Technical Note

All-Arthroscopic, 270° Reconstruction of the Inferior Glenohumeral Ligament With Palmaris Longus Autograft

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Abstract: Numerous factors play a role in anterior shoulder stability. The inferior glenohumeral ligament, especially the anterior band, is the main passive anterior stabilizer in the end range of motion. Surgical treatment of this pathology continues to be a challenge in patients with capsular deficiency, in whom the recurrence rate of soft-tissue arthroscopic repair increases significantly. There is not yet a fair solution for these patients without glenoid bone loss, in whom the poor tissue quality determines recurrent instability. We present an all-arthroscopic technique for reconstruction of the inferior glenohumeral ligament by means of palmaris longus autograft as an alternative to nonanatomic bone block procedures.

Multiple surgical techniques have been described for treatment of anteroinferior shoulder instability,[1-6] but the Bankart procedure continues to be an optional treatment for this pathology.[7-10] Despite the advantages of all-arthroscopic techniques, high failure rates of arthroscopic Bankart repair have been reported especially in the presence of bony defects.[11,12] In the long term, the failure rate could be as high as 50% in the absence of proper indications or poor surgical technique.[13,14] Many authors advocate that patients with hyperlaxity have a higher risk of failure because of inherent capsule deficiency.[15-17] These patients show a different proportion of elastic fibers in the capsule, which causes residual stretching and leads to an increased intra-articular volume over time, even after a Bankart repair.[18] Thus, meticulous surgical technique and restoration of anatomy are of paramount importance.

The anterior band of the inferior glenohumeral ligament (IGHL) is the main passive anteroinferior stabilizer in the abduction and external rotation (ABER) position. Detachment of the anterior IGHL band from the glenoid rim is frequently present in traumatic events. Several authors have focused on the importance of repairing this ligament to be able to reproduce the physiological anterior restraint.[19] Previously, glenohumeral ligament reconstruction techniques have been described as salvage procedures for chronic anteroinferior instability after failed surgery.[19-22] Recently, Bouaicha and Moor[23] presented an all-arthroscopic IGHL reconstruction technique in a cadaveric study as a proof of concept. A hamstring autograft was applied in a triangular configuration to re-create the anteroinferior restraint of the IGHL.

The aim of this technical note was to describe all-arthroscopic reconstruction of the IGHL by means of palmaris longus (PL) autograft. By use of the autograft, a 2-limbed, inferior restraint is attached to the anterior and posteroinferior glenoid rim, reproducing the complete sling effect of the IGHL. Possible indications for this technique could include the shoulder with inferior and potentially also anteroinferior or posteroinferior instability in a patient with severe hyperlaxity, as well as cases of residual capsular stretching after multiple dislocations and previously failed arthroscopic Bankart repair. In contrast, contraindications might include glenoid or humeral bone loss and the absence of a suitable source of autograft.

Surgical Technique

Patient Positioning

The surgical procedure is performed as shown in Video 1, with the patient positioned in a standard

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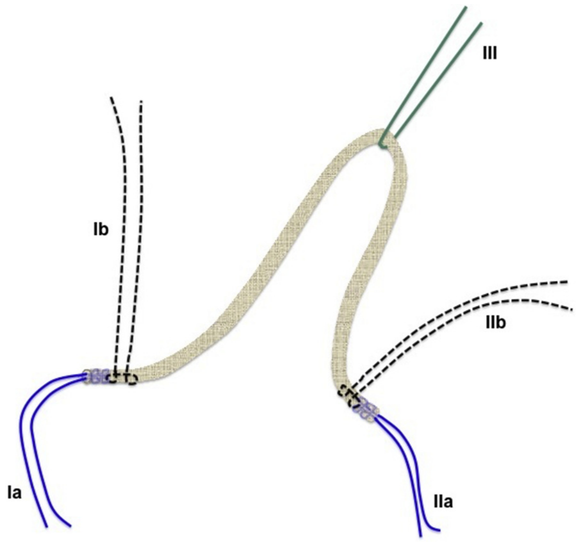

Fig 1. Suture configuration of harvested palmaris longus tendon graft. Heavy sutures are placed on the anterior limb (Ia and Ib), posterior limb (IIa and IIb), and Dogbone loop (III).

beach-chair position for shoulder arthroscopy. Preparation and draping of the affected arm are performed in the usual fashion, ensuring that the ipsilateral wrist is accessible for PL tendon harvesting.

Autograft Harvesting and Preparation

Harvesting of the ipsilateral PL tendon is performed using a standard tendon stripper. The graft length should be between 12 and 18 cm long and 2.5 mm wide. Preparation of the graft is performed by passing 2 heavy sutures on the thickest end of the graft: A FiberWire (Arthrex, Naples, FL) is whipstitched in Krackow fashion at the graft's end (Ia) and a TigerWire (Arthrex) is secured with a simple passing loop, 1 cm distal to the graft's tip (Ib). Then, a TightRope device (Arthrex) is placed at the graft's mid length (III) (Fig 1). The other end of the graft is left free in this stage, until the appropriate length is determined.

Diagnostic Arthroscopy

The arm is draped to the elbow and mounted on a SpiderArm device (Smith & Nephew, Watford, England). Diagnostic arthroscopy of the glenohumeral joint is performed through a standard posterior arthroscopic portal. Subsequently, anteromedial (AMed) and posterolateral (PLat) working portals are created. Silicone and rigid cannulas are placed in the AMed portal and PLat portal, respectively. The integrity of the anteroinferior and posteroinferior labral complex is examined. If a tear is confirmed, debridement and repair of the lesion are performed by means of all-suture anchors (Fig 2). Finally, an additional high lateral portal is created, which will be used later in the procedure.

Preparation of Humeral Tunnel

The aiming tip of the TightRope ACL aiming device (Arthrex) is brought through the PLat portal and positioned at the 6-o'clock humeral position, 1 cm distal-lateral to the cartilaginous junction (Fig 3). A K-wire is introduced percutaneously through the lateral portal and greater tuberosity under direct visual arthroscopic control. K-wire placement is also confirmed under fluoroscopic control in both the frontal and axial planes (Table 1). Subsequently, overdrilling with a 2.4-mm cannulated drill is performed.

Graft Length Sizing

At this point, measurement of the required final graft limb length is undertaken with the operated arm in the neutral position and rotation. First, the cannulated humeral drill must be retrieved until it lies flush with the intra-articular humeral entry hole. By shuttling a No. 0 polydioxanone (PDS) suture through the cannulated drill, the required graft length from the intra-articular humeral entry point to the desired glenoid anchor position is calculated. This provides the intra-articular length of 1 of the limbs; this should be doubled to account for both the anterior and posterior bundles of the IGHL construct. An additional total of 4 cm is added to the previous measurement to secure adequate docking of the graft inside the humeral tunnel. At this point, it is crucial to visually control that the graft construct will not be located beyond the equator of the head.

Next, heavy sutures (IIa and IIb) are stitched on the free end of the PL graft, at the predetermined length. The same suture configuration is applied as described previously (Fig 4).

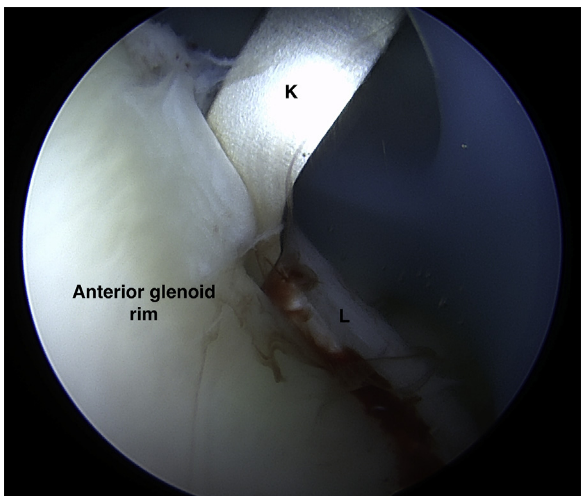

Fig 2. An intra-articular view through the posterior portal of a right shoulder confirms the labral tear. With a Bankart knife (K) from the anterior portal, complete detachment of the labrum (L) is performed before repair.

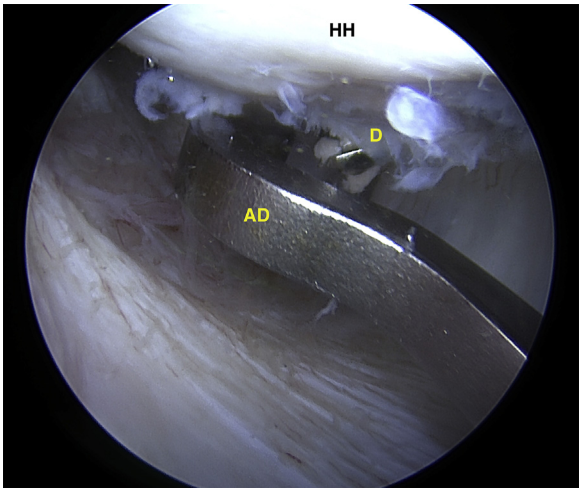

Fig 3. An intra-articular view through the posterior portal of a right shoulder shows a TightRope ACL aiming device (AD) brought through the posterolateral portal. The cannulated drill (D) aims the 6-o'clock humeral head (HH) distal to the cartilage transition line.

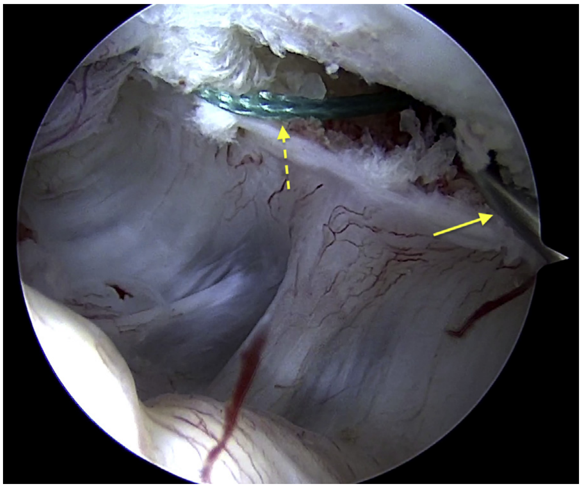

Fig 4. An intra-articular view through the posterior portal of a right shoulder shows a nitinol wire (solid arrow) and heavy suture (dashed arrow) brought inside through the humeral tunnel and retrieved from the posterolateral and anterior portals, respectively.

Introduction of Shuttling Sutures

The humeral tunnel is overdrilled to a minimum width of 4.0 mm. A nitinol wire (Arthrex) and PDS suture are shuttled through the tunnel and retrieved from the PLat and AMed portals, respectively (Fig 5). Next, the FiberWire (Ia) and TigerWire (Ib) sutures from the leading graft's end are shuttled to the AMed portal by means of the previously placed PDS suture. The step is repeated for the remaining FiberWire sutures (IIa and IIb) from the opposite graft's end to retrieve them through the PLat working portal by means of the nitinol wire.

Table 1. Pearls and Pitfalls

Pearls
The K-wire articular position should be checked arthroscopically and fluoroscopically before drilling of the definitive tunnel in the humerus.
Graft insertion and fixation are performed in 2 steps; intra-articular suture management is simplified.
Correct measurement of the required final graft limb length is undertaken with the operated arm in the neutral position.
For correct tensioning of the graft, the arm must be positioned in the mid-range ABER position.
The surgeon should verify, under fluoroscopic control, that the Dogbone lies flush with the cortical bone.
Pitfalls
Suture passage on both graft ends during graft preparation without intra-articular measurement of the appropriate length must be avoided.
Placing the humeral tunnel too anterior or posterior must be avoided.
Incorrect tensioning in the ABER position might compromise the range of motion.

ABER, abduction and external rotation.

Graft Fixation on Glenoid

The anterior graft limb is introduced into the joint by pulling on sutures Ia and Ib. Next, fixation of both anterior sutures to the anterior glenoid rim is performed with suture-less 2.9-mm PushLock anchors (Arthrex) at

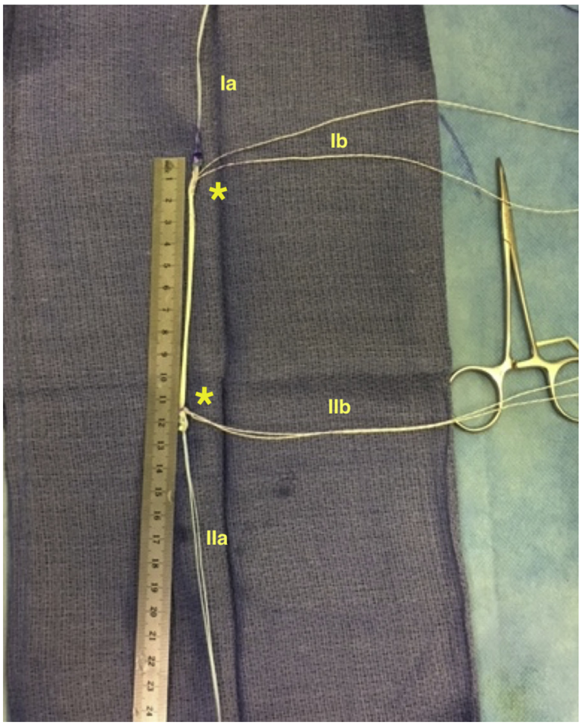

Fig 5. An intraoperative image of the harvested palmaris longus tendon graft shows the suture configuration as explained in Fig 1: anterior limb (Ia and Ib) and posterior limb (IIa and IIb). The same suture configuration is applied on both ends (stars) of the graft at the measured length. Ultimately, 2 double-limbed sutures grasp the graft on each side.

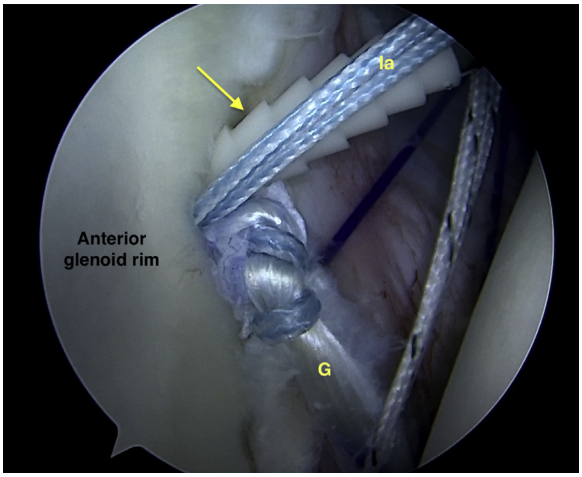

Fig 6. An intra-articular view through the posterior portal of a right shoulder shows the graft anterior limb (G) fixed to the anterior glenoid rim with a suture-less anchor (arrow) at the 2:30 clock-face position with the heavy suture (Ia).

the 2:30 and 3:30 clock-face positions, respectively (Fig 6). Then, the camera is switched to the AMed portal, and the posteroinferior glenoid rim is visualized. The posterior graft limb is introduced into the joint by pulling on the nitinol wire (Fig 7) and is fixed at the 9:30 and 8:30 clock-face positions with sutures IIa and IIb, respectively, by means of 2 additional suture-less anchors. The aim is to reproduce the anatomic origin of the posterior IGHL at this point. Careful suture management is paramount before introducing the posterior graft limb into the joint because of the limited visualization of the intra-articular portion of the tendon graft.

Final Humeral Fixation and Tensioning

The graft construct is pulled as a sling inside the humeral tunnel using the TightRope device (III). Then, the camera is switched to the lateral portal through the PassPort cannula (Arthrex). The plane between the greater tubercle and the deltoid muscle should be clearly developed to be able to securely fix the Dogbone plate (Arthrex). For correct tensioning of the graft, the arm must be positioned in the mid-range ABER position (alternatively, mid abduction in the case of predominant inferior instability) and the Dogbone is then tied and secured under arthroscopic control (Fig 8). This should be achieved by pushing the Dogbone down so that it lies flush with the cortical bone. Correct positioning is verified under fluoroscopic control (Fig 9).

Postoperative Care

Pain control is managed by means of an interscalene block during the early postoperative period. The arm is braced in the neutral position in the immediate postoperative period. Passive range of motion is started at 2 weeks postoperatively, after removal of the brace, and active range of motion is started at 4 weeks postoperatively. Strengthening exercises are introduced at 12 weeks postoperatively.

Discussion

Arthroscopic Bankart repair is considered valuable in the treatment of traumatic, unidirectional anteroinferior and inferior shoulder instability. However, failure with residual instability may occur in the presence of risk factors including age, sports, generalized hyperlaxity, and Hill-Sachs and/or bony glenoid defects.[13,24,25] Despite being able to identify negative predictors for arthroscopic Bankart repair, the failure rate is still high.[11,13] It seems that careful patient selection may warrant better outcomes.

Underlying capsule hyperlaxity is 1 common aspect that most authors agree is responsible for increased surgical failure rates. Recent studies have described the

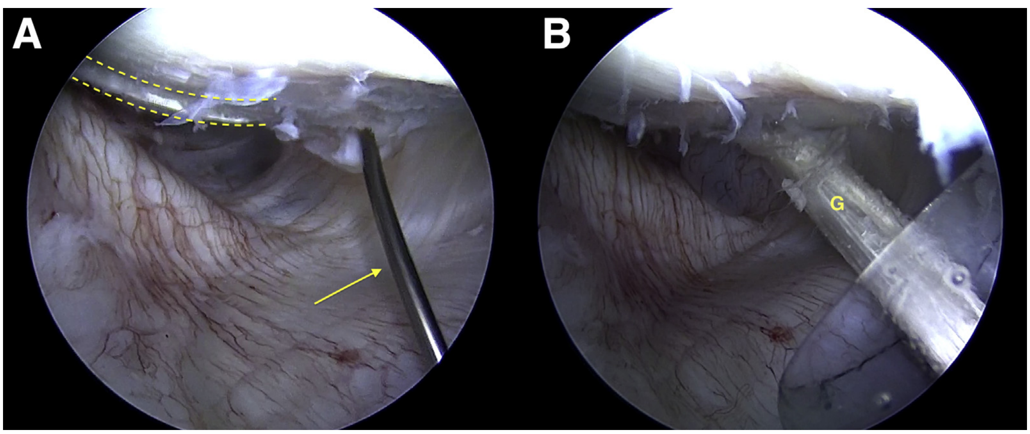

Fig 7. Intra-articular view through the posterior portal of a right shoulder. (A) The anterior limb of the graft (dashed lines) is already shuttled and remains anteriorly, whereas the nitinol wire (arrow) coming from the humeral tunnel exits through the posterolateral portal. (B) The posterior limb of the graft (G) is shuttled into the joint by pulling on the nitinol wire from the posterolateral portal.

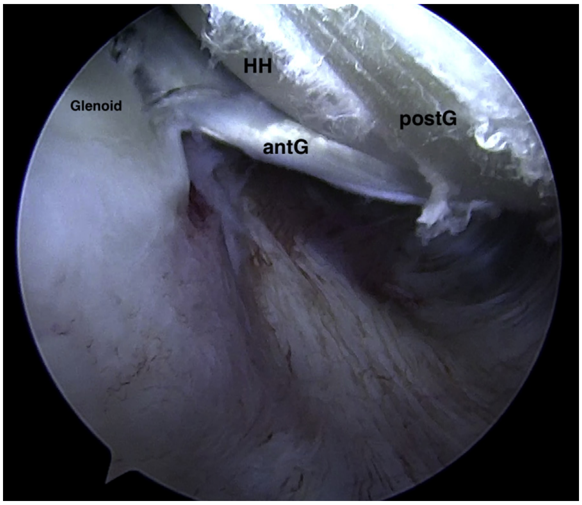

Fig 8. An intra-articular view through the posterior portal of a right shoulder shows the definitive construct with anterior (antG) and posterior (postG) limbs of the graft holding the humeral head (HH) inferiorly as a hammock. Final tensioning should be performed in the abduction and external rotation position.

influence of age and previous instability episodes on shoulder capsule composition, with younger patients and patients with multidirectional instability showing significantly higher elastin density.[17] At the same time, the presence of residual plastic deformity of the anteroinferior capsule (which includes the anterior bundle of the IGHL) due to repetitive dislocations or subluxations seems to play a crucial role.[18] These 2 conditions contribute to an insufficient capsuloligamentous complex that is prone to higher failure rates if only the native soft tissue has been repaired. In this case, a bone block procedure even without bony defects could present as a reasonable solution but does not address the underlying cause.[26,27] We also think that these patients would benefit from this technique as an anteroinferior augmentation, which will function as a restraint.

IGHL reconstruction was suggested as a possible solution more than 2 decades ago by Sanchez.[19] He described an all-arthroscopic technique transfixing the glenoid with a synthetic ligament (Leeds-Keio; Neoligaments, Leeds, UK) that is anchored to the posterior glenoid neck, shuttled anteriorly to the subscapularis, and finally anchored to the inferior humeral neck at the level of the circumflex vessels. Therefore, the reconstruction constituted an anterior, extra-articular constraint for the humeral head. Later, several authors described different intra-articular autograft configurations for reconstruction of the capsuloligamentous complex by using the iliotibial band or hamstring or tibialis anterior tendons.[20-22] In all cases, open surgery through a deltopectoral approach and detachment of the subscapularis from the humerus were performed. In addition, only the anterior capsuloligamentous complex—more specifically, the middle glenohumeral ligament and anterior band of the IGHL—was reconstructed. In contrast, the configuration proposed by Bouaicha and Moor[23] that aims to reconstruct both the posterior and anterior bands of the IGHL has the advantage of accurately reproducing the inferior ligamentous "hammock" and thus its biomechanical properties.

We present a modification of this technique using the PL tendon autograft. The main biomechanical advantage of this modified procedure is that it provides reconstruction of both limbs of the capsuloligamentous hammock compared with other techniques (Table 2). Thus, in the case of predominantly anteroinferior glenohumeral instability, the reconstruction will be more effective in the ABER position by constraining the humeral head. The PL has the advantage of reducing donor-area morbidity compared with hamstring autograft. Furthermore, by performing graft insertion and fixation in 2 steps, intra-articular suture management is simplified. This also allows accurate measurement of the desired graft length once the anterior limb is fixed. Regarding glenoid fixation,

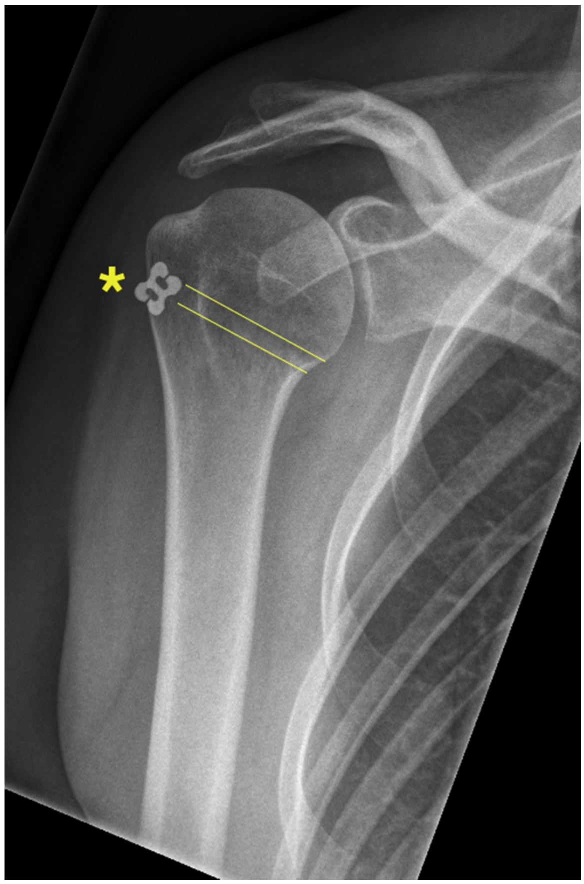

Fig 9. An anteroposterior radiograph of a right shoulder shows the correct position of the Dogbone plate (star) on the greater tubercle and the humeral transosseous tunnel (lines) for the tendon graft.

Table 2. Advantages and Disadvantages

Advantages	
	Because the procedure is performed in an all-arthroscopic manner, the capsular anatomy, as well as the integrity of the subscapularis tendon, is respected.
	Reconstruction of both limbs of the capsuloligamentous hammock complex is provided.
	The PL reduces donor-area morbidity compared with hamstring autograft.
	A cortical fixation device (Dogbone plate) is used on the humeral side instead of an interference screw, providing better stability and control during final graft tensioning.
Disadvantages	
	The PL tendon is weaker than the more robust hamstring.
	The PL tendon may be absent in a small group within the population.
	The technique is not suitable in cases of significant glenoid bone loss or an off-track Hill-Sachs lesion.
	Suture management and tensioning of the graft can be challenging.

PL, palmaris longus.

the limbs of the graft are fixed so that the sling arises from the inferior anchors conversely to the previously reported configuration,[23] making it positioned slightly lower. A cortical fixation device (Dogbone plate) is used on the humeral side instead of an interference screw to be able to achieve better fine-tuning and control during final graft tensioning. Finally, by performing the procedure in an all-arthroscopic manner, the capsular anatomy, as well as the integrity of the subscapularis tendon, is respected.

Potential disadvantages include the use of the weaker PL tendon compared with the more robust hamstring, which could hypothetically undermine the integrity of the construct. A further limitation is that the PL tendon may be absent in a small percentage of the population,[28] in which an alternative hamstring graft or an allograft should be used instead. Because this procedure does not address any osseous glenoid defects, it is not indicated in cases of significant bone loss. In the same way, an "off-track" Hill-Sachs lesion would compromise the success of the procedure. Although the procedure has the advantage of being performed in an all-arthroscopic manner, suture management and tensioning of the graft can be challenging. As noted, tensioning of the graft in the ABER position is critical to avoid overconstraining the glenohumeral joint, which might compromise the range of motion.

We believe that the described procedure might be suitable for primary cases with predominantly inferior glenohumeral instability with hyperlaxity but without bony deficiency in which poor capsular tissue quality is expected, as well as revision cases after failed arthroscopic Bankart repair. This technique, in theory, could be particularly effective in the absence of major glenoid bone loss. It can be viewed as an alternative solution prior to an arthroscopic or open nonanatomic bone block procedure.

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