Clinical outcomes of anterior glenohumeral joint dislocation

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Abstract

Background:
Anterior glenohumeral joint dislocation during sports activities or social life considers one of the most commonly seen pathologies in orthopedic traumatology clinical practice. The prevalence of anterior glenohumeral joint dislocation has been reported as 2%. The glenohumeral joint has been reported as the most commonly dislocated synovial joint of the human body. Forced abduction and external rotation of the shoulder can result in anterior dislocation and causing instability.
Objective: To evaluate the clinical and the radiological results of patients with recurrent traumatic anterior shoulder instability treated with Latarjet procedure.
Conclusion: The open Latarjet procedure has confirmed to be an effective and efficient procedure for shoulder stabilization.

Key Words: Anterior Shoulder, glenohumeral joint, Latarjet.

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Introduction

Glenohumeral joint is the most frequent dislocated joint and constitute about 50 % of all major joint dislocations, with anterior shoulder dislocation being the commonest. The glenohumeral joint is an unstable joint because of the shallow glenoid cavity that only articulates with a small part of the humeral head. The glenohumeral joint may dislocate forward, backward, downward, and may be completely or partially, but anteriorly is the commonest. Fibrous tissue that associates the bones can be stretched or torn, causing dislocation complication. It requires a strong force, like a blow to the shoulder to pull the bones out of place. Extreme rotation can stare the humeral head out of its socket. Contact sports injuries often lead to a dislocated shoulder. Also, trauma from motor vehicle accidents and falls are a common source of dislocation [1].

Glenohumeral joint instability occurs among a lot of activities and age groups. The reported incidence of acute traumatic shoulder instability varies from 8.2/100,000 individual-years to 23.9/100,000 individual-years in the general population, with an estimated prevalence of 1.7% [2]. Once a dislocation happens, the shoulder becomes less stable and manifests the tendency to re-dislocate. Rowe reported a high recurrence rate about 92 percent [3]. Younger patients are more liable to recurrent shoulder dislocations. For example, a study showed that 66% of individuals from 12 to 22 years old at the time of their first dislocation had 1 or more recurrences, whereas 24% of individuals from 30 to 40 years old their initial dislocation experienced recurrences at 10-year follow-up. Furthermore, the presence of a glenoid bone defect is an important factor in instability; therefore, the size and anatomy of glenoid bone defects must be carefully assessed. **Burkhart and De Beer** reported that the existence of a glenoid bone defect resulted in a risk of recurrence that varied from 4% to 68% [4].

Types of Dislocation [5-8]

Anterior dislocation is the most common, constituting up to 97% of all glenohumeral joint dislocations.

- Mechanism of injury is mostly a blow to an abducted, externally rotated and extended extremity.
- It may also happen with posterior humerus force or fall on an outstretched arm.
- On exam, the arm is abducted and externally rotated usually, and the acromion appears prominent
- There are accompanied injuries in up 40% of anterior dislocations including nerve damage, tears and fractures accompanied with the labrum, glenoid fossa, and/or humeral head.

Posterior dislocations constituting about 2% to 4% of glenohumeral joint dislocations.

- The injury is usually a hit to the anterior shoulder and axial loading of the adducted internally rotated arm.
- It also may be an outcome of violent muscle contractions (seizures, electrocution).
- On exam, the arm is usually grasped in adduction, and internal rotation and patient is incapable to rotate externally.
- Higher risk of associated injuries like fractures of surgical neck or tuberosity, reverse Hill-Sachs lesions (also named a Mclaughlin lesion, it is an impaction fracture of antero-medial aspect of humeral head), and labrum & rotator cuff injuries.

Inferior dislocations (also known as luxatio erecta) are the least common type (less than 1%).

- Usually occurs as a result of hyperabduction or with axial loading on the abducted arm.
- On exam, the arm is grasped above and behind the head and patient is incapable to adduct arm.
- Often accompanied by nerve injury, rotator cuff injury, tears in the internal capsule, and the highest incidence of axillary nerve and artery injury among all shoulder injuries.

Clinical evaluation

• History

An assessment of patient history should involve information about the following [9,10]:

- Age, activity level, sports participation and hand dominance.
- Recurrence or re-injury.
- Time to re-injury or recurrence.
- Continuous pain
- Subjective instability.
- Patient satisfaction.
- Complications (**e.g.,** fracture).

- Injury severity.
- First dislocations due to high-impact trauma in older people may be associated with shoulder fractures, which could displace if they are not detected prior to attempting reduction.
- Axillary nerve injuries can occur in up to 12.5% of dislocations. Performing a historical examination is important because it may aid in decision- making regarding whether surgical treatment should be recommended.

- **Physical examination** (11)

- Comparative evaluation of both shoulders.
- Any visible deformity or muscle atrophy with respect to contralateral shoulder, or any scar tissue related to past trauma or surgery are important and simply recognizable by a careful inspection.
- Palpation should include the bony prominences and tonus of the shoulder and scapular muscles.
- Specific attention should be given to the functioning of the axillary nerve and the rotator cuff, especially in elderly people. Additionally, scapular dyskinesia, global laxity, core stability and balance should be assessed.
- Active and passive range of motion in all planes should be measured and noted for both shoulders in every patient.

- **Clinical Assessment**

The most commonly used tests for detecting anterior shoulder instability include the positive apprehension test, the relocation test and the anterior drawer test, sulcus, load and shift tests.

- **Classification of glenoid rim fracture**

Table (1): Bigliani Classification of Glenoid Rim Fractures (12).

I	Ununited fragment attached to separated labrum
II	Malunited fragment detached from labrum
IIIA	Anterior glenoid deficiency: <25%
IIIB	Anterior glenoid deficiency: >25%

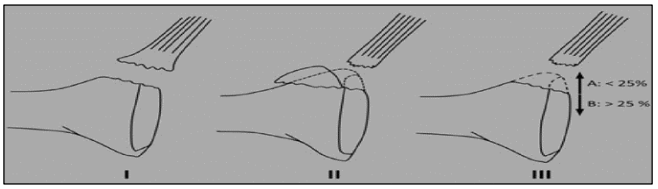

Figure (1): Classification of bony Bankart lesions according to **Bigliani et al.** Avulsion fracture with attached capsule, II medially displaced fragment malunited to the glenoid rim, III erosion of the glenoid with less **(A)** or more **(B)** than 25 % deficiency of the glenoid diameter (12).

Radiological assessment

Glenoid imaging

Radiography

Routine radiographic views (true AP and axillary) were found to have reduced accuracy and reliability in calculating glenoid bone loss (12) (13). On the other hand, special radiographic views particularly the Bernageau profile view **(Fig. 2)**, had better accuracy and reliability scores (14,15,16).

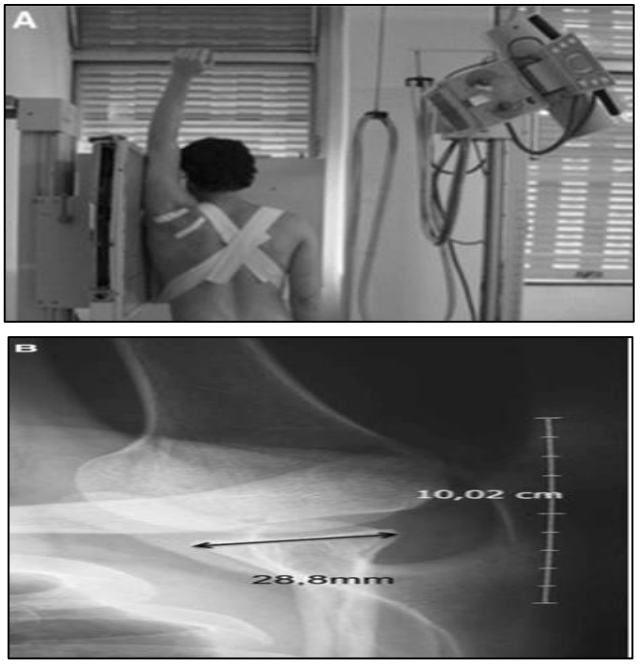

Figure (2): Bernageau Radiography. **A)** Patient positioning. **B)** Antero-posterior Glenoid width measurement on this view **(Murachovsky et al.)** (14).

However, this technique requires fluoroscopic control in order to obtain optimal diagnosable images and, therefore, radiation exposure is an unignorable issue by the use of fluoroscopy. In the meantime, we have developed a modified Bernageau method with the patient lying on their

axilla in their most relaxed position, which we called the "TV watching position **(Fig. 3).** In this method, clear X-ray images can be obtained more easily with a high probability of ascertaining bony pathology without using fluoroscopic imaging **(Fig. 4)** [17,18]. **Murachovsky and coworkers** quantified glenoid bone loss by measuring the distance between the posterior and anterior glenoid rim on Bernageau images and concluded that this quantification provides similar result with that obtained from 3DCT [19]. However, although clearly obtained Bernageau view is useful similar to axial images of 2-dimensionally reconstructed computed tomography (2DCT) for quantifying glenoid anterior-posterior bone loss [20,21], it is still difficult for surgeons to predict and understand glenoid shape as well as measure the area of glenoid bone loss.

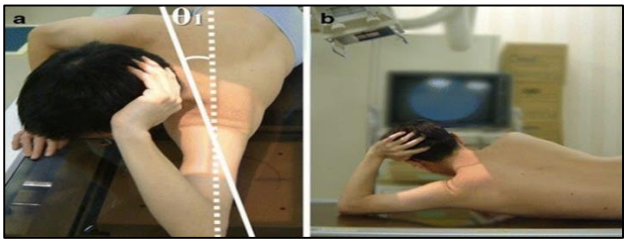

Figure (3): A modified Bernageau method. Patients lie on their axilla in their most relaxed position. In this position, scapula needs to incline 5° to the vertical line **(a).** Then the incident X-ray needs to be aimed craniocaudally with15°–20° of inclination to the vertical line **(b).** With permission from Sugaya H. Chapter 14. Instability with bone loss. In: Angelo, Esch, Ryu, editors. AANA Advanced Arthroscopy: The Shoulder. Philadelphia: Elsevier; 2010. P. 136–46 [17]

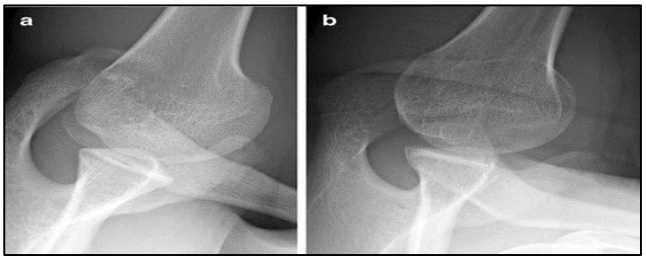

Figure (4): X-ray images obtained by the modified Bernageau methods. **A,** Normal glenoid (a black arrow indicates normal anterior glenoid contour). **B,** Glenoid with bone defect (a white arrow indicates the defect) [18].

Computed tomography

Surface area loss measurements

The surface area loss methods different in the manner to which a circle is approximated to the inferior glenoid based on either contralateral glenoid or intact posteroinferior margins of injured glenoid, but according to **Saliken et al**. Will be grouped together as best-fit circle surface area methods (BCSA) **(Fig.5)** [22]. The Pico Method **(Fig. 6)** is considered a BCSA based on the contralateral glenoid described by **Baudi et al.** [23] The Pico Method has clarified good inter-observer (ICC 0.90) and intra-observer (ICC 0.94, 0.96-1.0) reliability as well as a low coefficient of variation (2.2-2.5 %) [24-26].

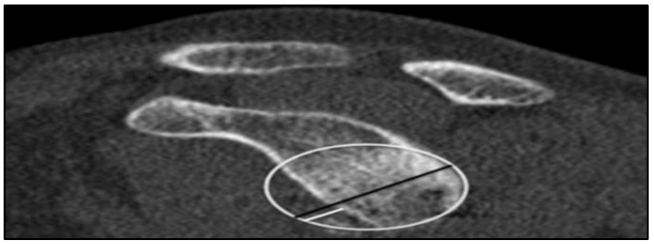

Figure (5): Best-Fit Circle Width Loss. A circle is approximated to the inferior glenoid and the expected diameter of the circle is compared to the defect width [26].

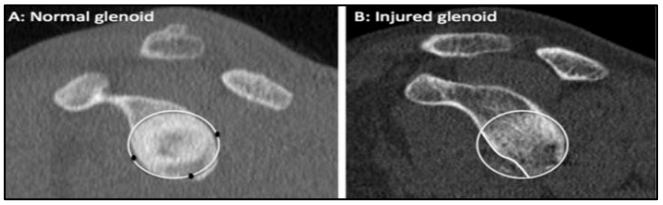

Figure (6): Pico Method. The original description of Pico Method included determining the circumference of the contralateral, normal inferior glenoid circle established on the intact 3–9 o'clock margin, transferring the circle to the injured glenoid, and manually tracing out the glenoid defect and using software to calculate surface area bone loss. Note that the Pico Method has also been used with the intact 6 o'clock-9 o'clock postero-inferior margin of the injured glenoid to determine the pre-injury glenoid circle (adapted from **Bois et al**) [27].

Width loss measurements

Griffith et al. Performed the Griffith Index using bilateral shoulder CT scans **(Fig. 7)** as one of the first width loss techniques and it has been established to be reliable and accurate [28, 29,30]. A

method similar to the Griffith Index, called the Glenoid Index **(Fig. 8)** was demonstrated to accurately predict if a patient would need a Latarjet procedure 96 % of the time [31].

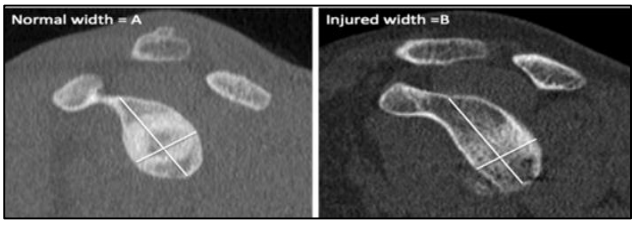

Figure (7): Griffith Index. Width measurements are made perpendicular to a line through the vertical axis of the glenoid and compared to the glenoid (B/A x 100) to determine percent width loss (adapted from **Griffith et al.**) [29].

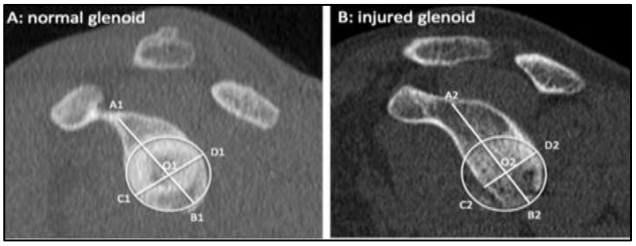

Figure (8): Glenoid Index. The Glenoid Index is calculated from injured width/normal width. Chuang et al. Use the parameters of the normal glenoid to normalize the pre-injury glenoid width accounting for any height difference between shoulders. They then compare the ratio of post-injury width to pre-injury width. Although demonstrated here using 2D CT, the description of the Glenoid Index by Chuang et al. Involves 3DCT. (Adapted from **Chuang et al.**) [31].

There is no doubt that 3DCT is the most important imaging study for assessing glenoid morphology accurately **(Fig. 9)** [32]. Preoperative 3DCT provides the following benefits: first, surgeons can recognize glenoid shape and the degree of bone loss intuitively at a glance; second, accurate quantification of bone loss can be possible by using an estimated inferior circle on the en face view of 3DCT; last, surgeons can easily assess the size and shape of the bony fragment in shoulders with bony Bankart lesion. This information greatly facilitates surgeons performing arthroscopic bony Bankart repair since normally it is difficult to identify configuration of the bony fragment during surgery because the bone fragment is embedded in the surrounding soft tissue [33-35].

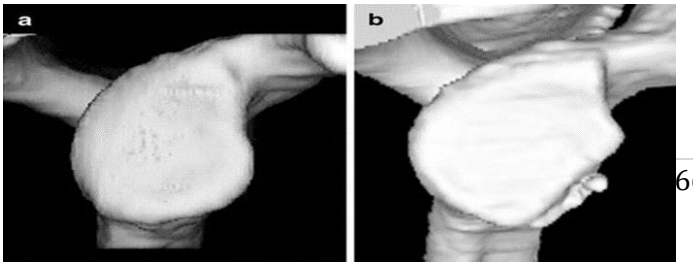

Figure (9): 3DCT images with humeral head digitally subtracted. **A,** Normal glenoid. **B,** Glenoid with bone defect [32].

Magnetic Resonance Imaging

MR imaging is used to assess the soft tissue mainly, (such as, labrum, capsule, and rotator cuff) in shoulder dislocation. Because only a single shoulder is imaged with MR imaging, side-to-side comparison is not practical, therefor; a best-fit circle method (also known as PICO method) was used [36]. MRI accuracy relays on obtaining a good quality dedicated en-face view of the glenoid surface. This high-resolution image en-face through the glenoid surface should be planned from axial, coronal and sagittal images [37]. Depending on standard sagittal images may not always provide a good en face view through the glenoid. Once a high quality en face view has been recognized, one should search for an anterior straight-line at first. If there is no anterior straight-line to the anterior glenoid rim, there is no GBL present and no further measurements needed. If an anterior straight-line is present, then a need to proceed with GBL measurements **(Fig. 10).** As the contralateral shoulder is not available for comparison, a best fit circle method is used. This circle should be planned to fit as close as possible to the posterior and inferior margins of the inferior glenoid. The diameter of the circle approximates to normal glenoid shape **(Figure 11)** [37].

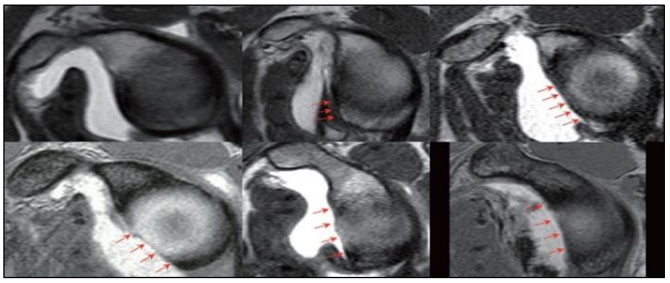

Figure (10): High-resolution MR arthrogram double oblique en face views of the glenoid in a patient with no glenoid bone loss **(A)** and in

patients with varying severity GBL **(B, C, D, E, F).** As glenoid bone loss becomes more severe, the anterior straight-line lengthens (arrows). With very severe glenoid bone loss, the glenoid develops an anterior concavity **(F)**. MR, magnetic resonance; GBL, glenoid bone loss [37].

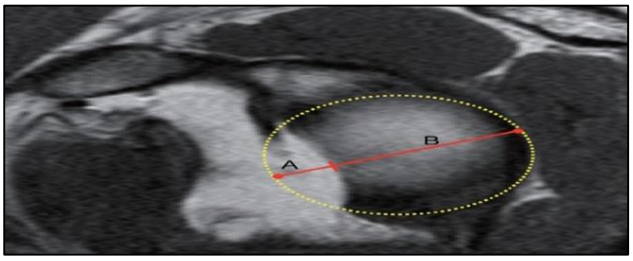

Figure (11): Measurement of GBL using the best fit circle method on MRI. The circle is placed so as to contact the posterior and inferior margins of the glenoid on a high-resolution double oblique image obtained specifically en face to the glenoid. The inferior part of the glenoid does approximate to a circle. GBL = A/A+B. The diameter line should be drawn at right angles to the long axis of the glenoid and not horizontally. GBL, glenoid bone loss; MRI, magnetic resonance imaging [37].

Hill-Sachs imaging
Radiography

According to Ito et al. Patients positioned supine with the shoulder in 135° flexion and 15° of internal rotation to get a view of the posterolateral notch and calculate depth and width of the Hill-Sachs lesion but accuracy was not explored [38]. **Kralinger et al.** Calculated a Hill-Sachs Quotient **(Fig. 12)** by calculating depth and width on a true AP radiograph with the arm in 60° internal rotation and length on a Bernageau profile [39]. Rate of recurrence was recognized to be higher with a larger quotient (Grade I 23.3 %; grade II 16.2 %; grade III 66.7%) although the reliability and accuracy have not been tested. A technique of performing a ratio using the Hill-Sachs defect depth and humeral head radius (d/R) on a true AP radiograph with the arm in internal rotation has been established to be reliable and clinically relevant **(Fig. 13).**

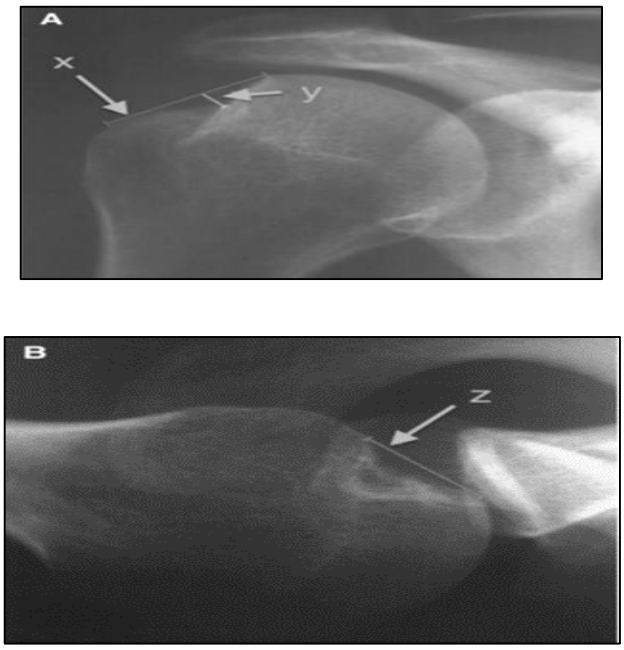

Figure (12): Hill-Sachs Quotient. **A)** True AP x-ray of the humerus with the shoulder in 60° internal rotation to measure the width (x) and depth (y) of the lesion. **B)** Bernageau profile view to measure the length (z) of the lesion. The Hill-Sachs Quotient is calculated by multiplying x, y and z. Grade: I <1.5 cm^2; II 1.5-2.5 cm2; III > 2.5 cm2 (Adapted from **Kralinger et al.** [39])

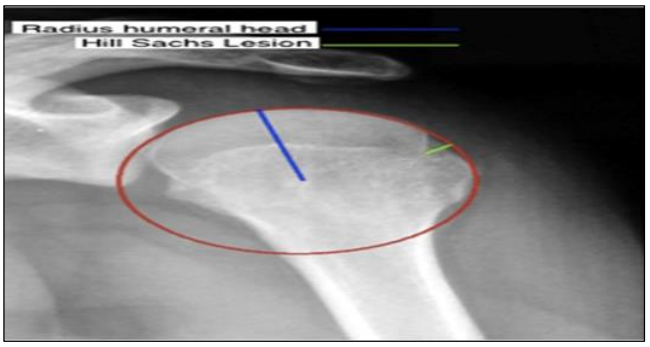

Figure (13): Humeral head depth: radius ratio (d/R). On a true AP x-ray with internal rotation, a circle template is fit to the contour of the articular surface of the humeral head and the depth of Hill-Sachs bone loss is measured. (Adapted from **Sommaire et al.** [40])

Latarjet: The Latarjet procedure was primarily described by **Michael Latarjet** in 1954 and modified later on to the Latarjet-Bristow procedure by **Arthur Helfet** in 1958 [41]). There are numerous described variations of the procedure, but the general technique includes transecting the coracoid at its base and transferring the graft intra-articular

to the glenoid neck with one or two screw fixations. The pectoralis minor is separated from the coracoid, and a portion of the coracoacromial ligament is preserved for capsular repair. There are currently two commonly used techniques for a coracoid transfer; traditional Latarjet and congruent arc [42].

The traditional Latarjet includes fixation of the inferior surface of the coracoid to the anterior surface of the glenoid. This technique provides a large surface area for fixation and bone healing, but leaves less anterior to posterior distance to fill the glenoid defect and restore glenoid width [42].

The congruent arc technique includes fixation of the medial aspect of the coracoid to the glenoid and is complemented by rotating the coracoid 90°. This performs a congruent surface between the inferior surface of the coracoid and the articular surface of the glenoid [43].

The congruent arc technique applies more anterior to posterior distance to restore glenoid width and can be used to fill larger glenoid defects [42]. In addition, it more closely matches the radius of curvature of the native glenoid [44].

However, this presents at the cost of less surface area for fixation between the glenoid and coracoid [42]. The Latarjet procedure remains the gold standard technique for treating anterior glenoid bone loss, and its success is evidenced by its low long-term failure rate. Several studies suggest excellent outcomes for both traditional and congruent arc techniques; however, there have been no clinical studies comparing the two methods [45].

Five of the seven studies performing a vertical tenotomy split only two-thirds of the tendon and reflected the upper half into an L-shape. Although a statistical analysis was not performed, the subscapularis split appears to maintain postoperative external rotation in comparison to a vertical tenotomy. The coracoid graft was most commonly placed flush with glenoid rim and less commonly placed medial to the glenoid rim **(figure 14).** Unfortunately, a comparative analysis of recurrent dislocations established on fixation site could not be accurately completed due to biased study results. Only a few studies showed graft position and orientation, making analysis difficult [46].

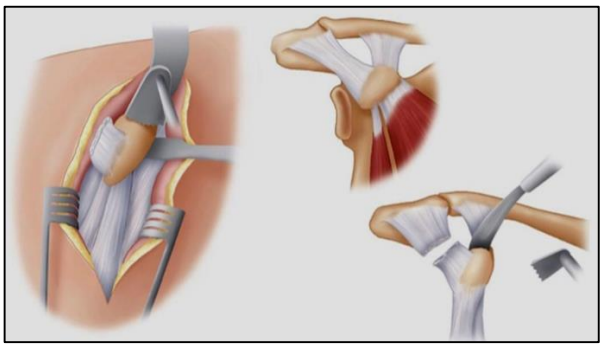

Figure (14): Coracoid osteotomy. The pectoralis minor is released and the inferior aspect of the coracoid is prepared with a periosteal elevator. With the arm adducted and internally rotated an osteotomy is performed from medial to lateral with a 90° saw at the knee of the coracoid, which is distal to the coracoclavicular ligament [46].

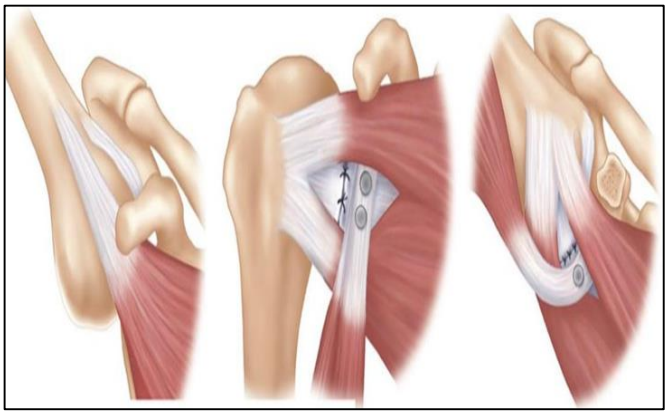

Figure (15): Triple blocking. **(A)** Normal position of subscapularis providing no inferior support in provocative position of the shoulder (i.e., abduction and external rotation); **(B)** completed Latarjet with arm in neutral position. Anterior bone block is visualized with the capsule repaired to CAL; **(C)** the inferior displacement of the subscapularis by the conjoint tendon creates a sling beneath the anteroinferior capsule, especially in the abducted, externally rotated position of the arm. CAL, coracoacromial ligament [47].

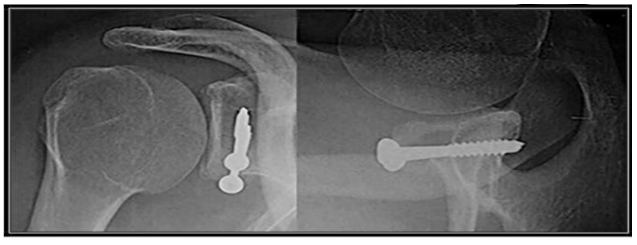

Figure (16): post-operative radiographs. The graft is well positioned with no overhang and screws parallel to the articular surface [47].

Complications

Coracoid transfer is a challenging procedure accompanied with a broad range and significant incidence of complications. A detailed consideration of anatomy and meticulous attention to technical detail, particularly graft placement, is key to decreasing complications. Understanding the complications associated with these procedures can lower their occurrence and is important for surgical training and in applying informed consent for patients in whom the operation is planned [48].

Despite the showed success of the Latarjet procedure for treatment of glenoid bone loss and recurrent anterior shoulder instability, there is a rarity of literature concerned specifically to complications of this procedure. Allain and colleagues showed a 7% complication rate in ninety-five patients treated with the Latarjet procedure; the complications involved infection, frozen shoulder, and humeral fracture (after manipulation) [49].

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