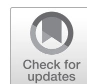

28 Advanced Soft Tissue Procedures for Glenohumeral Instability: Labral Augmentation

Maristella F. Saccomanno, Jacopo Maffeis, and Giuseppe Milano

Abstract

Surgical management of glenohumeral instability is still a challenge. Although several predisposing factors have been identified, a clear treatment algorithm is not available, especially in the subset of recurrent dislocations with subcritical bone defects. Several new soft tissue and bony procedures have been proposed in the last years, but there is no consensus yet of which technique could be considered the best treatment option. The following chapter describes a soft tissue procedure to address the reconstruction of the glenoid labrum by using a biologic scaffold augmentation, when the residual labrum is insufficient.

Keywords

Shoulder · Instability · Glenoid labrum · Reconstruction · Collagen · Scaffold · Augmentation

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28.1 Introduction

Surgical management for recurrent glenohumeral instability remains a controversial topic. Arthroscopic Bankart repair is still the most performed procedure worldwide. However, long-term studies showed highly variable recurrence rates, ranging from 2% [1, 2] up to 50% [3–6].

It is worth noting that Kennedy et al. [7], in a recent trim and fill meta-analysis pointed out that study design of reviewed articles significantly altered the reported rates of recurrence. After accounting for publication bias, the authors estimated an overall recurrence rate of 17.4%. However, taking into account that shoulder instability mainly affects young active people, even 17.4% recurrence rate is still too high. It is a common idea that selecting the ideal patient for any kind of surgical procedure is always the best strategy to achieve a successful outcome. Unfortunately, although shoulder instability is a common and well-studied pathology, there is still no consensus on how many and what risk factors can make the difference in the decision-making process. Recent data suggest that patient-related factors, including age < 20, male gender, hyperlaxity, number of preoperative dislocations, participation in contact sports as well as injury-related factors such as humeral head and glenoid bone loss [8, 9] and even beach-chair positioning during surgery [10] could increase the risk of recurrence of an arthroscopic Bankart repair.

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Several studies focused on bone defects as the main cause of failure of arthroscopic shoulder instability repair; for this reason several techniques of bone augmentation have been suggested as an alternative to a Bankart repair to lower recurrence rate, especially in "high-risk" patients [11]. However, little is known about the role of soft tissue deficiency in failure of shoulder instability repair. A recent study [12] showed that labral morphology can influence the risk of re-dislocation after primary Bankart repair. This assumption surely must draw surgeons' attention. A glenoid labral injury is identified in almost all cases of acute or recurrent traumatic glenohumeral instability [13], but sometimes, especially in long-term history of recurrent instability, scarred and residual tissue look so poor that an anatomic capsulolabral restoration is almost unachievable. On the other hand, atraumatic instability is often associated with insufficient chondrolabral containment [14] and a redundant capsule, which make any attempt of capsulolabral reconstruction very difficult, surely raising up the failure rate after primary arthroscopic soft tissue procedure [15]. Therefore, a focus on glenoid labral reconstruction is needed.

The aim of the present chapter is to describe a new surgical technique to address the reconstruction of the glenoid labrum by using a biologic scaffold augmentation, when a standard capsulolabral restoration is unsuitable.

28.2 Surgical Rationale

The shoulder is the least constrained and most mobile of all the joints in the human body, therefore preservation of its stability is crucial to its function [16]. Glenohumeral stability relies upon a complex interaction of static and dynamic stabilizing factors. The bony architecture of the glenohumeral joint is often associated to a ball-and-socket geometry. This shape provides a large arc of motion, but also requires the surrounding soft tissue to guide joint movement, which makes it highly susceptible to an inherent instability [17].

Anatomical structures that provide static shoulder stability include the bony congruency of the concave glenoid and spheroidal humeral head, the fibrocartilaginous glenoid labrum, glenohumeral ligaments, and negative intra-articular pressure. Recently, it has been shown that even a lack of glenoid concavity and/or a retroverted glenoid are frequently associated with atraumatic posterior instability (PI) or multidirectional instability (MDI) of the shoulder, thus further reducing primary glenohumeral stability [18, 19].

Dynamic stabilizers are primarily muscular and include the rotator cuff, in addition to the long head of biceps tendon (LHBT) and muscles that stabilize the scapula. The rotator cuff muscles generate a compressive stabilizing force that centers the humeral head onto the glenoid, a phenomenon known as "concavity compression." This mechanism is present in all positions, although particularly important in the functional mid-range when the capsule and ligaments are relaxed.

The glenoid labrum is critical for glenohumeral stability [20]. It deepens the glenoid cavity up to 50%, contributes to the concavity compression mechanism for about 20% [21] by increasing glenohumeral contact and preventing rollback of the humeral head, and represents the insertion line for capsule ligaments and LHBT. Although a loss of chondrolabral containment has been reported in patients affected by atraumatic PI or MDI [14], little is known about labral morphological variations. Vaswani et al. [12] first conducted a three-dimensional (3-D) magnetic resonance imaging (MRI) study to evaluate the role of the labral volume in predicting surgical failure after primary Bankart repair. The authors performed a retrospective case-control study in a series of 289 patients who underwent an anterior arthroscopic shoulder stabilization. They showed that patients with diffusely small labral morphology were 3.2 times more prone to experience a postoperative dislocation compared with those with normal labral morphology. This association held true even when controlling for number of preoperative dislocations, demonstrating that the diffusely small labral size was not necessarily due to the repeated preoperative dislocations, but

could also be an anatomic variation. And this clearly brings out that the spectrum of injuries present in glenohumeral instability is even wider than what is already known.

The glenoid labral augmentation technique has been mainly designed to account for at least two common clinical scenarios:

- Thinned or frayed glenoid labrum in traumatic recurrent glenohumeral instability with no or subcritical glenoid bone loss.
- Hypoplastic labrum commonly encountered in atraumatic instability.

Labral reconstruction by using a biologic scaffold aims to obtain a bumper effect and to increase glenoid concavity, thus restoring an efficient capsulolabral containment.

28.3 Indications and Contraindications

From a clinical standpoint, all patients being evaluated for shoulder instability must undergo a complete history and physical examination to aid in surgical decision-making. Besides anteroposterior (AP) view and axillary X-rays, it is part of authors standard decision-making process to rule out critical humeral and glenoid bone loss by performing a computed tomography (CT) scan in all patients prior to surgery. Estimate of glenoid bone loss is based on the circle method and achieved on 3-D *en face* views of the glenoid by volume rendering technique (VRT) reconstruction [22–24]. A 3-D osseous reconstruction is also performed to determine the severity of Hill-Sachs lesion. In addition to CT scan, an MR-arthrography (MRA) is required in case of MDI, after failure of conservative treatment, to study labral and capsule characteristics.

Intraoperative confirmation of insufficiency of the anterior glenoid labrum because of severe thinning, attenuation or absence due to repeated traumatic injuries or hypoplastic morphology are the main indications to a labral augmentation by using a biologic scaffold.

The procedure is contraindicated when critical bone defects are present, such as a glenoid bone defect exceeding 20% of the area of the inferior glenoid and an engaging Hill-Sachs lesion.

28.4 Surgical Technique

Step-by-step procedure for anterior labral augmentation is now described, as this is the most common scenario. Same technique is also applicable for the posterior labrum in case of PI or MDI with posterior labral deficiency.

28.4.1 Patient Positioning

Shoulder arthroscopy can be performed under general anesthesia, interscalene block, or a combination of the two depending on the preference of the surgical team. Patients can be placed in either the lateral decubitus or beach-chair position. It is authors' preference to perform this procedure under general anesthesia with the patient in lateral decubitus. A 3-Point Shoulder Distraction System (Arthrex, Naples, FL, USA) is then positioned at the distal end of the operating table on the contralateral side in order to keep the arm distracted at 70° of abduction and 15° of forward flexion. Lateral decubitus will allow an easy access to the entire glenoid, labrum, and capsule.

28.4.2 Portals

A dermographic pen is utilized to draw bony landmarks: the spine of the scapula, the acromion, the clavicle and the coracoid process.

A standard three-portal approach is usually performed.

- Posterior (P) portal: standard viewing portal. The diagnostic arthroscopy always starts by introducing the scope into the posterior portal. In case of posterior labral tears, the scope is

then switched in the anterior portal and the posterior portal is used as an operative portal for suture management.

- Anterosuperior (AS) portal placed with the outside-in technique. This portal is performed through the rotator interval. It is authors' preference to use plastic cannulas for the entire duration of the procedure in order to avoid soft tissue damaging or creation of false routes during the passage of arthroscopic instruments. A 5.5-mm plastic cannula is usually placed in this portal.
- Anterior mid-glenoid (AM) portal placed with the outside-in technique. This portal is performed through the rotator interval, just above the subscapularis tendon. An 8-mm plastic cannula is then positioned. This portal is used for the passage of arthroscopic instruments, anchor placement, and suture management.

28.4.3 Diagnostic Arthroscopy

Diagnostic evaluation of the glenohumeral joint should be performed systematically. It is important to assess for pathology commonly encountered in patients affected by glenohumeral instability: labral tears (anterior and/or posterior Bankart lesions, Perthes lesion, ALPSA lesion, Kim lesion, SLAP tears), HAGL or RHAGL lesion, capsule appearance (tearing, thinning, or redundancy), glenoid and humeral head bone loss. Attention should also be paid to rule out anatomic variants commonly encountered in hyperlax patients, such as sub-labral hole or Buford complex. Posterior inspection can be performed by switching the scope in the anterior portal. All the anatomic structures can be palpated by using a probe or a switching stick. Mobilization of the anteroinferior capsulolabral complex is then attempted by using a chisel dissector. At this point, if a glenoid labrum deficiency is encountered, a labral augmentation should be considered (Fig. 28.1).

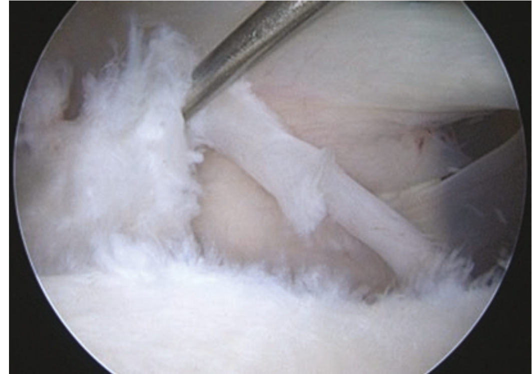

Fig. 28.1 Anterior glenoid labrum deficiency. In this case, a labral augmentation should be considered

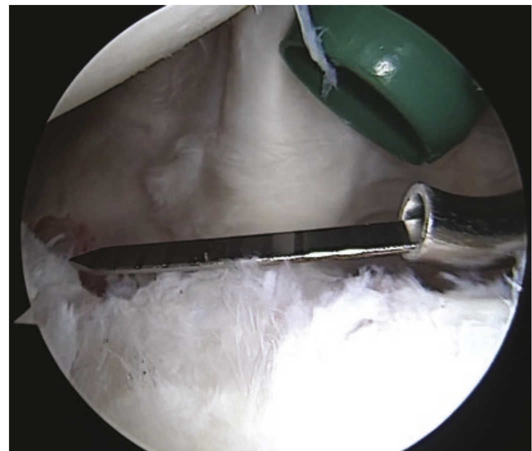

Fig. 28.2 A ruler is used to measure the length of the labral lesion (from inferior to superior)

28.4.4 Step-by-Step Procedure

After mobilization of the anteroinferior capsulolabral complex and abrasion of the anterior glenoid neck, a ruler is used to measure the length of the labral lesion (from inferior to superior). This measure is used for the preparation of the scaffold (Fig. 28.2).

28.4.4.1 Graft Preparation

A porcine dermal collagen matrix (DX Reinforcement Matrix; Arthrex Inc., Naples, FL)

is sized according to the measured length of the labral lesion and 2 cm in width. The membrane is then rolled-up to obtain a cylindrical scaffold 5-mm thick and sutured in a continuous fashion with a #2.0 braided suture. Each end of the scaffold is then armed with one #2 monofilament traction suture (Fig. 28.3).

28.4.4.2 Graft Passage and Fixation

A suture hook is introduced from the AM cannula and passed through the capsulolabral junction at the most inferior aspect of the injured capsule (approximately at 6-to-5-o'clock position for a right shoulder). The shuttle of the suture hook is retrieved out of the AS cannula and one strand of the distal traction suture of the scaffold is loaded over the eyelet of the shuttle and retrieved out of the AM cannula after passing through the capsulolabral junction in a retrograde way. The other strand of the same traction suture is retrieved from the AM cannula and the scaffold is introduced into the joint from the AS cannula by pulling the inferior traction suture while maintaining a slight tension on the proximal traction suture. The scaffold is then placed over the anterior glenoid rim and fixed at its distal end to the capsule by knot tying of the distal traction suture (Fig. 28.4).

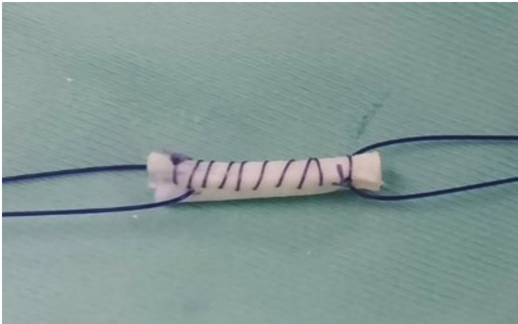

Fig. 28.3 A porcine dermal collagen matrix (DX Reinforcement Matrix; Arthrex Inc., Naples, FL) is sized according to the measured length. The membrane is then rolled-up to obtain a cylindrical scaffold and sutured in a continuous fashion with a # 2.0 braided suture. Each end of the scaffold is then armed with one #2 monofilament traction suture

Capsulolabral repair is then performed in an inferior-to-superior direction by passing #2 high-strength permanent braided sutures (Fiberwire, Arthrex) through the capsule and under the residual labrum and the scaffold in a simple configuration. Sutures are fixed to the anterior glenoid rim with three to four knotless suture anchors (2.9 PEEK Pushlock, Arthrex) placed over the articular margin of the anterior glenoid, by including the capsule, the labrum and the scaffold (Fig. 28.5). A slight tension is maintained on the proximal traction suture of the scaf-

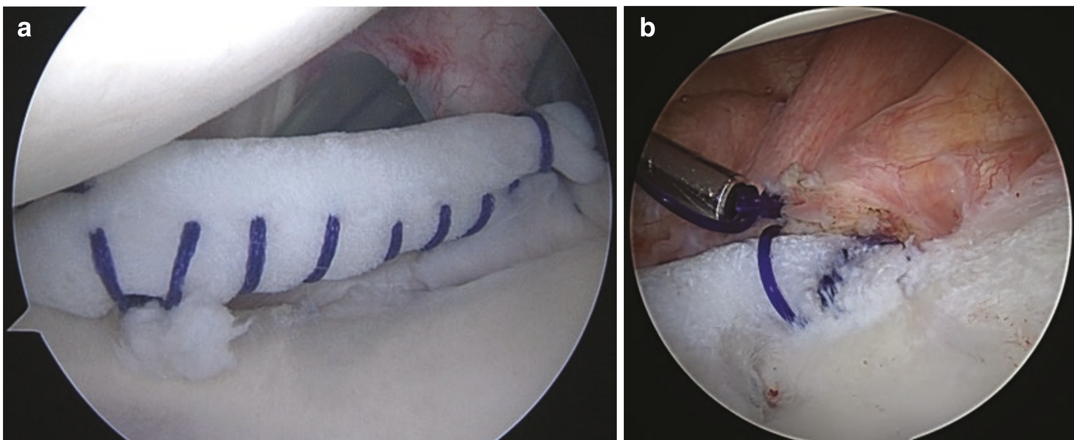

Fig. 28.4 (**a**) The scaffold is introduced into the joint from the AS cannula by pulling the inferior traction suture while maintaining a slight tension on the proximal traction suture. (**b**) The scaffold is placed over the anterior glenoid rim and fixed at its distal end to the capsule by knot tying of the distal traction suture

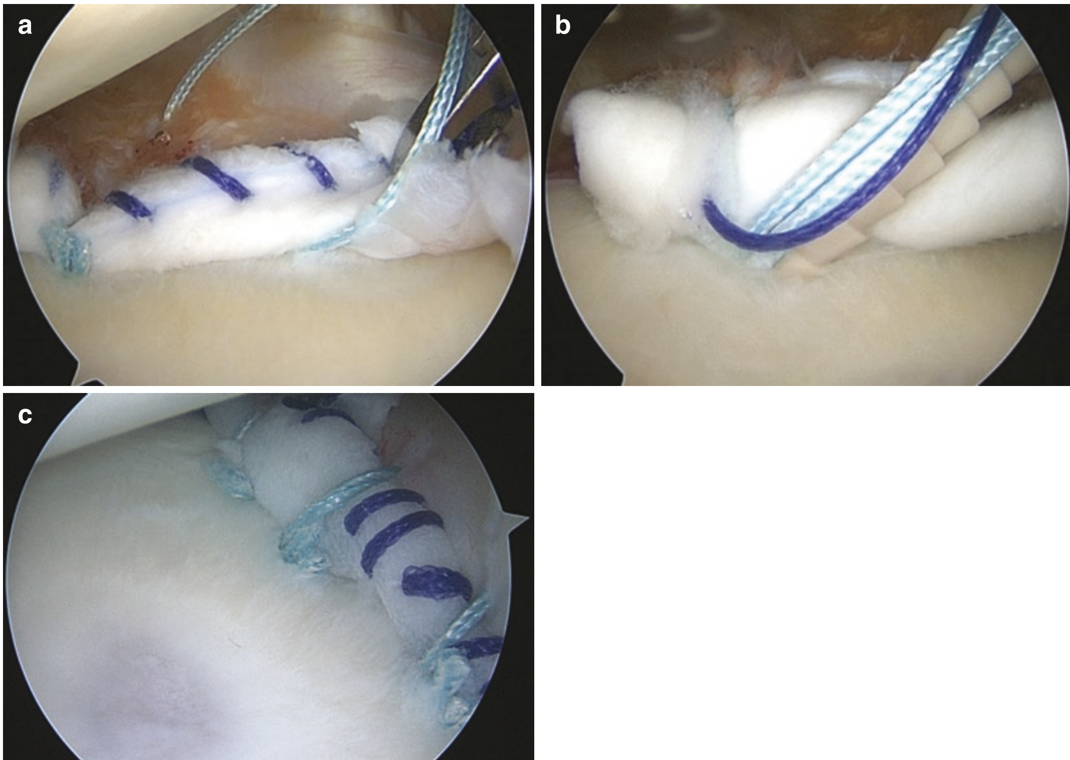

Fig. 28.5 (**a**) A #2 high-strength permanent braided sutures (Fiberwire, Arthrex) is passed through the capsule and under the residual labrum and the scaffold in a simple configuration. (**b**) A 2.9 PEEK knotless anchor (Pushlock, Arthrex) is used to fix the graft. Suture anchors are placed over the articular margin of the anterior glenoid, by including the capsule, the labrum and the scaffold. (**c**) Three to four knotless suture anchors are used to fix the graft

fold during tissue fixation. Finally, the proximal traction suture can be fixed to the most superior aspect of the stable capsulolabral tissue.

28.4.5 Tip & Tricks

As described above, the scaffold is inserted into the joint through the AS portal. Before scaffold introduction, remove the 5.5-mm cannula and place an 8 mm flexible cannula, by using a switching stick in order to avoid a new route. The scaffold is quite stiff and thick, so the passage through a 5.5-mm cannula could require an unnecessary high pulling strength.

28.5 Postoperative Care

After surgery, the operated arm is placed in a sling for 4 weeks. The rehabilitation program usually starts after sling removal and lasts for at least 2 months. It is articulated in progressive phases starting with full recovery of passive range of motion (ROM). Active ROM exercises and muscle strengthening are initiated 8 weeks after surgery. For the athletes, a specific training to recover the athletic gesture based on re-programming of specific muscle activation patterns is added at the end of the standard rehabilitation program. Return to sports activities and heavy manual work are allowed 6 months after surgery.

28.6 Literature Review

Glenoid labral augmentation is one of the innovative surgical strategies to address the "grey zone" of glenohumeral instability: when an arthroscopic Bankart repair is not enough and a bone augmentation procedure is too much. The main focus of the current literature still remains on bony procedures. Recently, the so-called arthroscopic "Bankart-plus" procedure has been described to address small to intermediate glenoid bone defects by using an allogeneic demineralized cancellous bone matrix between the glenoid neck and the labrum, in addition to the conventional capsulolabral repair [25]. Although the idea surely makes sense and it is definitively an option, the role of soft tissue should not be underestimated. Suffice to say that Lavoué et al. [26] recently reported good functional results after arthroscopic soft tissue stabilization in case of failed Latarjet procedure.

In order to improve the efficacy of soft tissue procedures, several additions or slight modifications to the traditional arthroscopic Bankart repair have been proposed in the last 5 years. Maiotti et al. [27] described the arthroscopic subscapularis augmentation (ASA) technique consisting of a tenodesis of the upper third of the subscapularis tendon in addition to a Bankart repair. The authors reported good functional results not only in recurrent anterior instability with capsular inconsistence and subcritical glenoid bone loss, but also in revision surgery of failed prior stabilization procedures. Brzóska et al. [28] proposed an anterior extracapsular stabilization, which relies on augmentation of the damaged anterior soft tissues by a part of the subscapularis muscle and was named "between glenohumeral ligaments and subscapularis muscle" (BLS) stabilization. Transposition of the LHBT within a subscapularis split to the anterior glenoid margin has also been advocated, thereby creating a "sling effect" [29, 30]. Recently, Milenin et al. [31] slightly modified the technique by using the proximal part of the long head of the biceps tendon as static and dynamic stabilizer. They first performed a trans-subscapular transposition of the tendon and then use its proximal part to add an augmentation to the anterior labrum followed by a subsequent refixation of the glenohumeral ligaments to the same anchors, aiming to provide the triple effect of the Latarjet procedure without using a bone block.

Main weakness of the above-described soft tissue procedures is that none of them could be considered anatomic. It is authors' deep conviction that reproducing, as much as possible, the normal anatomy is the key to success in order to avoid ROM restrictions and degenerative changes of the glenohumeral joint over time, often reported after non-anatomic procedures [32]. Therefore, labral augmentation by using a biologic scaffold is a viable option to address labral reconstruction when labral deficiency is one of the problems that need to be fixed.

A separate discussion should be made in case of surgical treatment of atraumatic PI and MDI. First-line option still remains the conservative treatment [33–35]. When it fails, open and arthroscopic soft tissue procedures become an option, in the absence of critical bone defects. Main problems often associated to this setting are loss of chondrolabral containment due to an hypoplastic labrum, redundant capsular volume, and a flat or retroverted glenoid [14, 18, 19]. It is still unclear whether these features are congenital or acquired, but they should be considered as contributing factors that just set the bar very high when it comes to surgical stabilization.

Gervasi et al. [36] described a labral augmentation technique, similar to that presented herein, by using a biological scaffold to reconstruct the glenoid labrum from anteroinferior to posteroinferior in case of atraumatic MDI associated with generalized hyperlaxity.

It is authors' opinion that an anatomic labral augmentation by using a biologic scaffold should be considered not only in case of MDI, but also in recurrent anterior shoulder instability when repairing the residual glenoid labrum is not a feasible option. The authors already performed a cohort study (*unpublished data*), including both traumatic and atraumatic instability cases, which showed that the arthroscopic labral reconstruction with a porcine dermal collagen scaffold is a safe and an effective procedure to obtain a stable

bumper effect, to increase glenoid concavity and to restore an efficient capsulolabral containment, with no adverse events related to the use of biologic scaffold at mid-term follow-up.

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