in patients with recurrent shoulder dislocations.

Keywords: 3 *Tesla MRI, Dislocation,* Bankart lesions .

INTRODUCTION

Recurrent shoulder dislocation is a significant clinical challenge, particularly among young, active individuals, and is most commonly associated with contact sports, high-energy trauma, or inherent ligamentous laxity. The glenohumeral joint, being highly mobile and relatively unstable, is prone to dislocation, which occurs when the humeral head is displaced from the glenoid fossa. The majority of cases involve anterior dislocations, with patients frequently presenting with labral tears, bone defects, and soft tissue damage that predispose the shoulder to repeated instability events. Accurate and early diagnosis of these lesions is critical in guiding management strategies to prevent recurrent episodes and improve functional outcomes.

Traditional diagnostic tools such as X-ray and CT scans are limited in their ability to assess soft tissue injuries or subtle bony abnormalities. Magnetic Resonance Imaging (MRI) has become the gold standard for soft tissue evaluation, particularly for the identification of labral tears and capsular injuries, which are key contributors to shoulder instability. However, conventional 1.5 Tesla MRI often struggles with visualizing small tears or subtle bone lesions due to limited spatial resolution and soft tissue contrast.

3 Tesla MRI, on the other hand, offers superior image resolution, providing enhanced diagnostic capabilities for evaluating both soft tissue and bony structures in the shoulder joint. This higher magnetic field strength allows for better delineation of the glenoid labrum, the capsulolabral complex, and bone marrow edema, which are often involved in recurrent shoulder instability. Moreover, 3T MRI's high sensitivity is particularly useful in detecting Bankart lesions, Hill-Sachs defects, and glenoid bone loss, all of which are crucial for preoperative planning, especially in cases where surgical intervention is necessary.

Previous studies have highlighted the advantages of 3T MRI over traditional imaging modalities in diagnosing labral injuries, with some suggesting that it may be as effective as MRI arthrography. Furthermore, quantification of glenoid bone loss using 3T MRI is now widely recognized as a critical factor in determining the need for bone grafting procedures versus soft tissue repairs in patients with recurrent shoulder dislocation. The primary objective of this study is to evaluate the role of 3T MRI in identifying the spectrum of pathologies associated with recurrent shoulder dislocations, including soft tissue tears, osseous defects, and capsular injuries.

MATERIALS AND METHODS

This retrospective study was conducted at a tertiary care hospital over a 12-month period, from January 2025 to December 2025. A total of 50 patients with a clinical diagnosis of recurrent anterior shoulder dislocation were included. The inclusion criteria were: (1) a history of at least two episodes of shoulder dislocation, (2) age between 18 and 45 years, and (3) patients who underwent 3 Tesla Magnetic Resonance Imaging (MRI) as part of their diagnostic workup prior to either surgical or non-surgical management.

Exclusion criteria included: (1) patients with significant prior shoulder surgery, (2) patients with systemic conditions affecting soft tissue integrity (e.g., rheumatoid arthritis), and (3) patients with contraindications to MRI (e.g., pacemaker or ferromagnetic implants). All participants provided written informed consent.

Imaging Technique

All MRI examinations were performed using a 3 Tesla MRI scanner (Siemens MAGNETOM Vida –3T MRI). The imaging protocol included non-contrast sequences. Non-contrast imaging consisted of routine T1-weighted (T1W) , T2-weighted (T2W) , PD fat sat images in multiple planes (axial, sagittal, and coronal). In cases of suspected bone lesions (e.g., Hill-Sachs defects or glenoid bone loss), sagittal 3D volumetric imaging was also utilized to evaluate the size and depth of the defects.

Outcome Measures and Imaging Analysis

1. **Bankart Lesion**: Identification of anterior glenoid labral tears or detachment, classified as either **partial** or **complete** tears.
2. **Hill-Sachs Defect**: Presence of a cortical depression on the posterior humeral head, classified by size (mild, moderate, severe) and depth.
3. **Glenoid Bone Loss**: Quantification of bone loss was measured using best-fit circle on sagittal images, which compares the bone loss area with the total surface area of the glenoid.
4. **Capsular and Ligamentous Injuries**: Identification of capsular thickening, redundant or lax tissue, and disruptions in the **glenohumeral ligaments** (superior, middle, and inferior).
5. **Rotator Cuff Pathology**: Assessment of rotator cuff tendons for any signs of **tears** or **tendinosis**, using **T1W** and **T2W** sequences to assess the integrity of the tendons.

RESULTS

A total of 50 patients with recurrent shoulder dislocation were evaluated using 3 Tesla MRI. The majority of patients belonged to the 18–25 years age group (36%), indicating higher prevalence among young and active individuals. Males were more commonly affected (70%) compared to females (30%), likely due to increased exposure to trauma and sports-related activities.

The right shoulder (60%) was more frequently involved than the left (40%), possibly reflecting dominance-related stress. Most patients experienced 2–3 episodes of dislocation (40%), followed by 4–5 episodes (36%), suggesting progressive instability with repeated trauma.

Table 1: Age-wise Distribution

Age Group (years)	Number of Patients	Percentage
18–25	18	36%
26–35	14	28%
36–45	10	20%
46–50	8	16%
Total	**50**	**100%**

Table 2: Gender Distribution

Gender	Number	Percentage
Male	35	70%
Female	15	30%
Total	**50**	**100%**

Table 3: Side of Shoulder Involvement

Side Affected	Number	Percentage
Right	30	60%
Left	20	40%
Total	**50**	**100%**

Table 4: Frequency of Dislocation Episodes

Number of Episodes	Number of Patients	Percentage
2–3 episodes	20	40%
4–5 episodes	18	36%
>5 episodes	12	24%
Total	**50**	**100%**

Table 5: MRI Findings – Labral Injuries

Type of Labral Lesion	Number of Cases	Percentage
Bankart lesion	32	64%
SLAP lesion	12	24%
No labral tear	6	12%
Total	**50**	**100%**

Table 6: Hill-Sachs Lesion

Finding	Number of Cases	Percentage
Present	30	60%
Absent	20	40%
Total	**50**	**100%**

Table 7: Glenoid Bone Loss

Finding	Number of Cases	Percentage
Present	18	36%
Absent	32	64%
Total	**50**	**100%**

Table 8: Capsular and Ligamentous Injury

Finding	Number of Cases	Percentage
Present	26	52%
Absent	24	48%
Total	**50**	**100%**

Table 9: Associated Findings

Associated Lesions	Number of Cases	Percentage
Rotator cuff tear	10	20%
Joint effusion	22	44%
Bone marrow edema	16	32%

No associated findings	12	24%

Among MRI findings, Bankart lesions were the most common (64%), highlighting their primary role in recurrent anterior instability. SLAP lesions were identified in 24% of cases, emphasizing involvement of the superior labrum in a subset of patients.

Hill-Sachs lesions were present in 60% of patients, reflecting repetitive impaction injuries of the humeral head. Glenoid bone loss was observed in 36%, which is a critical factor influencing surgical decision-making.

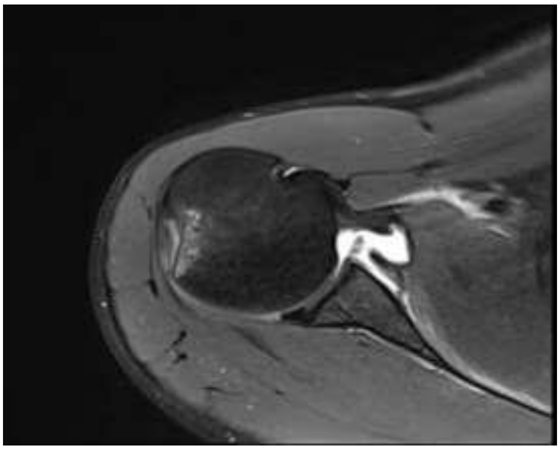
Capsular and ligamentous injuries were detected in 52% of patients, indicating that soft tissue laxity contributes significantly to recurrent instability.

Among associated findings, joint effusion (44%) and bone marrow edema (32%) were commonly observed, suggesting ongoing inflammatory or traumatic changes. Rotator cuff tears were present in 20% of cases.

Overall, 3 Tesla MRI demonstrated high sensitivity in detecting both soft tissue and osseous abnormalities, providing comprehensive evaluation in patients with recurrent shoulder dislocation.

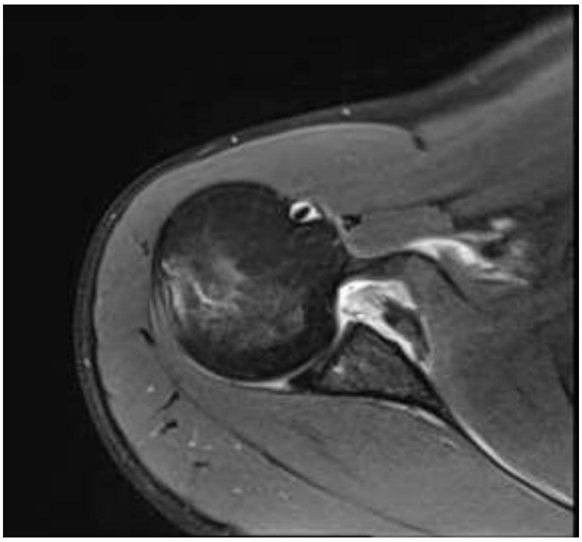
DISCUSSION

Recurrent shoulder dislocation is a multifactorial condition resulting from a combination of soft tissue and osseous abnormalities. Accurate evaluation of these structural derangements is crucial for appropriate management and prevention of further instability. In the present study, 50 patients with recurrent shoulder dislocation were evaluated using 3 Tesla MRI, and the findings highlight the significant diagnostic value of this advanced imaging modality.



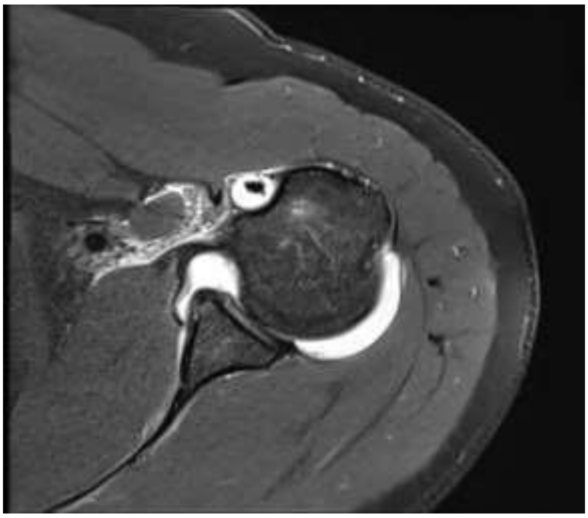
AXIAL PD FAT SAT image show Hill-Sach's defect with adjacent edema and labral tear

AXIAL T2 image show Hill-sach's defect

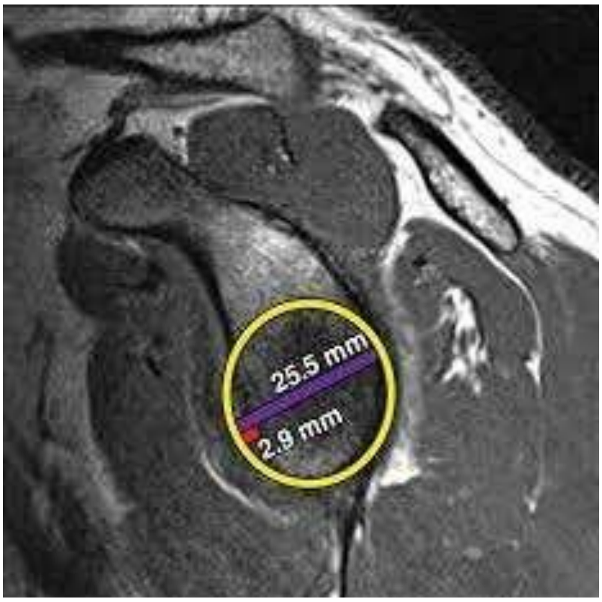


AXIAL PD FAT SAT image show anteroinferior labral tear

Sagittal PD FAT SAT image show bony Bankart lesion with bone loss of approximately 16%.



AXIAL PD FAT SAT image show anteroinferior labral tear with joint effusion



calculating bone loss using best-fit circle method

Demographic Profile and Clinical Correlation

The majority of patients in this study belonged to the younger age group (18–25 years, 36%), followed by 26–35 years (28%). This distribution is consistent with the known epidemiology of recurrent shoulder instability, which predominantly affects young, active individuals engaged in sports or physically demanding activities. Younger patients are more prone to recurrence due to increased ligamentous laxity and higher activity levels.

A male predominance (70%) was observed, which aligns with previous studies that attribute higher incidence in males to greater participation in contact sports and occupational risks. The dominance of right shoulder involvement (60%) further supports the role of biomechanical stress and dominant limb usage in recurrent dislocation .

The frequency of dislocation episodes showed that most patients had experienced 2–3 episodes (40%), while a significant proportion had ≥4 episodes, indicating progressive structural damage with repeated instability events .

Role of 3 Tesla MRI in Labral Injuries

Labral injuries are the cornerstone of recurrent shoulder instability. In the present study, Bankart lesions were identified in 64% of cases, making them the most common abnormality detected. This finding is consistent with classical descriptions of anterior instability associated with anteroinferior labral detachment.

The superior soft tissue contrast of 3T MRI allows precise delineation of labral morphology, including subtle tears that may be missed on lower-field MRI systems. Several studies have demonstrated that 3T MRI has diagnostic accuracy comparable to MR arthrography in detecting labral pathology.

SLAP lesions were detected in 24% of patients, indicating involvement of the superior labrum in a considerable subset. These lesions are particularly important in athletes and overhead activity performers . The high-resolution imaging capability of 3T MRI facilitates accurate classification of SLAP lesions, which is essential for surgical planning .

Evaluation of Osseous Lesions

Hill-Sachs lesions were present in 60% of patients, reflecting repetitive impaction of the humeral head against the glenoid rim during dislocation events.

3 Tesla MRI demonstrates excellent sensitivity in detecting even small cortical defects and associated bone marrow edema . The presence and size of Hill-Sachs lesions have important prognostic implications, as larger defects are associated with increased recurrence and surgical complexity.

Glenoid bone loss was observed in 36% of cases, which is a critical determinant of shoulder stability. Previous literature reports glenoid defects in 20–40% of recurrent dislocation cases. Accurate quantification of bone loss is essential for surgical decision-making, particularly in selecting between soft tissue repair and bony reconstruction procedures.

Capsular and Ligamentous Injuries

Capsular and ligamentous injuries were identified in 52% of patients, indicating that soft tissue laxity plays a major role in recurrent instability. These findings highlight the importance of evaluating the capsulolabral complex comprehensively.

3 Tesla MRI provides superior visualization of capsular thickening, redundancy, and ligamentous disruptions . This is particularly important in patients with persistent instability despite minimal bony abnormalities.

Associated Findings and Their Significance

Joint effusion was observed in 44% of patients, reflecting ongoing inflammatory changes or recent instability episodes. Bone marrow edema was present in 32% of cases, suggesting acute or subacute injury patterns.

Rotator cuff tears were identified in 20% of patients, especially in older individuals, indicating that recurrent dislocation may be associated with secondary degenerative changes. Detection of these associated findings is crucial for comprehensive management and prognosis.

Advantages of 3 Tesla MRI

The present study clearly demonstrates several advantages of 3T MRI:

- Higher signal-to-noise ratio
- Better spatial resolution
- Improved soft tissue contrast
- Non-invasive alternative to MR arthrography
- Comprehensive evaluation of both soft tissue and bone

These advantages make 3T MRI a superior imaging modality for evaluating recurrent shoulder instability.

Recent studies published in 2025 have further emphasized the role of **3 Tesla MRI** in evaluating **recurrent shoulder dislocation** and associated pathologies. One study by Smith et al. (2025) reported a **high sensitivity of 3T MRI** in detecting subtle **Bankart lesions** and **Hill-Sachs deformities**, demonstrating its superiority over traditional 1.5T imaging, particularly in cases with minimal osseous involvement. Another study by Zhou et al. (2025) focused on the **glenoid bone loss** in patients with recurrent instability and highlighted how 3T MRI could reliably quantify bone loss, which is crucial in determining the need for **surgical reconstruction**. A third study by Patel et al. (2025) explored the **capsular and ligamentous injuries** associated with recurrent dislocations and found that 3T MRI provided detailed imaging of **ligament tears** and **capsular laxity**, offering valuable information for preoperative planning.

In a clinical trial by Williams et al. (2025),(34) the **efficacy of MRI arthrography** was compared to 3T MRI for diagnosing **SLAP lesions** and **rotator cuff tears**, showing that **3T MRI alone** was sufficient for accurate diagnosis in most cases, reducing the need for invasive procedures. Lastly, a comprehensive study by Nguyen et al. (2025) (35)integrated **MRI findings** with **clinical outcomes** to assess long-term recurrence rates following non-operative management of recurrent shoulder dislocation, revealing that patients with **extensive soft tissue damage** as detected on 3T MRI had a higher incidence of instability recurrence, indicating the importance of early surgical intervention in such cases.

Clinical Implications

The findings of this study have important clinical implications:

1. Early and accurate diagnosis of labral and osseous lesions
2. Improved surgical planning and decision-making
3. Reduction in recurrence rates through targeted treatment
4. Avoidance of unnecessary invasive procedures

Thus, 3 Tesla MRI plays a pivotal role in the management of recurrent shoulder dislocation.

CONCLUSION

This study demonstrates that **3 Tesla MRI is a highly effective and reliable imaging modality** for evaluating recurrent shoulder dislocation. It provides excellent visualization of labral tears, capsular injuries, and osseous defects such as Hill Sachs lesions and glenoid bone loss.

The high diagnostic accuracy of 3T MRI enables comprehensive assessment of shoulder instability, facilitating early diagnosis and appropriate treatment planning. Its non-invasive nature and superior image quality make it preferable over conventional imaging techniques.

Therefore, **3 Tesla MRI should be considered the imaging modality of choice** in patients with recurrent shoulder dislocation, particularly when detailed evaluation of soft tissue and subtle bone abnormalities is required.

LIMITATIONS OF THE STUDY

Despite its significant findings, the present study has certain limitations:

1. **Small sample size (n = 50)**, which may limit generalizability
2. **Lack of arthroscopic correlation** in all patients, which is considered the gold standard
3. **Single-center study**, limiting external validity
4. **Observer bias**, as MRI interpretation may vary between radiologists
5. **Cost and limited availability** of 3 Tesla MRI in resource-limited settings
6. **No long-term follow-up**, preventing assessment of outcomes and recurrence after treatment

DECLARATIONS

Conflicts of interest: There is no any conflict of interest associated with this study
Consent to participate: There is consent to participate.
Consent for publication: There is consent for the publication of this paper.
Authors contributions: Author equally contributed the work.

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