Case Reports and Reviews

Case Report

Recurrent Anterior Shoulder Instability with Inferior Glenoid Fracture Leading to Mechanical Subacromial Impingement: Imaging Considerations and Diagnostic Algorithm

Ayten Akhundova

Scientific Surgery Center named after Academician M. Topchubashov, and The Central Clinical Hospital, Baku, Azerbaijan

Correspondence

Ayten Akhundova

Scientific Surgery Center named after Academician M. Topchubashov, and The Central Clinical Hospital, Baku, Azerbaijan

ORCID: 0009-0008-6683-1540

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Abstract

Background: *Traumatic anterior shoulder instability is frequently associated with osseous defects of the glenoid and humeral head, which significantly influence recurrence risk and surgical decision-making. Beyond instability, structural bone loss may also contribute to secondary mechanical subacromial impingement through altered glenohumeral biomechanics and superior humeral migration. The coexistence of glenoid fracture and secondary post-traumatic impingement represents an underreported clinical scenario, and an evidence-informed imaging strategy for this combined pathology has yet to be clearly established.*

Objective: *To explore the complementary diagnostic utility of MRI and CT in a clinically undercharacterized scenario - post-traumatic shoulder impingement secondary to inferior glenoid fracture in recurrent anterior instability.*

Case Presentation: *A 41-year-old physically active male presented with persistent shoulder pain two weeks following a traumatic episode on a background of recurrent anterior dislocations. The pain intensified at night and during arm elevation above 90° and posterior movements, raising clinical suspicion of subacromial impingement.*

Methods: *Initial evaluation with MRI revealed a post-traumatic fracture of the inferior glenoid rim with partial displacement, narrowing of the glenohumeral joint space, partial superior migration of the humeral head, reduced acromiohumeral distance, supraspinatus tendinopathy with partial-thickness tearing and bone marrow edema, as well as subacromial bursitis and rotator cuff edema. Subsequent CT imaging was performed to refine osseous assessment and demonstrated detailed fracture morphology, articular surface deformation, displacement extent, and associated cystic osteodegenerative changes of the humeral head.*

Results: *Imaging findings supported a sequential pathomechanism: glenoid bone defect → increased instability → superior humeral migration → subacromial narrowing → supraspinatus compression and degeneration. MRI proved superior for detecting soft tissue pathology and marrow edema, whereas CT provided high-resolution characterization of fracture configuration and articular involvement, critical for therapeutic planning.*

Conclusion: *In post-traumatic shoulder impingement associated with glenoid fracture and recurrent instability, reliance on a single imaging modality may result in incomplete structural assessment. MRI and CT serve complementary roles: MRI excels in evaluating soft tissue and inflammatory components, while CT remains indispensable for precise osseous mapping and assessment of articular surface displacement. A staged, multimodal imaging approach enhances diagnostic accuracy and supports informed management decisions.*

Introduction

The shoulder joint, owing to the wide range of motion of the glenohumeral complex, is one of the most frequently dislocated joints in the human body, with anterior instability representing the dominant pattern within this spectrum. Contemporary literature emphasizes that appropriate decision-making in the management of traumatic anterior instability extends beyond the resolution of clinical symptoms and requires systematic assessment of structural lesions that increase recurrence risk, including glenoid and humeral head bone loss, labro-capsular injuries, and rotator cuff pathology. The 2024 formal consensus statement of the European Society of Sports Traumatology, Knee Surgery and Arthroscopy (ESSKA) and its shoulder section (ESSKA-ESA) highlights that patient age and

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timing of presentation significantly influence treatment strategy in traumatic anterior shoulder instability [1]. Importantly, glenoid bone loss and fractures are identified as key factors capable of altering the direction of management. The document further acknowledges that the optimal diagnostic algorithm for defining clinically significant bone loss thresholds remains an area of ongoing investigation.

Recent radiologic data demonstrate that quantification of glenoid and humeral bone loss in anterior instability directly influences surgical strategy selection, such as isolated arthroscopic Bankart repair versus bone block procedures, as well as application of the "on-track/off-track" concept. Accordingly, standardization of bone loss assessment remains a clinically relevant issue. A comprehensive review published in Journal of Clinical Medicine in 2024 systematically outlined the association between glenohumeral bone loss, recurrent instability, and surgical failure, while also discussing the strengths and limitations of various measurement approaches, including CT and MRI [2]. Concurrently, the acromiohumeral distance (AHD) has become central to discussions regarding the pathomechanism of subacromial pain. A 2025 systematic review demonstrated an association between reduced AHD and rotator cuff tears, with several studies reporting that an AHD $\leq$ 6 mm may show high specificity for full-thickness rotator cuff tears [3]. However, heterogeneity in measurement protocols was noted to influence interpretation. The review proposed AHD as both a structural and functional biomarker, emphasizing not only static measurements but also the clinical relevance of dynamic assessment.

Within this context, the clinical relevance of the present case lies in the observation that, in the setting of recurrent anterior instability, not only the classical spectrum of labral injury was present, but also a post-traumatic fracture of the inferior glenoid rim as a structural bone component. This defect contributed to superior humeral head migration and the development of secondary mechanical impingement. From a practical standpoint, in such combined injuries, reliance on a single imaging modality may result in incomplete evaluation - either insufficient morphological assessment of the bone defect or inadequate visualization of soft tissue and bone marrow components.

In recent years, meta-analytic data have suggested that MRI-based measurement of glenoid bone loss may be comparable to CT. A 2025 systematic review and meta-analysis reported that MRI-based quantification of glenoid bone loss (using 2D/3D linear and surface methods) demonstrated statistically comparable results to CT and may even be sufficient as a standalone modality in selected clinical cases [4]. Nevertheless, when considering the impact of articular surface displacement and deformity of glenoid fractures on surgical planning, CT continues to play a critical role in detailed osseous "bone mapping" and remains a priority modality in certain scenarios.

Materials and Methods

This study presents a single-patient clinical case analysis focusing on diagnostic imaging strategy in post-traumatic shoulder impingement associated with inferior glenoid fracture in the setting of recurrent anterior instability. A staged imaging approach was applied: MRI was performed as the first-line modality. Standard shoulder protocol sequences were obtained in axial, coronal oblique, and sagittal oblique planes, including T1-weighted, T2-weighted, and fluid-sensitive fat-suppressed sequences. MRI assessment included evaluation of glenoid rim integrity and contour, presence of bone marrow loss/edema, degree of fracture displacement, humeral head position with signs of superior migration, AHD, rotator cuff integrity - particularly the supraspinatus tendon - subacromial-subdeltoid bursal fluid, and labro-capsular structures. Following MRI detection of an inferior glenoid fracture with suspected articular involvement, CT with multiplanar reconstructions was performed for detailed osseous analysis, assessing fracture morphology and fragment configuration, degree of displacement and articular surface involvement, glenoid contour deformation, associated humeral head osteodegenerative changes, and the overall extent of structural bone loss. CT was primarily used for high-resolution evaluation of cortical bone and articular surface mapping. A qualitative assessment approach was used.

Ethical Considerations

The patient provided informed consent for the use of anonymized clinical and imaging data for academic publication purposes.

Case report

A 41-year-old male patient actively engaged in recreational sports presented with persistent shoulder complaints. His medical history was significant for multiple prior episodes of recurrent anterior shoulder dislocation. Two weeks before presentation, he sustained another traumatic event during sports activity, resulting in repeated shoulder dislocation. Although the joint was successfully reduced, the patient continued to experience persistent pain, particularly at night. The pain was exacerbated during arm elevation above 90 degrees and during posterior-directed movements, suggesting a mechanical component to the symptomatology. A rheumatologist raised suspicion of subacromial impingement syndrome and referred the patient for magnetic resonance imaging (MRI) of the shoulder girdle. Coronal magnetic resonance imaging demonstrates marked narrowing of the acromiohumeral interval, indicating superior migration of the humeral head relative to the acromion (Figure 1).

T2-weighted fat-suppressed imaging demonstrates bone marrow signal replacement by edematous changes. The supraspinatus tendon is visibly compressed within the subacromial space, consistent with mechanical impingement beneath the acromial arch. The supraspinatus tendon exhibits increased intratendinous signal intensity and structural heterogeneity, compatible with tendinosis. In addition, focal discontinuity of tendon fibers is observed, consistent with a partial-thickness tear. The abnormal signal and morphological alteration are most pronounced at the critical zone near the tendon insertion, suggesting chronic overload and degenerative change. These findings collectively support the diagnosis of subacromial impingement syndrome, characterized by mechanical compression of the supraspinatus tendon, associated tendinopathic degeneration, and partial tearing within the setting of reduced subacromial space.

T1-weighted imaging was utilized for fracture identification: MR imaging of the shoulder demonstrates structural abnormalities involving both the glenoid and the humeral head (Figure 2).

At the inferior glenoid rim, a fracture line is identified extending to the articular surface. The fracture fragment demonstrates minimal displacement and is associated with cortical irregularity and deformity of the inferior glenoid contour. Articular surface involvement indicates disruption of normal glenohumeral congruity, with potential

implications for joint stability and altered load transmission across the articulation. Additionally, the humeral head exhibits osteodegenerative alterations localized to the rotator cuff footprint region. On T1-weighted imaging, this area demonstrates heterogeneous marrow signal with focal changes suggestive of osteonecrotic transformation. The degenerative involvement spans a relatively extensive portion of the humeral head, consistent with chronic biomechanical stress, most likely secondary to recurrent instability and altered joint mechanics. Collectively, these findings demonstrate a minimally displaced inferior glenoid rim fracture in combination with degenerative and osteonecrotic changes of the humeral head at the rotator cuff insertion, reflecting structural compromise of the glenohumeral joint and instability-related pathomechanical sequelae.

Given the articular surface deformity and suspected displacement of the inferior glenoid fracture fragment, CT with multiplanar reconstruction was performed for detailed osseous characterization. CT confirmed an inferior glenoid rim fracture with measurable displacement and articular surface involvement. The three-dimensional configuration of the fragment and degree of cortical disruption were more clearly delineated compared to MRI. Glenoid contour irregularity and focal articular incongruity were evident. Additionally, CT demonstrated cystic osteodegenerative changes within the humeral head, supporting chronic biomechanical alteration in the setting of recurrent instability (Figure 3).

The Coronal CT scan of the shoulder taken in bone window to clearly show the bones presents the space between the acromion and the humeral head (acromiohumeral interval) that can be seen above the humeral head. The greater tuberosity, where the supraspinatus tendon attaches, is visible on the outer side of the humeral head. There is a clearly visible bright (dense) calcium deposit at the insertion of the supraspinatus tendon on the greater tuberosity of the humerus (shown by the yellow arrow). The deposit is well defined, dense, and located next to the bone surface. There is no sign of fragmentation. The underlying bone cortex appears intact, and there is no visible fracture or displaced bone fragment in this image. The glenohumeral joint alignment is preserved. The humeral head is centered relative to the glenoid, and there is no sign of subluxation in this slice. The space under the acromion appears relatively maintained. The calcification at the supraspinatus tendon insertion raises concern for subacromial impingement, particularly due to arm elevation-related pain.

Overall, these findings are consistent with calcific tendinopathy of the supraspinatus tendon, resulting from calcium deposition at its insertion on the humerus. This condition commonly presents with shoulder pain, particularly during overhead activities, may restrict arm abduction, and can be associated with subacromial bursitis and secondary impingement. Although CT clearly demonstrates the calcific deposit, MRI or ultrasound is more valuable for assessing tendon integrity, surrounding soft tissue inflammation, and associated structural abnormalities.

Discussion

In this case, the clinical presentation characterized by nocturnal exacerbation of pain and increased discomfort during arm elevation above 90° and posterior-directed movements, raised suspicion for mechanical subacromial impingement syndrome. This suspicion was subsequently confirmed through radiologic evaluation. The underlying pathophysiological cascade can be conceptualized as follows: recurrent anterior shoulder dislocations resulted in a post-traumatic fracture of the inferior glenoid rim. This structural defect disrupted the contour of the articular surface and deepened joint instability. The resultant biomechanical imbalance facilitated superior migration of the humeral head. As a consequence, AHD decreased, leading to compression of the supraspinatus tendon within the subacromial space. Chronic mechanical compression precipitated tendinopathy, intratendinous edema, and partial tearing, accompanied by reactive subacromial bursitis and persistent pain collectively manifesting as clinical impingement syndrome. The elucidation of this sequential cause-effect relationship was made possible by the complementary use of MRI and CT, which together enabled a comprehensive evaluation of both soft tissue and osseous pathology and clarified the interrelated mechanisms underlying the patient's symptoms.

When contextualized within contemporary literature, two aspects render this case clinically salient. First, it illustrates that osseous injury within the spectrum of anterior shoulder instability is not only relevant for predicting recurrent dislocation risk but may also serve as a structural substrate for secondary subacromial impingement. Second, as emphasized in the 2024 review by Zinner et al., the presence of glenoid and humeral bone defects is associated with higher rates of recurrent instability and failure of arthroscopic stabilization, underscoring the critical importance of precise quantification of bone loss in determining optimal treatment strategies [2]. The combined pathology observed in our patient extends this concept further by demonstrating that glenoid bone defects may contribute not only to instability but also to superior humeral migration and increased impingement risk. Thus, structural bone loss may represent a shared mechanistic pathway linking instability and secondary rotator cuff pathology.

From an imaging strategy perspective, this case provides a clinically nuanced answer to the question of whether a single imaging modality is sufficient for management planning. Although a 2025 meta-analysis demonstrated that MRI measurements of glenoid bone fracture/loss may be comparable to CT in quantitative assessment [4], the principal value of CT in this patient was not limited to measurement accuracy. Rather, CT provided superior delineation of articular surface displacement, fragment morphology, and cortical contour deformity. In this context, CT was not employed as an alternative modality but as a complementary tool for detailed morphological characterization. Such an approach is particularly advantageous in fractures involving articular surface deformation, where precise visualization of osseous architecture informs surgical planning, risk stratification, and therapeutic decision-making.

Regarding the impingement component, the clinical significance of reduced AHD has increasingly been discussed in recent literature as a potential biomarker of rotator cuff integrity. A 2025 systematic review demonstrated an association between decreased AHD and both the presence and severity of rotator cuff tears, and further suggested that AHD should be interpreted not solely as a static parameter but as a dynamic variable influenced by arm elevation [3]. In our patient, partial superior migration of the humeral head and reduced AHD were observed in conjunction with supraspinatus tendon edema and partial tearing. This strengthens the correlation between mechanical compression and clinical symptoms and supports the post-traumatic mechanical nature of the impingement

process. The sensitivity of MRI for detecting supraspinatus pathology and identifying impingement risk factors has also been highlighted in prior studies. A 2022 clinicoradiological investigation demonstrated a statistically significant association between a history of shoulder dislocation and the presence of impingement syndrome and supraspinatus tendon pathology [5]. Moreover, reduced AHD was shown to correlate with tear severity. These findings align with the present case, in which trauma and recurrent instability appear to have contributed to supraspinatus tendinopathy and partial tearing. MRI effectively translated these otherwise "invisible" soft tissue alterations into radiologically demonstrable pathology.

Based on this case, a practical diagnostic algorithm may be proposed. In patients with persistent nocturnal pain and discomfort during overhead movement following trauma, despite apparent reduction of dislocation, MRI should be prioritized as the initial imaging modality. MRI is optimal for detecting intratendinous edema, partial tearing, subacromial bursitis, and bone marrow loss. If MRI reveals irregularity of the glenoid contour, suspicion of inferior glenoid fracture, articular surface deformation, or osseous components suggestive of instability, CT should be performed as a second-step investigation, despite that some investigators suggest CT as first-line diagnostic tool [6]. In this setting, CT more accurately defines articular displacement, deformity extent, and detailed osseous morphology, thereby refining therapeutic planning. This two-step approach may be viewed as a practical, condition-based, and resource-efficient strategy addressing the diagnostic variability highlighted in the 2024 ESSKA–ESA consensus [1]. MRI should first be employed for comprehensive soft tissue assessment and evaluation of bone marrow changes, followed by targeted CT for detailed cortical and articular surface analysis when structural deformity is suspected [4].

Limitations

As this diagnostic sequence is derived from a single patient observation, caution must be exercised in generalizing the findings. Future prospective studies should evaluate the prognostic significance of superior humeral migration in patients with recurrent instability and glenoid fractures, including both static and dynamic AHD measurements. Additionally, the relationship between AHD reduction and progression of supraspinatus pathology, as well as the impact of MRI-CT sequencing on clinical outcomes (pain duration, rehabilitation time, and surgical necessity), warrants systematic investigation. In light of the methodological heterogeneity emphasized in the 2025 systematic review on AHD, our findings may also contribute to the development of standardized measurement protocols and improved imaging quality control in future research.

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