Review Article

Chronic anterior shoulder instability with bone loss: a practical approach

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Abstract: The stability of the glenohumeral joint, known for its remarkable mobility, relies on several factors, including the congruency of the joint's bones and the integrity of capsulolabral structures, encompassing the labrum, the capsule, and the glenohumeral ligaments. In cases of anterior shoulder instability, bone lesions are a common occurrence, most frequently involving glenoid bone loss and Hill-Sachs lesions. When both glenoid and humeral bone lesions coexist, the isolated Bankart procedure has exhibited a significant rate of failure. In such instances, the Latarjet procedure, especially when bone loss is present, retains its position as the gold standard, thanks to its consistent success in both short- and long-term outcomes. Recent advancements in research have explored alternative strategies to address bone loss, including the Remplissage procedure for humeral bone deficits and the use of bone block grafts to manage glenoid bone lesions, with a focus on achieving more anatomical techniques. However, it's crucial to recognize that, beyond bone loss, a multitude of intrinsic and extrinsic factors come into play when determining the most suitable treatment. The patient's profile, including factors like constitutional laxity and activity level, must be carefully considered in the decision-making process. The Latarjet procedure maintains its esteemed status as a benchmark in the field, thanks to its consistent excellence in both short- and long-term results. This article seeks to provide insights into the roles and placement of various surgical techniques within the context of chronic anterior shoulder instability, taking into account the intricate interplay of factors that influence treatment decisions.

Keywords: Bone loss; Bankart; Latarjet; Remplissage; bone block

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Introduction

The shoulder joint is unique because of its large range of motion and anatomical complexity. Its configuration and biomechanics allow for great mobility, but also make it more prone to instability (1). The stability of this joint, considered one of the most mobile joints in the human body, depends on several factors (*Figure 1*), including:

- Joint congruency, which in the case of the glenohumeral joint is quite limited. Only 25% to 30% of the humeral head is in contact with the glenoid surface, sometimes the position. It is this low congruence, combined with sphericity, that allows for great mobility.
- The capsulolabral structures including the labrum, the capsule, and the capsular reinforcements that are

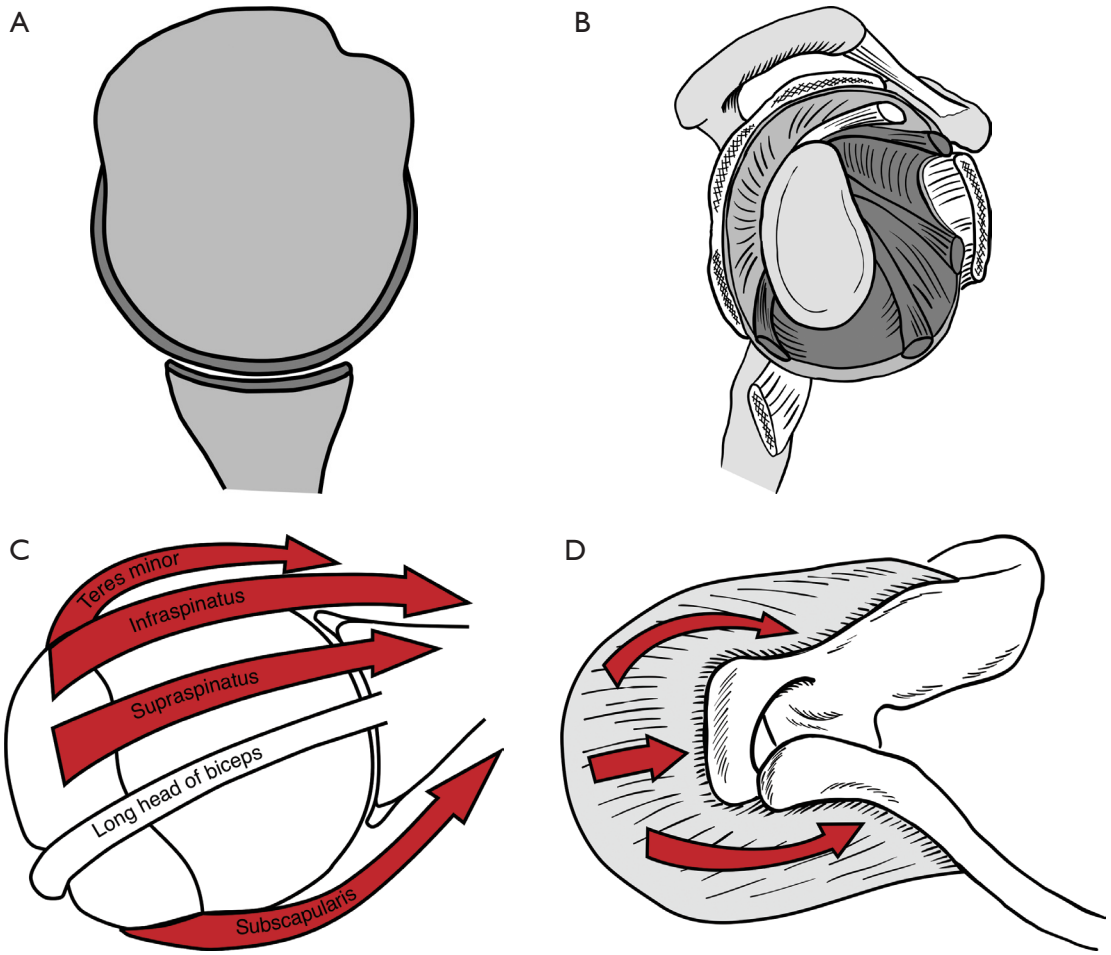

Figure 1 Factors contributing to glenohumeral stability. (A) Joint congruency. Only 25% to 30% of the humeral head is in contact with the glenoid surface, sometimes the position. (B) The capsulolabral structures including the labrum, the capsule, and the capsular reinforcements that are the glenohumeral ligaments. (C) The rotator cuff muscles: including the subscapularis muscle, the supraspinatus muscle, the infraspinatus muscle, and the teres minor. (D) The intra-articular negative (effect indicated by the red arrows) pressure which plays a secondary role.

the glenohumeral ligaments.

- ❖ The rotator cuff muscles: including the subscapularis muscle, the supraspinatus muscle, the infraspinatus muscle, and the teres minor.
- ❖ The intra-articular negative pressure which plays a secondary role.

The significance of the rotator cuff muscles underscores the critical role of rehabilitation in achieving shoulder stability. However, when it comes to addressing anterior instability, it's essential to emphasize that in the abduction and external rotation (ABER) position, the subscapularis muscle no longer acts as a significant barrier against the anterior displacement of the humeral head. Instead, the control of anterior instability is primarily reliant on the bony and capsuloligamentous structures.

As a result, the restoration of these two factors becomes paramount, particularly in the context of chronic anterior instability (2).

Anatomic lesions in anterior shoulder instability

Soft tissue injuries (Figure 2)

The classic Bankart lesion is well known (3,4). It is an avulsion of the antero-inferior capsulolabral complex with rupture of the periosteal tissue. The Perthes lesion is a

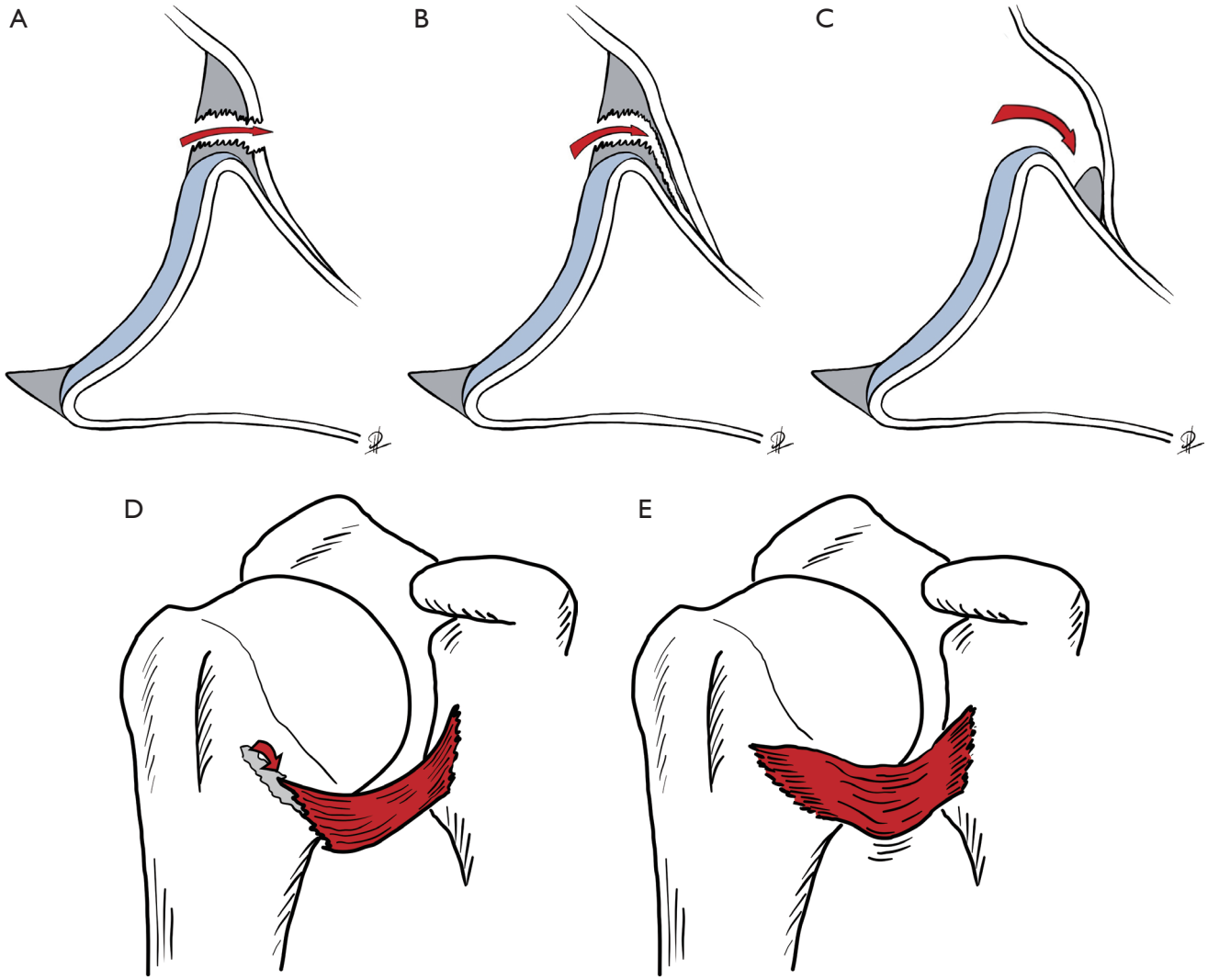

Figure 2 Soft tissue injuries in anterior shoulder instability (the red arrows indicate the location of the lesion). (A) Bankart lesion, avulsion of the antero-inferior capsulolabral complex with rupture of the periosteal tissue. (B) Perthes lesion is a variant in that the periosteum remains intact. (C) ALPSA lesion is a chronic lesion where the labrum detaches and then heals in a more medial position. (D) HAGL lesion. (E) The capsule itself can be damaged with rupture or progressive distension. ALPSA, anterior labral periosteal sleeve avulsion; HAGL, humeral avulsion glenohumeral ligament.

variant in that the periosteum remains intact. The anterior labral periosteal sleeve avulsion (ALPSA) lesion is a chronic lesion where the labrum detaches and then heals in a more medial position. The lesion may be a humeral avulsion glenohumeral ligament (HAGL) lesion. Finally, the capsule itself can be damaged with rupture or progressive distension. This last factor is sometimes difficult to assess but it plays an essential role in instability alongside the other factors.

Bone injuries (Figure 3)

It can occur at the glenoid level or on the humeral head.

In Bony Bankart, acute lesion, the capsulolabral complex is avulsed along with a fragment of anterior glenoid rim bone. The bone deficit can be chronic, either after Bony Bankart or after progressive erosion of the anterior rim of the glenoid.

Bone lesions (5) occurring on the humeral head are summarized in the term Hill-Sachs lesion (formerly called

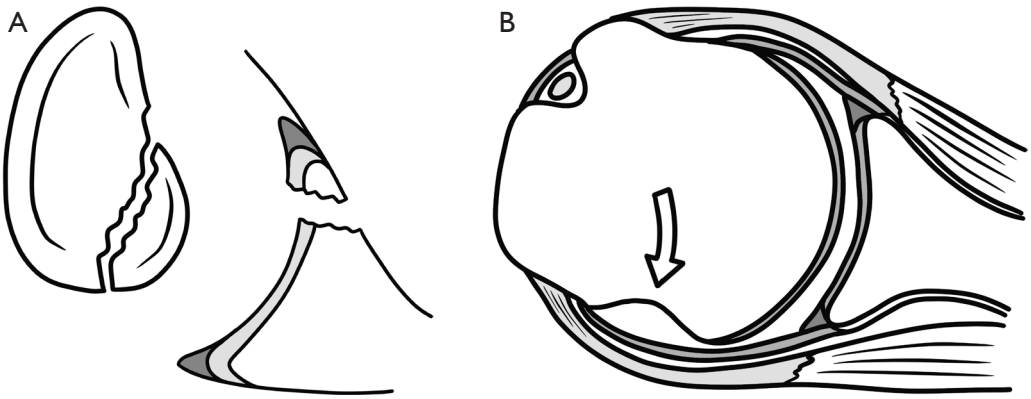

Figure 3 Bone injuries in anterior shoulder instability. (A) Bony Bankart. (B) Hill-Sachs lesion (shown by the white arrow).

Broca and Hartmann lesion or Malgaigne notch). This is a posterior lateral compression fracture on the humeral head which happens during an anterior dislocation when the glenoid anterior rim hits the posterior part of humeral head (6).

Bone injuries epidemiology

Bone lesions are a common occurrence in cases of anterior shoulder instability. On the glenoid side, numerous studies have reported a prevalence ranging from 30% to 80% (4,7-10).

This variability is associated with the sensitivity of the imaging modality employed and the characteristics of the studied population, with particular consideration given to the duration of chronic instability. Research indicates that the prevalence is notably higher in cases of chronic instability compared to instances following the first dislocation, with figures of 86% *vs.* 41%, as observed in Griffith's study (10).

Likewise, Hill-Sachs lesions are frequently observed, and their occurrence tends to escalate in cases of chronic shoulder instability (4,11,12), ranging from 45% to 80%.

Consequently, when both types of lesions are considered together, the presence of bone lesions in the context of anterior shoulder instability is highly common. Prevalence figures vary, with rates typically ranging from 40% to 50% in cases of the first episode of anterior dislocation, and increasing to substantial values between 80% and 95% in instances of chronic instability (8).

Assessment of glenoid and humeral bone loss

Initial assessment of bone lesions involves X-ray imaging. Glenoid contour loss, which is visible on the anteroposterior (AP) radiograph, and Hill-Sachs lesions, which are apparent on the AP view with internal rotation, provide an initial indication of the presence or absence of bone loss. For a more precise evaluation, the Bernageau view has been recognized as a reliable and reproducible technique for identifying and quantifying glenoid bone loss. However, it is important to note that this particular view requires meticulous and accurate execution to yield the best results (8,13). The radiographs do not allow for reliable quantification of the osseous lesion when compared with cross-sectional imaging modalities (14).

For a more accurate evaluation of humeral and glenoid bone loss, magnetic resonance imaging (MRI) or computed tomography (CT) scans are preferred (*Figure 4*). Various techniques have been developed for quantifying glenoid bone loss. Three-dimensional (3D) CT imaging provides a valuable "en face" sagittal view of the glenoid surface, which is particularly useful. Most of the measurement methods for assessing glenoid bone loss employ a width-measurement technique (15) or a "best-fit circle" technique (16).

For assessment of humeral bone loss, a circle is drawn to fit the humeral head allowing to measure the depth and width of the Hill-Sachs (17). Both size and location influence the risk of engagement, with larger and medial Hill-Sachs lesions more likely to engage the glenoid.

The "on-track" and "off-track" concept (18) is a calculation method to predict the risk of engagement, particularly in case of bipolar lesions. While this method is elegant and valuable, it relies on a static analysis, essentially treating the glenohumeral joint as a purely spheroid joint. However, clinical experience has shown that in cases of capsulo-ligamentous laxity, significant anterior translation

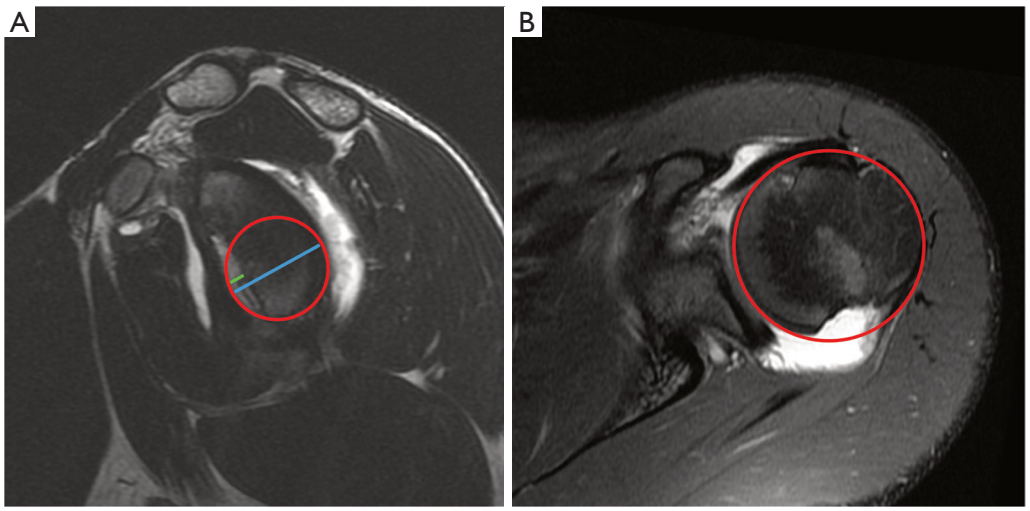

Figure 4 MRI assessment of glenoid and humeral bone loss. (A) Assessment of glenoid bone loss with the "best-fit circle" technique. The red circle represents the best-fit circle. The green line is reported to the blue line to evaluate the percentage of glenoid bone loss. (B) For assessment of humeral bone loss, a circle in red is drawn to fit the humeral head allowing to measure the depth and width of the Hill-Sachs. MRI, magnetic resonance imaging.

can occur. In practice, all Hill-Sachs lesions are potentially "off-track", either through a simple rotational movement or in combination with anterior translation. Given that the existence of a Hill-Sachs lesion indicates that engagement has occurred at least once during the history of anterior shoulder instability, this method is not employed in our daily practice.

Bone lesions should be treated

The 1990s witnessed significant advancements in arthroscopic Bankart techniques, which, for a period, were regarded as the gold standard for addressing anterior instability. However, as initial enthusiasm waned, it became increasingly evident that disregarding bone lesions posed a substantial risk of treatment failures. As such, the publication of Burkhart and De Beer is a milestone (19). They analyzed 194 consecutive arthroscopic Bankart repairs by suture anchor technique performed for traumatic anterior-inferior instability. A total of 101 patients were contact athletes. Significant bone deficit was defined either by an "engaging" Hill-Sachs lesion of the humerus or by an "inverted-pear" glenoid. The incidence of recurrence in the group without bone deficit was 4% whereas it was 67% in the group with bone defect. This difference was even greater if the patients participated in contact sports (6.5% *vs.* 89%).

The literature then largely confirmed this notion of bone lesions as a risk factor for failure after Bankart procedure (20).

Traditionally, the critical bone loss (greater than 20–25%) is considered a contraindication for soft tissue procedures alone due to high clinical failure (19). Recent research has identified the concept of "subcritical" bone loss suggesting that bone augmentation may result in better outcomes for patients with this subcritical bone loss between 13.5% and 17.3% (21,22). Further research will shed light on whether it is necessary to address all bone lesions, regardless of their size. In our clinical practice, we do not differentiate between the concept of critical or subcritical bone loss; instead, we advocate treating any bone lesion that is identified.

Current techniques for the surgical treatment of anterior shoulder instability

Numerous interventions are available for addressing shoulder instability (20). We will only discuss those routinely performed in everyday clinical practice. The Bankart procedure entails the reattachment of the labrum using sutures and anchors. This procedure is typically performed arthroscopically (*Figure 5*).

Repairing a HAGL can be performed using a similar technique at the humeral level.

These procedures are often complemented by capsular retention. However, there are ongoing debates regarding

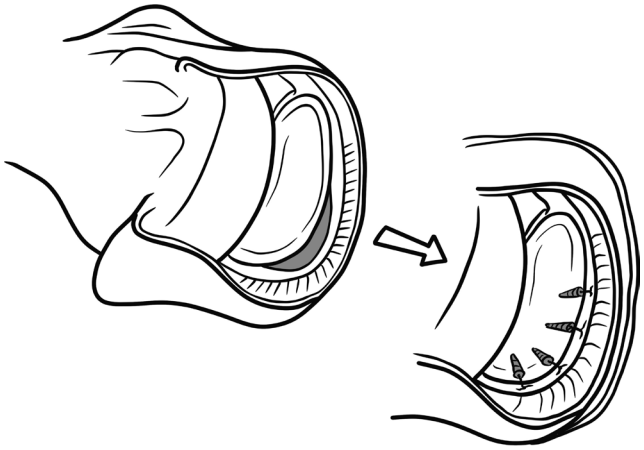

Figure 5 Bankart procedure. The current Bankart procedure entails the reattachment of the labrum using sutures and anchors.

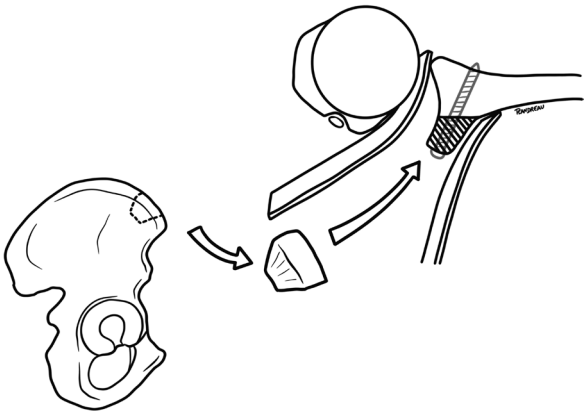

Figure 7 Eden-Hybinette. The Eden-Hybinette procedure involves grafting an iliac bone fragment onto the anterior glenoid rim to restore the AP surface of the glenoid. AP, anteroposterior.

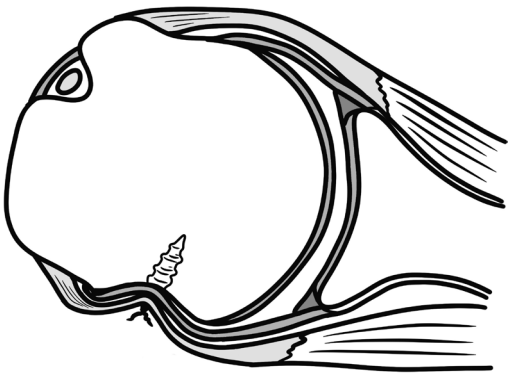

Figure 6 Remplissage procedure. The Remplissage consists in making the Hill-Sachs lesion extra-articular by fixing the posterior capsule in the lesion.

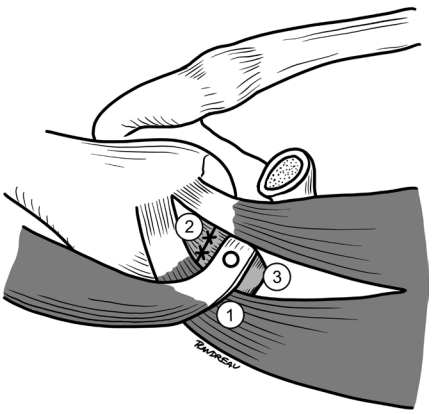

Figure 8 Latarjet procedure with the "triple locking effect": sling effect ①, Bankart effect ②, and bone effect ③.

the effectiveness of capsular plasty in treating anterior instability. Excessive capsular plasty can lead to restricted joint motion. On the other hand, if the capsular tissue's quality is poor, the capsular plasty may not be effective. While capsular retention is a fundamental component of the Bankart procedure, we find it unrealistic to attempt to address joint hyperlaxity solely through arthroscopic capsular plasty.

The Remplissage consists in making the Hill-Sachs lesion extra-articular by fixing the posterior capsule in the lesion (*Figure 6*) (23,24).

The Eden-Hybinette procedure involves grafting an iliac bone fragment onto the anterior glenoid rim to restore the AP surface of the glenoid (*Figure 7*) (25,26). The distal clavicle has been used for reconstruction of the anterior glenoid rim (27). Bone allografts (iliac crest, distal tibial, and xenograft) are now regularly used and the term bone-block is frequently used for these modifications of the Eden-Hybinette procedure (28).

The Latarjet procedure is a transfer of the coracoid process with the attached conjoined tendon to the anteroinferior aspect of the glenoid rim (29). It combines bone grafting, capsular repair, and tendon plasty which create the "triple locking effect": bone effect, Bankart effect, and sling effect (*Figure 8*) (30). The sling effect is particularly important in ABER position, moving the inferior part of the subscapularis muscle distally to control the anterior humeral translation. The Latarjet procedure

Table 1 Surgical approach for chronic anterior shoulder instability

Anatomic lesions	No capsular hyperlaxity and no high-risk activity	Capsular hyperlaxity	High risk activity (contact and collision sport)
Soft tissue glenoid lesion	Bankart	Option 1: Bankart	Option 1: Bankart
		Option 2: Latarjet	Option 2: Latarjet
Soft tissue glenoid lesion + Hill-Sachs lesion	Bankart + Remplissage	Option 1: Bankart + Remplissage	Option 1: Bankart + Remplissage
		Option 2: Latarjet	Option 2: Latarjet
Glenoid bone loss	Option 1: Latarjet	Option 1: Latarjet	Option 1: Latarjet
	Option 2: Bone block	Option 2: Bone block	Option 2: Bone block
Glenoid bone loss + Hill-Sachs lesion	Option 1: Latarjet	Option 1: Latarjet	Option 1: Latarjet + Remplissage
	Option 2: Bone block + Remplissage	Option 2: Bone block + Remplissage	Option 2: Bone block + Remplissage

The selection between option 1 and option 2 will be contingent on several factors, including the extent of the bone defect and the patient's characteristics, encompassing their level of joint laxity and involvement in sports activities.

have the lowest rate of dislocation recurrence and do not seem to increase the risk of osteoarthritis if the bone block is not lateralized (20).

Personalized treatment approach: tailoring interventions to lesion, capsulo-ligamentous status, and patient profile

Chronic anterior shoulder instability is predominantly associated with anatomical abnormalities. It is essential to consider the loss of integrity of the capsule attachment, including lesions like the Bankart or ALPSA lesions on the labrum and HAGL on the humerus, along with bone loss such as glenoid bone loss and Hill-Sachs lesions. Equally significant are the considerations of the joint capsule and its supporting structures, particularly the glenohumeral ligaments (3). Indeed, this capsule can be damaged following episodes of dislocations with progressive distension but it can also be lax by constitution. This capsular laxity is clinically assessed with the Gagey test (31), the importance of external rotation and the assessment of constitutional laxity (Beighton score) (32). It is known that the age of the patient also influences the degree of capsular laxity (9). In parallel, extrinsic dynamic factors can lead to a risk of capsular distension and repeated damage to the repair. Some sport activities lead to capsuloligamentary constraints. The type of sports activity (contact and collision) as well as the level of competition must be taken into account in the overall evaluation (33). At an end stage, epilepsy represents a major extrinsic risk factor for the capsulo-ligamentous structures (34).

Clearly, in addition to soft tissue lesions and bone lesions, the ability of the joint capsule to distend to a greater or lesser extent must be evaluated by assessing the intrinsic and extrinsic factors (35).

While the significance of the muscle factor should not be overlooked, it's important to recognize that surgical interventions do not directly influence it. Rather, it's the post-operative rehabilitation process that plays a pivotal role in harnessing the full potential of the surgical procedure (36).

In the therapeutic choice of an anterior instability of the shoulder, our approach is summarized in *Table 1*. The primary author of this article places significant emphasis on the Latarjet procedure, as the literature indicates its lower dislocation recurrence rate and, when executed correctly, minimal risk of osteoarthritis (20). Despite the emergence of new "bone block" techniques derived from Eden-Hybinette's intervention, it's crucial to note that they do not possess the same biomechanical equivalence as the Latarjet procedure. The Latarjet procedure, apart from its bone effect, offers the added advantage of capsular plasty through the "sling effect" (28). This provides undeniable benefits in limiting anterior humeral head translation, especially in cases of capsuloligamentary hyperlaxity or participation in contact sports.

Additionally, the Remplissage procedure, involving infraspinatus tendon tenodesis, may yield favorable dynamic effects while making Hill-Sachs lesions extra-articular (24). However, we still lack conclusive evidence to determine the true advantages of Remplissage in comparison to the

Latarjet procedure (37).

A treatment algorithm serves as a valuable tool to assist clinicians in determining their treatment approach, but it should not be viewed as inflexible. In our treatment guide, we often present two viable options, as supported by the literature, since both options have demonstrated beneficial outcomes. Moreover, when evaluating the extent of bone loss and discussing treatment options with the patient, it is crucial to engage in a comprehensive dialogue.

Patients should be well-informed about the advantages and potential risks associated with each surgical option, allowing them to actively participate in the decision-making process. Notably, while the Bankart procedure is considered more anatomical than the Latarjet procedure, some patients may choose to assume a higher risk of recurrence in favor of a procedure that preserves the potential for a subsequent Latarjet procedure, particularly if they are young.

The decision regarding whether to opt for the Latarjet procedure or a bone block is similarly based on a similar rationale.

Conclusions

The surgical management of chronic anterior shoulder instability has undergone significant evolution over the last two decades. In cases involving bone lesions, the isolated Bankart procedure has shown a high rate of failure. For us, the Latarjet procedure stands as a benchmark due to its excellent outcomes in both the short- and long-term.

The introduction of techniques like Remplissage for addressing humeral bone loss and bone blocks for glenoid bone lesions has expanded the therapeutic options. However, we require more substantial evidence to precisely define the role of these various procedures within the treatment algorithm. It's entirely possible that our approach will evolve in the coming years as we gather more knowledge and experience in this field.

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Footnote

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