

Bankart Repair Combined with Subscapularis Augmentation for Anterior Shoulder Instability: A Review Article

Sameh Holy1, Abdelsalam Eid Abdelsalam, Mahmoud Ali El-alfy, Ahmed Hatem Farhan Imam

Department of Orthopedic Surgery, Faculty of Medicine, Zagazig University, Egypt

***Corresponding author:** Mahmoud Ali El-alfy

Abstract

Background: Subcritical glenoid bone loss has become an increasingly recognized contributor to failure following isolated soft-tissue stabilization for anterior shoulder instability. Although historically considered insufficient to mandate bony reconstruction, contemporary biomechanical and clinical evidence demonstrates that even modest loss of the anteroinferior glenoid rim significantly compromises joint stability and increases recurrence rates following arthroscopic Bankart repair.

Objective: To review the anatomical configuration and biomechanical function of the subscapularis and the rationale, indications, contraindications, and comparative role of Bankart repair combined with subscapularis augmentation in anterior shoulder instability with subcritical glenoid bone loss.

Conclusion: Subscapularis augmentation enhances Bankart repair by reinforcing dynamic stabilization, reducing dependence on static restraints alone. Clinical evidence suggests that this combined approach lowers recurrence rates in high-risk patients while maintaining satisfactory range of motion and low morbidity. Its role lies in carefully selected patients with preserved or subcritical bone stock, high functional demand, or additional risk factors for recurrence following isolated Bankart repair. Accurate preoperative quantification of bone loss remains fundamental to surgical decision-making.

Keywords: anterior shoulder instability; Bankart repair; subscapularis augmentation; glenoid bone loss; dynamic stabilization.

Introduction

The subscapularis muscle constitutes the anterior component of the rotator cuff and plays a pivotal role in both shoulder motion and stability. As the only anterior rotator cuff muscle, it forms the primary dynamic barrier against anterior translation of the humeral head and represents a key link between static capsuloligamentous stabilizers and dynamic muscular control of the glenohumeral joint (1,2).

Its anatomical size, broad footprint, and intimate relationship with the anterior capsule uniquely position the subscapularis to influence stability throughout the functional range of shoulder motion, particularly in positions associated with anterior instability (3).

Subcritical glenoid bone loss has become an increasingly recognized contributor to failure following isolated soft-tissue stabilization for anterior shoulder instability. Although historically considered insufficient to mandate bony reconstruction, contemporary biomechanical and clinical evidence demonstrates that even modest loss of the anteroinferior glenoid rim significantly compromises joint stability and increases recurrence rates following arthroscopic Bankart repair (4,5).

Subscapularis augmentation has emerged as an adjunctive strategy aimed at enhancing dynamic anterior stabilization. Rather than replacing anatomical repair, augmentation reinforces the primary anterior dynamic stabilizer of the shoulder, thereby protecting the repaired capsulolabral structures during functional motion. This

combined approach represents an intermediate solution between isolated soft-tissue repair and bony reconstruction in carefully selected patients (1,6).

1. Anatomy and Biomechanics of the Subscapularis Muscle in Shoulder Instability

General Anatomical Overview

The subscapularis muscle constitutes the anterior component of the rotator cuff and plays a pivotal role in both shoulder motion and stability. As the only anterior rotator cuff muscle, it forms the primary dynamic barrier against anterior translation of the humeral head and represents a key link between static capsuloligamentous stabilizers and dynamic muscular control of the glenohumeral joint (1,2).

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Origin, Insertion, and Morphology

The subscapularis originates from the entire anterior (costal) surface of the scapula, occupying the subscapular fossa. The muscle fibers converge laterally to form a thick tendon that inserts primarily onto the lesser tuberosity of the humerus, with consistent extensions blending into the anterior capsule of the glenohumeral joint (1).

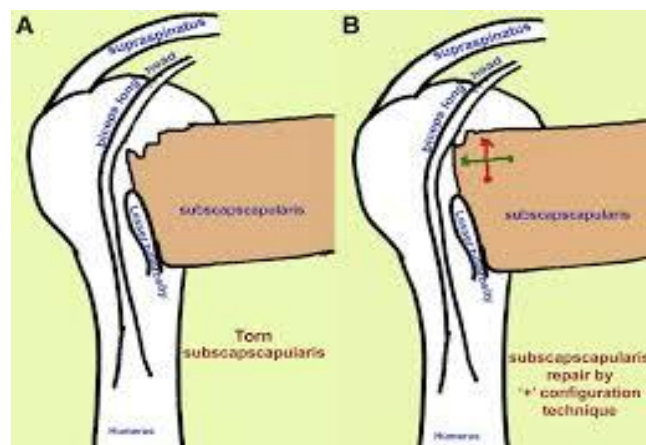
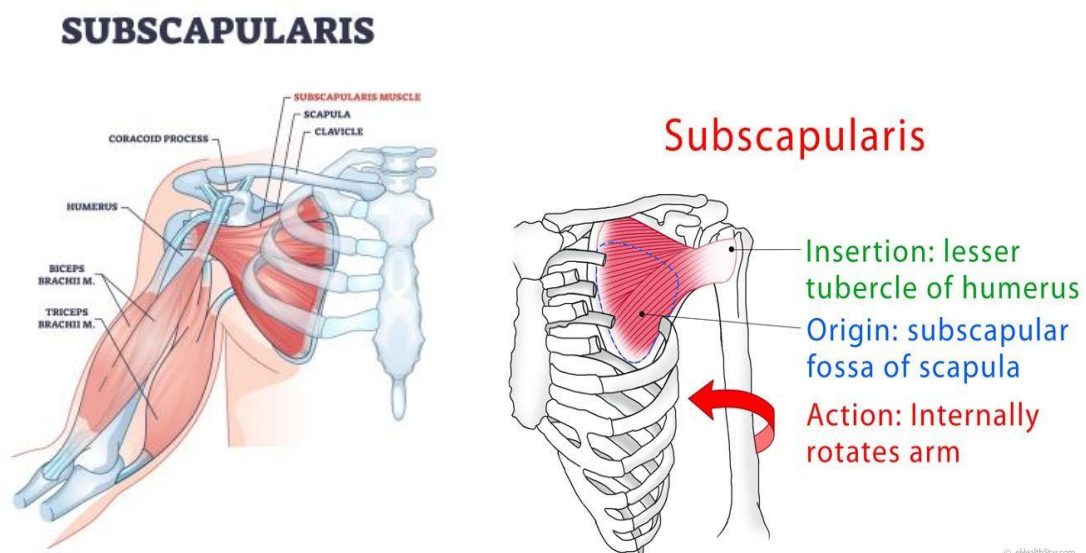


Figure (1): Gross anatomy of the subscapularis muscle showing its origin from the subscapular fossa and its anterior relationship to the glenohumeral joint.

Anatomical investigations have demonstrated that the subscapularis tendon exhibits a broad, trapezoidal insertional footprint with variable fiber orientation. The superior fibers are more tendinous and closely integrated with the capsule, contributing predominantly to dynamic anterior stabilization, whereas the inferior fibers are more muscular and contribute primarily to internal rotation strength and capsular tension (2).

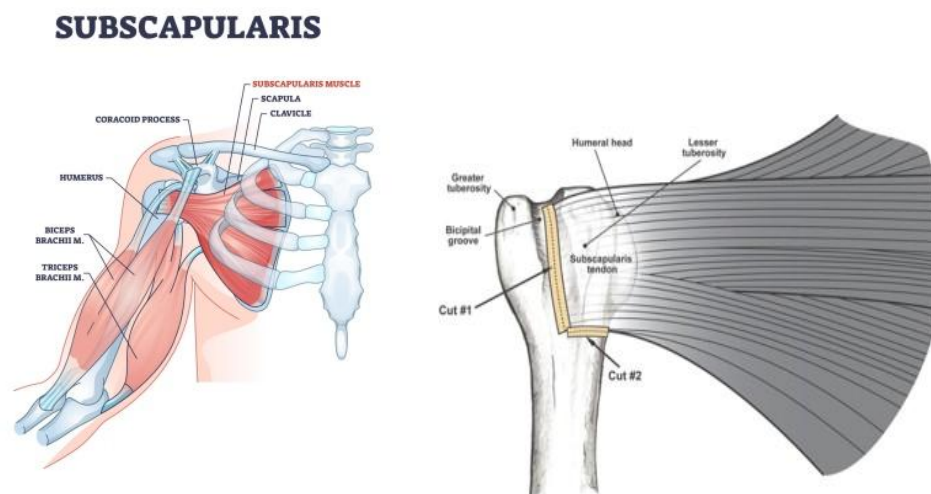


Figure (2): Origin and insertion of the subscapularis muscle

Illustrates the converging fibers of the subscapularis muscle from the subscapular fossa inserting onto the lesser tuberosity of the humerus, highlighting the broad tendon footprint and its blending with the anterior joint capsule.

Variations in tendon thickness, fiber orientation, and capsular blending are common and may influence both biomechanical behavior and susceptibility to dysfunction in patients with anterior shoulder instability (2).

Vascular Anatomy

The vascular supply of the subscapularis muscle is derived mainly from branches of the subscapular artery, with additional contributions from the circumflex scapular artery and branches of the suprascapular artery. This rich vascular network supports tendon viability and healing and is of particular relevance during surgical dissection or augmentation procedures involving the anterior shoulder (7).

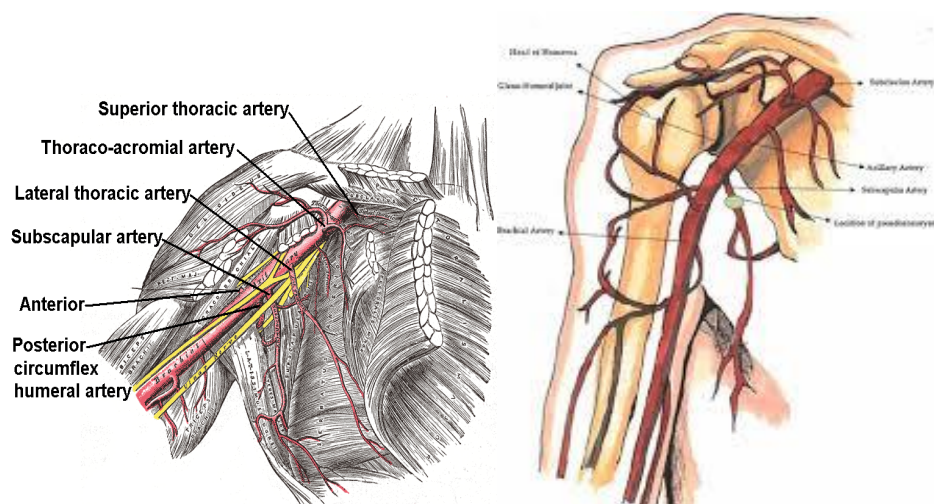


Figure (3): Arterial supply of the subscapularis muscle demonstrating branches of the subscapular and circumflex scapular arteries.

Innervation

Innervation of the subscapularis muscle is provided by the upper and lower subscapular nerves, which arise from the posterior cord of the brachial plexus (C5–C7). These nerves enter the muscle on its anterior surface and supply both motor and proprioceptive function (8).

Neuromuscular impairment of the subscapular nerves results in reduced internal rotation strength and diminished anterior dynamic restraint, predisposing the shoulder to recurrent instability even when static stabilizers have been anatomically restored (8).

Biomechanical Role in Glenohumeral Stability

Biomechanically, the subscapularis is the dominant anterior dynamic stabilizer of the shoulder. Quantitative studies have demonstrated that it contributes approximately 53–55% of the total rotator cuff cross-sectional area, reflecting its substantial force-generating capacity relative to the remaining cuff muscles (1,9).

Activation of the subscapularis produces a posteriorly directed force vector that counteracts anterior translation of the humeral head. This effect is particularly critical in abduction and external rotation, where the anterior capsule and inferior glenohumeral ligament complex are subjected to maximal stress (3,10).

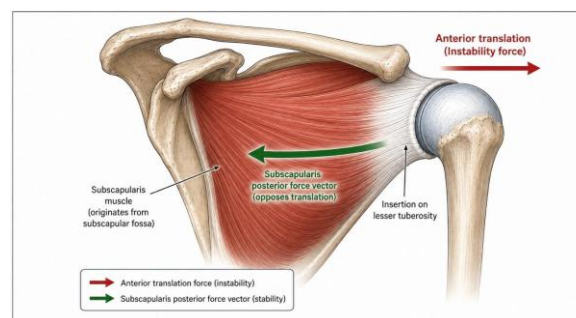


Figure (4): Biomechanical role of the subscapularis illustrating the posterior force vector opposing anterior humeral head translation. [38]

Biomechanical and clinical investigations have shown that subscapularis insufficiency or fatigue leads to increased anterior humeral head translation, even following anatomically successful Bankart repair. This provides a biomechanical explanation for recurrent instability in high-risk patients (11).

Integration Within Rotator Cuff Force Couples

The stabilizing function of the subscapularis must be interpreted within the context of balanced rotator cuff force couples. In the transverse plane, anterior forces generated by the subscapularis are counterbalanced by posterior forces from the infraspinatus and teres minor, allowing dynamic centralization of the humeral head during rotational movement (10).

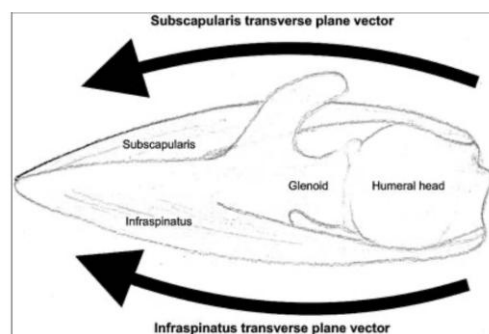


Figure (5): Transverse plane rotator cuff force couples demonstrating balance between subscapularis and posterior cuff muscles. [10]

Disruption of this balance leads to abnormal anterior translation and increased reliance on static stabilizers alone, which may be insufficient to maintain stability in patients with recurrent anterior shoulder instability (3).

Clinical and Surgical Relevance

The anatomical configuration and biomechanical function of the subscapularis provide a strong rationale for subscapularis-based augmentation techniques in anterior shoulder instability. By reinforcing its posteriorly directed force vector, these techniques enhance dynamic anterior restraint without altering osseous anatomy or significantly restricting physiological range of motion (12,6).

Recent clinical studies suggest that subscapularis-based augmentation is particularly beneficial in patients with subcritical glenoid bone loss or high functional demand, where isolated capsulolabral repair may fail to provide durable stability (13).

Rationale and Comparative Role of Subscapularis Augmentation in Anterior Shoulder Instability with Subcritical Glenoid Bone Loss

Rationale of Subscapularis Augmentation in the Presence of Subcritical Glenoid Bone Loss

Subcritical glenoid bone loss has become an increasingly recognized contributor to failure following isolated soft-tissue stabilization for anterior shoulder instability. Although historically considered insufficient to mandate bony reconstruction, contemporary biomechanical and clinical evidence demonstrates that even modest loss of the anteroinferior glenoid rim significantly compromises joint stability and increases recurrence rates following arthroscopic Bankart repair (4,5).

Biomechanically, glenoid bone loss results in reduction of the effective articular arc and weakening of the concavity-compression mechanism responsible for resisting anterior humeral head translation. Experimental and cadaveric models have demonstrated that loss of stability in this setting is non-linear; once bone loss exceeds a subcritical threshold, anterior translation increases disproportionately despite anatomical restoration of the labrum and capsule (14). Consequently, repaired capsulolabral structures are exposed to increased shear forces during functional positions, particularly abduction and external rotation.

Clinical outcome studies strongly support these biomechanical findings. Young, physically active patients with subcritical glenoid bone loss treated with isolated Bankart repair demonstrate higher recurrence rates despite technically adequate procedures (5,15). Importantly, these failures reflect persistent functional instability rather than structural failure of the repair itself. This discrepancy highlights a therapeutic gap between isolated soft-tissue repair and bony reconstruction procedures.

Subscapularis augmentation addresses this gap by enhancing dynamic anterior stabilization rather than attempting to restore osseous containment. As the primary anterior dynamic stabilizer of the shoulder, the subscapularis generates a posteriorly directed force vector that counteracts anterior humeral head translation. In the setting of subcritical bone loss, augmentation of this dynamic restraint compensates for reduced glenoid concavity and unloads overstressed static stabilizers (3).

Compared with bony reconstruction, subscapularis-based augmentation preserves native osseous anatomy and avoids complications related to graft malposition, hardware failure, and altered joint biomechanics. When appropriately tensioned, it improves stability without excessive restriction of external rotation, which is a major advantage in overhead and contact athletes (12).

Recent clinical series evaluating dynamic stabilization techniques incorporating subscapularis reinforcement have demonstrated reduced recurrence rates and high rates of return to sport in patients with subcritical bone loss. These findings indicate that augmenting dynamic restraint can restore functional stability where isolated soft-tissue repair is insufficient, yet bony reconstruction may represent overtreatment (6).

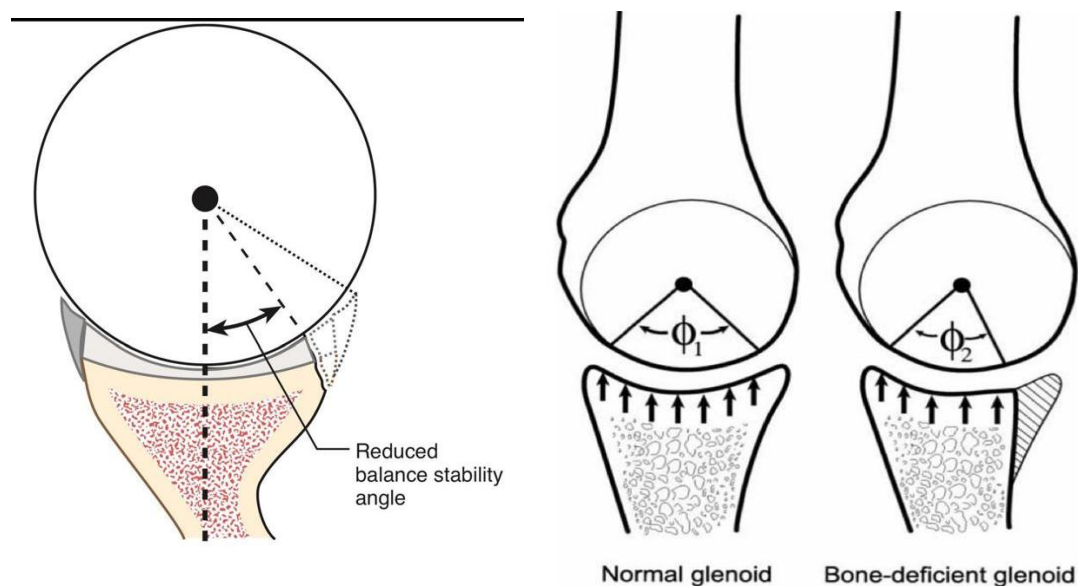


Figure (6): Effect of subcritical glenoid bone loss on anterior shoulder instability and the loss of glenoid concavity. [15]

It is critical to emphasize that subscapularis augmentation is not a substitute for bony reconstruction in cases of critical glenoid bone loss. Its role lies in carefully selected patients with preserved or subcritical bone stock, high functional demand, or additional risk factors for recurrence following isolated Bankart repair. Accurate preoperative quantification of bone loss remains fundamental to surgical decision-making (13).

Comparison of Subscapularis Augmentation with Established Stabilization Techniques

Comparison with Isolated Bankart Repair

Arthroscopic Bankart repair restores labral height and retensions the inferior glenohumeral ligament complex, providing reliable stability in patients with minimal bone loss and low recurrence risk (16). However, recurrence rates increase substantially in young athletes and patients with subcritical bone loss, with reported failure rates ranging between 15% and 30% despite technically sound repairs (17,18).

Subscapularis augmentation enhances Bankart repair by reinforcing dynamic stabilization, reducing dependence on static restraints alone. Clinical evidence suggests that this combined approach lowers recurrence rates in high-risk patients while maintaining satisfactory range of motion and low morbidity (19).

Comparison with Bony Reconstruction Procedures

Bony reconstruction techniques reliably restore stability in the presence of critical glenoid bone loss through restoration of the articular arc and sling effects. Reported recurrence rates are typically below 5–10% (20). However, these procedures are associated with higher complication rates, including graft malposition, neurovascular injury, hardware failure, and long-term degenerative changes (21,22).

Subscapularis augmentation avoids these risks by preserving native anatomy and joint kinematics. While it does not restore osseous containment, it provides sufficient functional stability in subcritical bone loss, where bony reconstruction may be unnecessary (6,19).

Comparison with Other Dynamic Stabilization Techniques

Dynamic stabilization techniques aim to restore functional stability without altering osseous anatomy. Subscapularis-based augmentation is biomechanically intuitive, as it reinforces the primary anterior dynamic stabilizer of the shoulder.

Compared with other dynamic approaches, subscapularis augmentation provides a direct posterior force vector counteracting anterior translation, particularly in abduction–external rotation. Early comparative data

suggest favorable stability with preserved external rotation when tensioning is appropriately controlled (12). Nevertheless, long-term comparative evidence remains limited, necessitating further investigation (13).

General Overview

Arthroscopic Bankart repair remains the cornerstone of surgical management for anterior shoulder instability when glenoid bone loss is absent or minimal. By restoring labral height and retensioning the inferior glenohumeral ligament complex, Bankart repair re-establishes static anterior stability. Despite favorable outcomes in selected patients, recurrence rates remain substantial in young, high-demand individuals and in the presence of subcritical glenoid bone loss, even after technically sound repairs (15,4).

Subscapularis augmentation has emerged as an adjunctive strategy aimed at enhancing dynamic anterior stabilization. Rather than replacing anatomical repair, augmentation reinforces the primary anterior dynamic stabilizer of the shoulder, thereby protecting the repaired capsulolabral structures during functional motion. This combined approach represents an intermediate solution between isolated soft-tissue repair and bony reconstruction in carefully selected patients (1,6).

Indications for Bankart Repair Combined with Subscapularis Augmentation

Bankart repair combined with subscapularis augmentation is indicated in patients with anterior shoulder instability who demonstrate an increased risk of recurrence following isolated soft-tissue stabilization. Indications include:

Recurrent anterior shoulder instability in young and physically active patients, particularly contact or overhead athletes, where functional demands exceed the capacity of static stabilizers alone (15,4).

Subcritical glenoid bone loss, typically in the range of approximately 10–20%, where isolated Bankart repair is associated with higher failure rates but bony reconstruction may represent overtreatment (1,4).

Capsular laxity or poor-quality labral tissue, in which static restoration alone may be insufficient to provide durable stability during high-risk shoulder positions (6).

Clinical or imaging evidence of dynamic stabilizer insufficiency, particularly involving the subscapularis muscle, despite preserved tendon continuity (1).

Failure of prior isolated Bankart repair in the absence of critical bone loss, where dynamic augmentation may address the underlying biomechanical cause of recurrence (17).

Contraindications for Bankart Repair Combined with Subscapularis Augmentation

Despite its advantages, subscapularis augmentation is not appropriate in all instability patterns. Contraindications include:

Critical glenoid bone loss, generally exceeding 20–25%, where loss of osseous containment cannot be compensated by dynamic stabilization alone and bony reconstruction is required (4,21).

Irreparable subscapularis pathology, including advanced fatty infiltration, severe tendon degeneration, or non-repairable full-thickness tears that compromise effective augmentation (8).

Advanced glenohumeral osteoarthritis or inflammatory arthropathy, in which instability is secondary and augmentation provides limited benefit.

Pre-existing significant restriction of external rotation, where additional anterior restraint may worsen stiffness and impair function (10).

Neuromuscular disorders or poor rehabilitation compliance, as dynamic stabilization relies on preserved muscle function and neuromuscular control (8,10).

Capsular–Subscapularis Reinforcement Techniques

Capsular–subscapularis reinforcement techniques aim to strengthen the functional connection between the anterior capsule and the subscapularis tendon without significantly altering tendon anatomy. The augmentation enhances anterior stability by increasing resistance to humeral head translation while preserving physiological motion.

Biomechanically, these techniques enhance the posteriorly directed force generated by the subscapularis and offload repaired capsulolabral structures during abduction and external rotation. They are most commonly utilized in patients with subcritical bone loss, capsular laxity, and preserved tendon quality, serving as a conservative dynamic augmentation strategy (1,6).

Subscapularis Tendon–Based Augmentation Techniques

Subscapularis tendon–based augmentation techniques utilize controlled engagement of the tendon itself to enhance dynamic anterior restraint. Rather than simply reinforcing the capsule, these approaches increase the mechanical contribution of the subscapularis by modifying its line of action to more effectively oppose anterior translation.

These techniques provide a stronger dynamic stabilizing effect than capsular reinforcement alone and are typically reserved for high-demand patients with preserved tendon integrity and elevated recurrence risk. When appropriately tensioned, tendon-based augmentation improves stability while maintaining acceptable ranges of motion (6,12).

Open and Mini-open Bankart Repair with Subscapularis Augmentation

Open and mini-open techniques apply the same biomechanical principles as arthroscopic augmentation while allowing direct visualization and precise tension control. These approaches may be preferred in revision cases, poor arthroscopic visualization, or compromised tissue quality.

Although more invasive than arthroscopic techniques, open augmentation allows reliable reinforcement of dynamic anterior restraint while preserving native osseous anatomy. These techniques are typically reserved for selected cases and should be performed by surgeons familiar with subscapularis anatomy and neurovascular safety zones (21,13).

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