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Imaging in shoulder instability with focus on identifying and measuring bone loss: A narrative review

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ABSTRACT

Bone loss is a key burning issue in shoulder instability, mainly because its presence or the lack of it can significantly swing the surgical pendulum from an open bony augmentation to a standard arthroscopic soft tissue repair, respectively. Each of these surgeries has its own separate technical challenges and a separate recovery protocol hence, it behoves upon the surgeon to be able to precisely calculate the amount of bone loss pre-operatively, to assist in clinical decision making. We review the recent literature studying the commonly used imaging methods for calculating bone loss in shoulder instability, to enable the reader in integrating these concepts in their practice.

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1. Introduction

The shoulder is the most commonly dislocated large joint of the human body, with an estimated incidence of 1–2% of the population and the majority of these, to the tune of 90–95%, are in the anterior direction.[1] Glenohumeral instability (GHI) is associated with a recurrence rate ranging from 30 to 90%.[2–4] Glenoid bone loss occurs in up to 90% of patients with recurrent GHI.[5] It is generally agreed upon that an anterior glenoid bone width loss in excess of 25% is a marker for poor results with just a soft tissue procedure.[6–12] It is important to note that the threshold for glenoid width loss and surface area loss as measured by the best fit circle are different, the latter amounting to 20%.[13] The Hill-Sachs lesion, first reported by Hill and Sachs in 1940,[14] is a depression created in the soft bone of the posterolateral aspect of the humeral head, when it collides against the hard anterior glenoid cortical rim.[15] The incidence of Hill-Sachs lesions has been reported to be as high as 93% in patients with recurrent GHI.[16] Bipolar lesions, involving both the anterior glenoid and the humeral head, occur in upto 62% of anterior GHI patients.[17]

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The less common posterior dislocation of the shoulder also presents with it's own unique spectrum of bone loss, the posterior glenoid bone loss and bone loss in the antero-superior portion of the humeral head, the Reverse Hill-Sachs Lesion (RHSL). RHSL's are also called Malgaigne lesions as they were first described by the 19th century French surgeon Joseph-Francois Malgaigne.[18] Bipolar bony defects are also described for posterior shoulder instability, with a reported incidence of 20-30%.[18,19]

2. Current popular methods of measurement

CT with 3D reconstruction is emerging as the method of choice for the pre-operative assessment of bone loss in a shoulder instability scenario. The commonly used methods for calculating glenoid bone loss are:

1) Calculating the percentage of glenoid width loss on a 2D view of the glenoid, known as the Griffiths index.[20]
2) Calculating the percentage of glenoid surface area loss on a 3D CT en face view of the glenoid using data from the opposite or ipsilateral glenoid, known as the Pico method.[21]
3) Calculating the percentage of glenoid width loss on a 3D CT en face view of the glenoid by drawing a circle on the inferior glenoid, known as the Sugaya method.[5]

The Sugaya method requires the presence of an intact posterior and inferior rim of the glenoid[5] and is thus prone to error compared to the Pico method that takes the size of the contralateral glenoid into account. In a shoulder CT scan, both shoulders are simultaneously irradiated and it is just a matter of requesting the radiologist to acquire data from the opposite shoulder for these measurements. The guidelines for measurements and the critical thresholds, for the Hill-Sachs lesions and RHSL's are less clear.[13]

Surgeons sometimes like to base their decisions on measurements obtained intra-operatively during arthroscopy. It is important to note that arthroscopic measurement of bone loss is prone to error.[13] One study estimated that the defect size measured arthroscopically, overestimated the actual size measured on a 3D CT by a whopping 55%.[22] Arthroscopic intraoperative measurements rely on the bare spot technique. The bare spot may not always be in the centre of the glenoid, in most instances it lies closer to the anterior edge, leading to overestimation of the defect size.[23–25] The spot may not actually be a discrete spot, but an area ranging in size from 2.4 to 9 mm, making centre point estimation difficult.[26]

3. Other emerging methods

The curvature of the glenoid has been studied as a causative factor for recurrent anterior instability. Unstable shoulders were found to have flatter glenoid profile than controls, in the anteroposterior and superoinferior directions as measured on a 3D CT reformatted image.[27] Glenoid version, especially excess retroversion has been associated with an increased incidence of posterior instability.[28,29] Excess retroversion has also been linked with contralateral shoulder posterior instability.[29]

4. X-ray

Plain radiography is the most popular and readily available modality of initial investigation for any orthopaedic condition. Standard X-ray views (true AP and axillary) were found to have lower accuracy and reliability in calculating glenoid bone loss.[10,30–32] Plain X-rays are useful as a good screening tool for suspecting bone loss, both at the glenoid and humeral ends.[13]

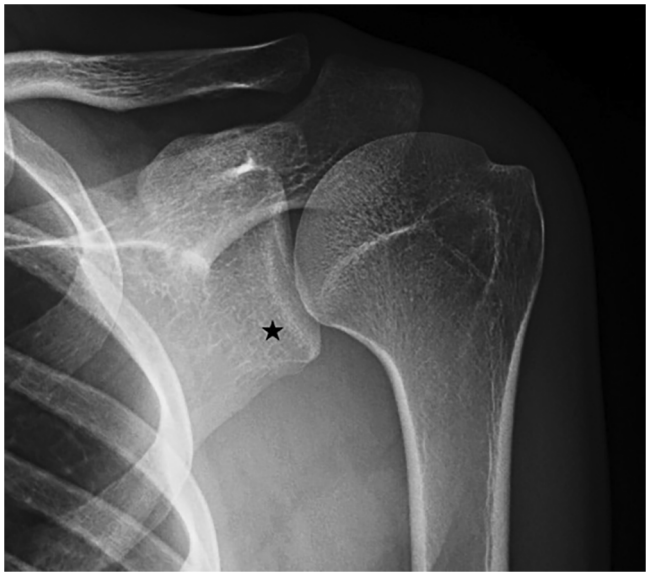

Fig. 1. Normal true AP view of the left shoulder of a recurrent anterior instability patient. Black asterix marks the normal double contour sclerotic line seen in the inferior portion of the glenoid in a situation where there is no bone loss.

4.1. Glenoid

In a true AP view, also known as the Grashey view (Fig. 1), loss of the sclerotic line of the glenoid, for more than 5 mm from the inferior glenoid edge (Fig. 2), has good predictive value in detecting significant anterior glenoid bone loss.[32] This was found to be independent of lesions of the posterior glenoid rim.[32] Specialised views like the Bernageau profile view had better accuracy and reliability scores in detecting and calculating glenoid bone loss.[13,33,34]

The true AP view is taken by positioning the patient's thorax at an angle of 35–45 degrees from the coronal plane, keeping the arm

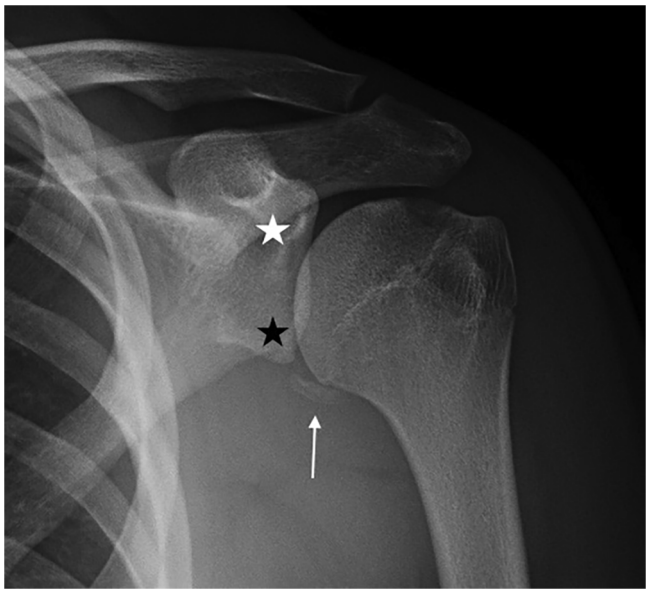

Fig. 2. True AP view showing loss of double cortical line at the glenoid of the left shoulder in a recurrent anterior instability patient. The black asterix marks the loss of the double contour of the normally sclerotic anteroinferior rim of the glenoid. The white asterix denotes the beginning of the normal cortical outline in the anterosuperior cortex. The white arrow points to a free floating bone piece in the axillary recess.