Technical Note

Transglenoid Fixation Technique for Arthroscopic Subscapularis Augmentation Using an Adjustable-Length Loop Cortical Suspensory Fixation Device

Shiyou Ren, Ri Zhou, M.D., Siyao Guan, and Wentao Zhang, M.D.

Abstract: The optimal surgical management of anterior shoulder instability remains controversial. Although it has low recurrence rates and good clinical results, the Latarjet procedure has some disadvantages and is considered "overtreatment" in inactive patients with moderate glenoid bone loss. Several studies have described an arthroscopic technique called arthroscopic subscapularis augmentation. We developed a technical variation of the arthroscopic subscapularis augmentation technique involving tenodesis of the upper third of the subscapularis tendon using a graft. This technique uses a transglenoid fixation—immobilization with 2 knotless TightRope devices instead of anchors.

Anterior shoulder dislocation is common, with an incidence rate ranging from 8 to 25 per 100,000 person years in the general population, and causes recurrent instability of the shoulder joint, particularly in young patients.[1,2] Although it has low recurrence rates and good clinical results, the Latarjet procedure, which involves nonanatomic reconstruction, has some disadvantages and may limit functionality and increase the rate of secondary osteoarthritis by up to 60%.[3] The Latarjet technique and its variations are associated with a considerable number of intraoperative complications, the indications for bone graft procedures with anterior capsulolabral insufficiency are not well defined, and failure may occur after graft reabsorption.[4,5] In addition, Russo et al.[6] concluded that the Latarjet technique can be considered "overtreatment" in inactive patients with moderate glenoid bone loss (GBL).

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Johnson[7] was the first to report the technique using the subscapularis tendon to repair capsulolabral insufficiency and avoid a high complication rate, especially nerve palsy, a major complication. This technique was abandoned as the result of potential complications related to the metal staple used for fixation of the tendon to the glenoid edge.

There are 3 new techniques based on that reported by Johnson: using part of the subscapularis tendon, which is detached from the distal part and fixed at the anterior glenoid rim[8]; stabilizing the shoulder with a tendon graft and enhancing the anterior rim of the glenoid with the same graft[9]; and augmenting the anterior capsulolabral tissue using the articular portion of the subscapularis tendon and knotless suture anchors paired with high-strength tape for its fixation to the anterior glenoid edge.[10] Several studies have shown the advantages of anterior soft-tissue augmentation,[3,9-11] and for anterior shoulder instability with moderate GBL, it is an effective procedure without any significant differences from the open Latarjet procedure.[6]

We developed an arthroscopic subscapularis augmentation (ASA) technical variation involving tenodesis of the upper third of the subscapularis tendon using an autologous or allogeneic tendon and a transglenoid fixation immobilization technique with 2 knotless TightRope devices instead of an anchor (Fig 1). Currently, the indications for using the technique to treat recurrent anterior shoulder instability are insufficiency of the anterior capsulolabral unit in primary patients and patients with failed previous surgical

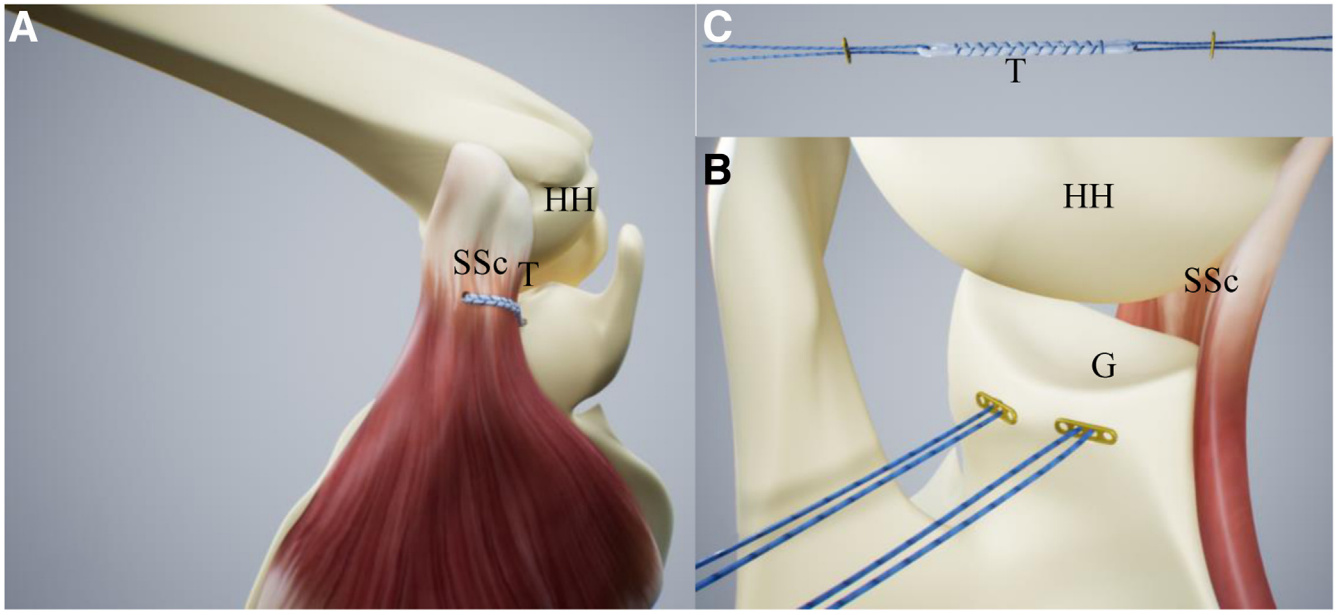

Fig 1. Schematic drawings of the arthroscopic subscapularis augmentation method (a and b) involving tenodesis of the upper third of the subscapularis tendon using a graft (c) and a transglenoid fixation–immobilization technique with 2 knotless TightRope devices (b). (G, glenoid; HH, humeral head; SSc, subscapular tendon; T, tendon.)

procedures, Hill–Sachs lesions, and GBL (<20%).[3,6,10,11] The purpose of this study is to specify the details of the operation process. This study protocol was approved by the institutional review board of the Eighth Affiliated Hospital, Sun Yat-Sen University (No. 2023-018-01).

Surgical Technique (With Video Illustration)

The surgical technique is demonstrated in Video 1.

Preoperative Planning

Preoperatively, we perform preoperative imaging for patients with 3-dimensional computed tomography and the Pico surface area method[12] to ascertain the percentage of anteroinferior GBL and severity of Hill–Sachs lesions of the humeral head compared with the contralateral shoulder. Magnetic resonance imaging is effective in evaluating capsular insufficiency, the presence of a subscapularis tear, bony anomalies, and muscle pathology, including retraction and fatty infiltration. These images can aid in the decision-making process regarding repair of other tears in addition to fixation of tendon allografts or autografts. The indication is GBL <20%. Table 1 displays the indications and contraindications for this procedure.

Patient Positioning

Patients are positioned in the lateral decubitus position and secured in a "sloppy lateral" position with the patient's torso leaning posteriorly approximately 20 to 30°; the arm is maintained at 15° of forward flexion and 40° of abduction flexion and suspended in a traction arm holder (SPIDER 2; Smith & Nephew, Andover, MA) under 5 to 10 lb of traction. The operative shoulder and axilla are prepped and draped in the usual sterile fashion.[13]

Table 1. Indications and Contraindications for the Technical Variation of the ASA Technique

Indications	Contraindications
Activities requiring forceful external rotation and abduction movements of the shoulder	Increased ante- or retroversion of the glenoid
Anteroinferior capsulolabral insufficiency	Large Hill–Sachs defects
Glenoid bone loss <20%	Glenoid bone loss >20%
Loss of labral integrity after multiple dislocations and/or surgical labral reconstruction attempts	Preexisting glenohumeral osteoarthritis
Soft-tissue disorders (e.g., Ehlers–Danlos syndrome) or defects (e.g., electrothermal capsular necrosis) with anterior or anterior–inferior instability	Voluntary anterior, posterior, or multidirectional instability
Salvage procedure for "end-stage" instability	Subscapular tendon tear

ASA, arthroscopic subscapularis augmentation.

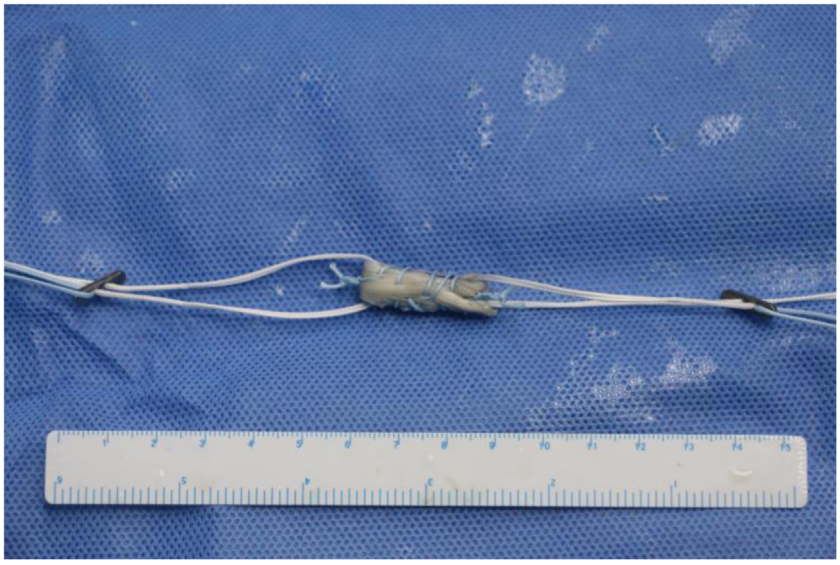

Fig 2. Final GraftLink construction after preparation with a quadrupled tendon and an anterior cruciate ligament TightRope RT on each side (right). Circumferential sutures are placed 10 mm on either end of the graft.

Tendon Graft Preparation

The reinforcing graft is either a tibialis anterior allograft or a semitendinosus autograft. The choice of graft is based on the patient's preference. Hamstring autografts are obtained in a standard fashion via a small incision below the knee. A graft-preparation station facilitates suturing the tendon into a loop, which is linked on each end to a suspensory fixation device (ACL TightRope and ACL TightRope RT; Arthrex, Naples, FL), similar to the links of a chain. The graft is approximately 2.5 cm in length (Fig 2).[14]

Posterior Glenoid Guide and Drilling

Standard anterior and posterior portals are used. An accessory anterior portal is set up into the glenohumeral joint just over the superior border of the subscapularis tendon. The damaged anterior labrum is debrided, and the glenoid rim is prepared with a burr to free the bone from any residual soft tissue and the labrum to create a bleeding bone bed, which will facilitate healing of soft tissue to the bone. The arthroscope is inserted into the joint through the anterosuperior portal. The hook of a special glenoid guide arm (Fig 3a) is inserted into the shoulder through the posterior portal, which is below the soft-spot portal. The hook is positioned at the equatorial line to the glenoid face to avoid damage to the articular surface and then advanced over the anterior edge. The hook is located at the center of the anterior glenoid (at the 3:30-clock positions of the glenoid) (Fig 3c). It is mandatory to align the glenoid guide with the posterior and anterior glenoid rims, according to the technique of Maiotti et al.[15] Once the guide is positioned, a sleeve is placed in each hole of the guide (Fig 3b). A 2-mm K-wire is drilled into the glenoid posteriorly to anteriorly through each hole of the guide. The anterior exit points of the K-wires are located 1 cm above the midpoint and 1 cm below the midpoint of the glenoid, and both are located 5 mm below the glenoid surface. The K-wire is overdrilled with a 4.0-mm cannulated drill to create 2 glenoid tunnels (Fig 3d). Two flexible looped guidewires are introduced into the joint by passing 1 wire through each cannulated drill in a posterior-to-anterior direction (Fig 4a).

The upper third of the subscapularis tendon is punctured approximately 20 mm from its superior border with a punch cannula device (Fig 5a and c). The cannula is introduced into the joint flush to the articular surface and just close to the anterior exit tunnel of the K-wires located 1 cm below the midpoint of the glenoid (Fig 5d). The lower flexible looped guidewire is fed out of the shoulder joint through the anterosuperior portal by the punch cannula device (Fig 4a and b), and the greater flexible looped guidewire is pulled out of the joint through the same portal to avoid the presence of soft tissue between the 2 guidewires (Fig 4c).

Passage of TightRopes

Flexible looped guidewires are used as leading sutures for the passage of the suspensory fixation devices. The TightRopes (one through the superior and one through the inferior drill hole; the inferior is pulled first, but the superior needs to bypass the subscapularis tendon) are pulled into the joint and introduced through the anterosuperior portal. The TightRopes are passed through the corresponding tunnels, and the graft is positioned just in front of the subscapularis tendon (Fig 4).

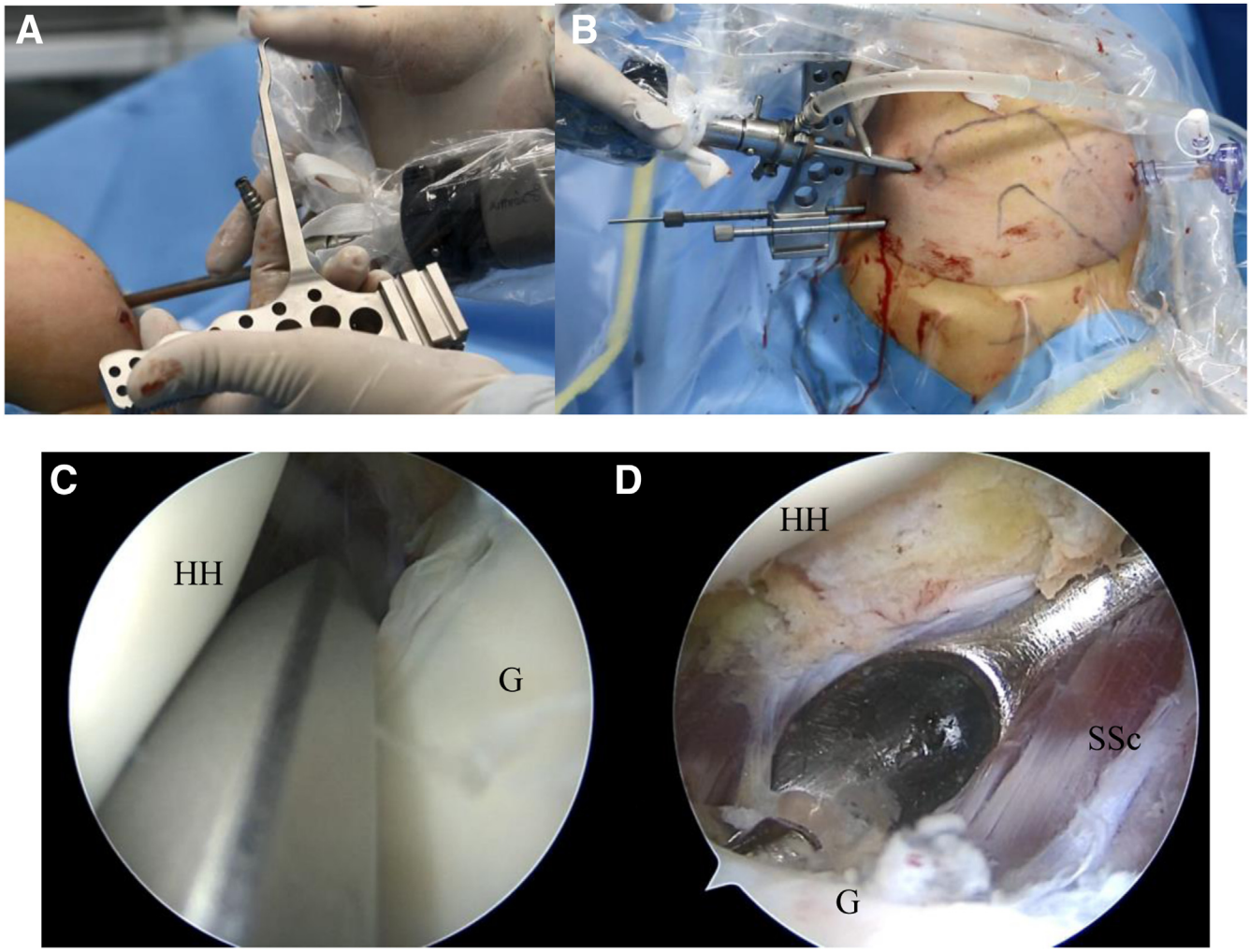

Fig 3. The hook of a special glenoid guide arm is used to create the transglenoid tunnels. (a) The hook of a special designed glenoid guide arm. (b) The guide is positioned, and a sleeve is placed in each hole of the guide. A 2-mm K-wire is drilled into the glenoid posteriorly to anteriorly through each hole of the guide. (c) The hook is positioned at the equatorial line to the glenoid face to avoid damage to the articular surface and then advanced over the anterior edge viewed, left shoulder from the posterior portal viewing. (d) The K-wire is overdrilled with a 4.0-mm cannulated drill to create 2 glenoid tunnels, left shoulder from the posterior portal viewing. (G, glenoid; HH, humeral head; SSc, subscapular tendon.)

Tensioning of the Transplant Graft

When the TightRopes are tensioned, the posterior buttons are placed on the cortex of the posterior glenoid neck. The final position of the graft is inspected to ensure that the graft touches the glenoid at the positions of the 2 drill holes and that there are no gaps, and the subscapularis tendon is brought tightly back to the anterior rim of the glenoid (Fig 6). The sutures of the TightRopes are cut with no knots due to their self-locking capabilities.

As a result, the transplant graft in front of the subscapularis tendon used as the sling is placed around the upper part of the subscapularis, and then the subscapularis is pulled posteriorly to the anterior glenoid rim (Fig 7).[9]

Postoperative Rehabilitation

Postoperatively, the shoulder is immobilized with dynamic shoulder immobilization in a special sling,[9-11] and external rotation is limited to neutral and 30° of abduction for 6 weeks. Passive shoulder range of motion (ROM) exercises is used to increase joint mobility, and pendulum exercises and wrist and hand exercises are permitted during this time. Active ROM exercises are started at 7 to 8 weeks, and the aim is recovery of full ROM. After that, we focus on the recovery of strength and proprioceptive abilities. When full ROM and strength are recovered, return to activity (basketball, football, et al.) is expected after 6 months.

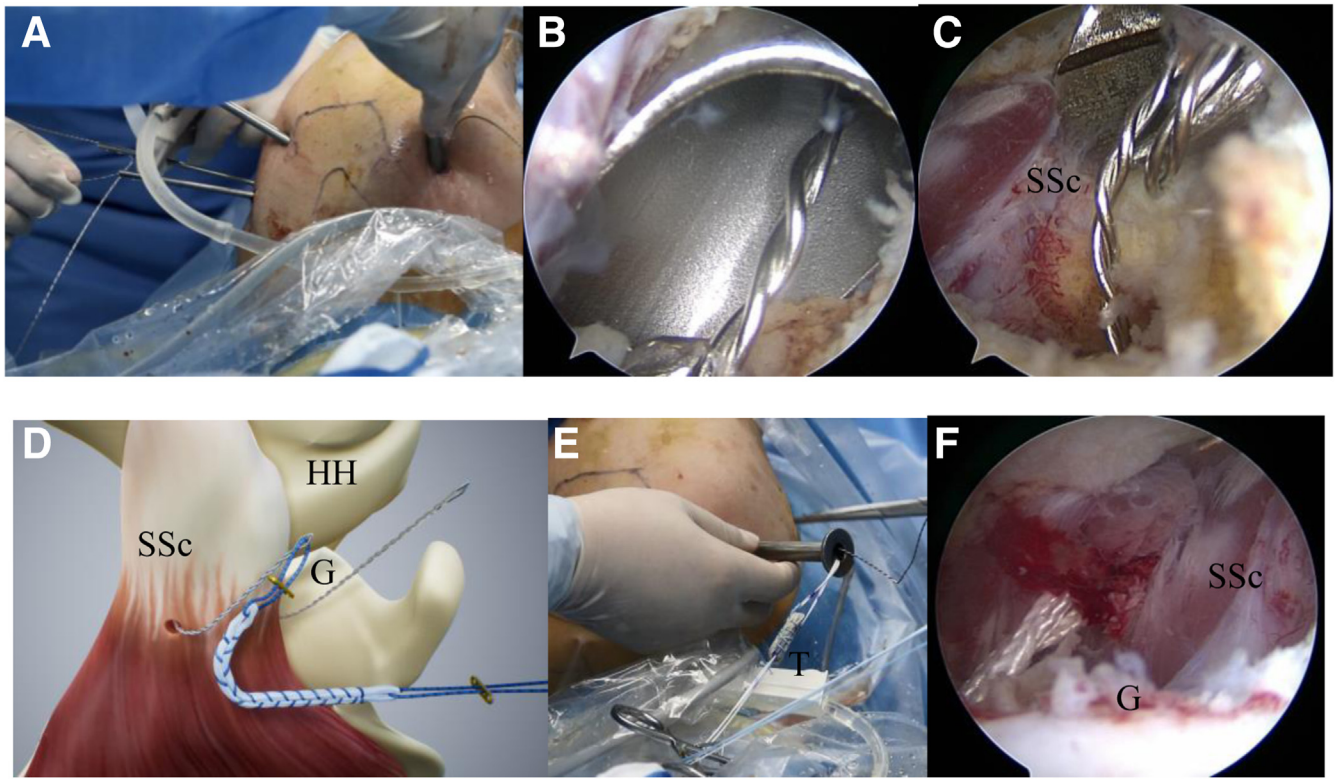

Fig 4. A punch cannula device is used to traverse the subscapularis tendon. (a) The special punch cannula device. (b) The cannula device is used to puncture subscapularis tendon. (c) The upper third of the subscapularis tendon is punctured approximately 20 mm from its superior border, left shoulder from the posterior portal viewing. (d) The cannula is passing through subscapularis tendon and introduced into the joint flush to the articular surface, left shoulder from the posterior portal viewing. (G, glenoid; HH, humeral head; SSc, subscapular tendon.)

Discussion

We introduce a technical variation for ASA using an adjustable-length loop for cortical suspensory fixation via a transglenoid route. The technique for subscapularis tenodesis is different from that of Klungsøyr et al.[9] and Maiotti and Massoni.[10] The graft is not doubled, and there is no graft on the rim of the glenoid anteriorly. The loop that binds the subscapularis consists of the graft and anterior rim of the glenoid. In addition, the transglenoid technique[16] is used to avoid procedures on the anterior surface of the subscapularis muscle, which might damage the axillary nerve. Furthermore, no suture anchors are used to immobilize the subscapularis in the procedure,[10,17] which might limit proper sliding of the subscapularis tendon. In contrast, Klungsøyr et al.[9] verified that the loop had no adverse effect on sliding of the subscapularis tendon with the arm in abduction. Because there are virtually nonexistent glenohumeral ligaments in chronic recurrent dislocation, shoulder stabilization has to involve the subscapularis tendon,[7] we performed most of the described surgeries without Bankart repair. In addition, arthroscopic Hill–Sachs remplissage, if needed, can be combined[18] in young patients with an anterior GBL of less than 20% and capsular deficiency, thereby addressing Hill–Sachs lesions without changing the anatomy of the coracoacromial arch.

As previously reported, after isolated Bankart repair was performed for patients with anterior shoulder instability and less than 25% GBL, the recurrence rate ranged from 0% to 40%,[3] high recurrence rate of Bankart repair caused a widespread need for Bristow–Latarjet procedures worldwide. Although it has a low recurrence rate and good clinical results,[19] there are some disadvantages to the open Latarjet procedure, whose overall complication rate is 15%,[20] and the arthroscopic Latarjet technique is more time-consuming and expensive.[21] The surgical area of both the open and arthroscopic Latarjet procedures is not only on the anterior surface of the subscapularis muscle but also close to the axillary nerve, and there have been reports of injuries to the nerve.[22]

However, the "triple effect" that results in success of the Latarjet procedure is worth learning: the coracoid bone graft effectively lengthens the glenoid in the anteroposterior dimension, the lower subscapularis muscle fibers reinforce the inferior glenohumeral ligament by the conjoint tendon, acting as a sling

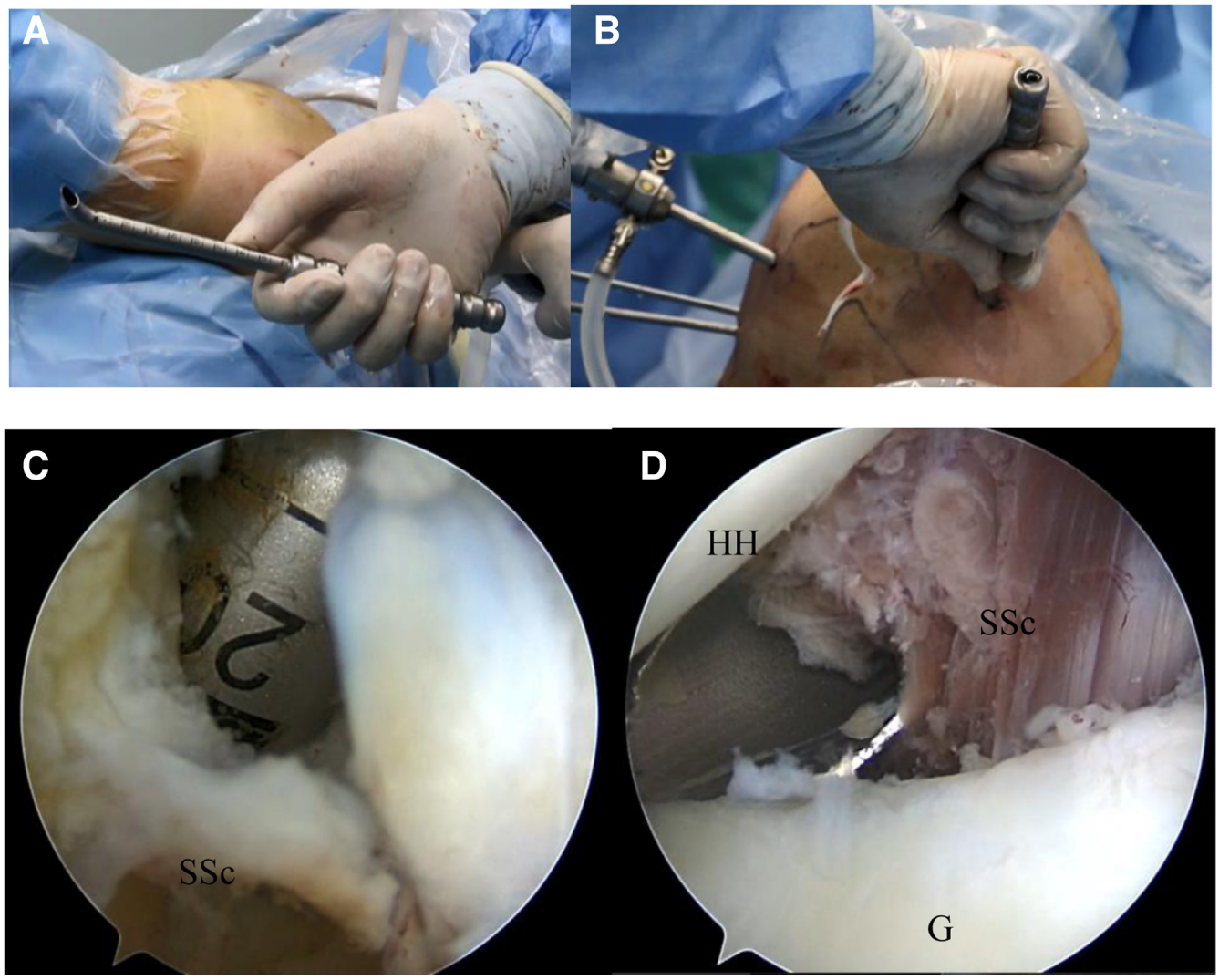

Fig 5. Flexible looped guidewires are used as leading sutures for passage of the suspensory fixation devices. (a) The flexible looped guidewire is introduced into the joint by cannulated drills. (b) The lower flexible looped guidewire is fed out of the shoulder joint through the anterosuperior portal by the punch cannula device, left shoulder from the posterior portal viewing. (c) Both flexible looped guidewires are pulled out of the joint through the same portal to avoid the presence of soft tissue between the 2 guidewires, left shoulder from the posterior portal viewing. (d) Schematic drawings of passage of TightRopes. (e) Flexible looped guidewires are used as leading sutures for the passage of the suspensory fixation devices viewed from the anterosuperior portal. (f) The loop of suspensory fixation devices is passing through SSc, left shoulder from the posterior portal viewing. (G, glenoid; HH, humeral head; SSc, subscapular tendon.)

(hammock effect),[11] and the lateral aspect of the anterior capsule is strengthened by imbrication of the coracoacromial ligament, which acts as an additional restraint.[11] To prevent anterior shoulder dislocation, the surgeon's attention is given to the subscapularis. In 2011, Denard et al.[23] described arthroscopic Bankart augmentation for capsulolabral deficiency using a split subscapularis tendon flap to reinforce a damaged capsule. In 2013, Maiotti and Massoni[10] proposed Bankart repair combined with an ASA technique to treat recurrent instability with a moderate glenoid bone defect and capsular deficiency. In 2014, Chaudhury et al.[17] reported an arthroscopic subscapularis tenodesis technique as a salvage procedure for challenging glenohumeral instability cases; the subscapularis tendon and capsule were sutured together, and the rotator interval was closed with superior and medial advancement of anterior and inferior tissue. In 2021, Klungsøyr et al.[9] reported a method involving creating a sling around the subscapularis tendon, using a hamstring graft and enhancing the anterior rim of the glenoid with the same graft to stabilize the shoulder. In 2019, Ren et al.[11] reported a new anatomical surgical technique combining ASA with tenodesis of the upper third of the tendon using a graft, arthroscopic capsulolabral

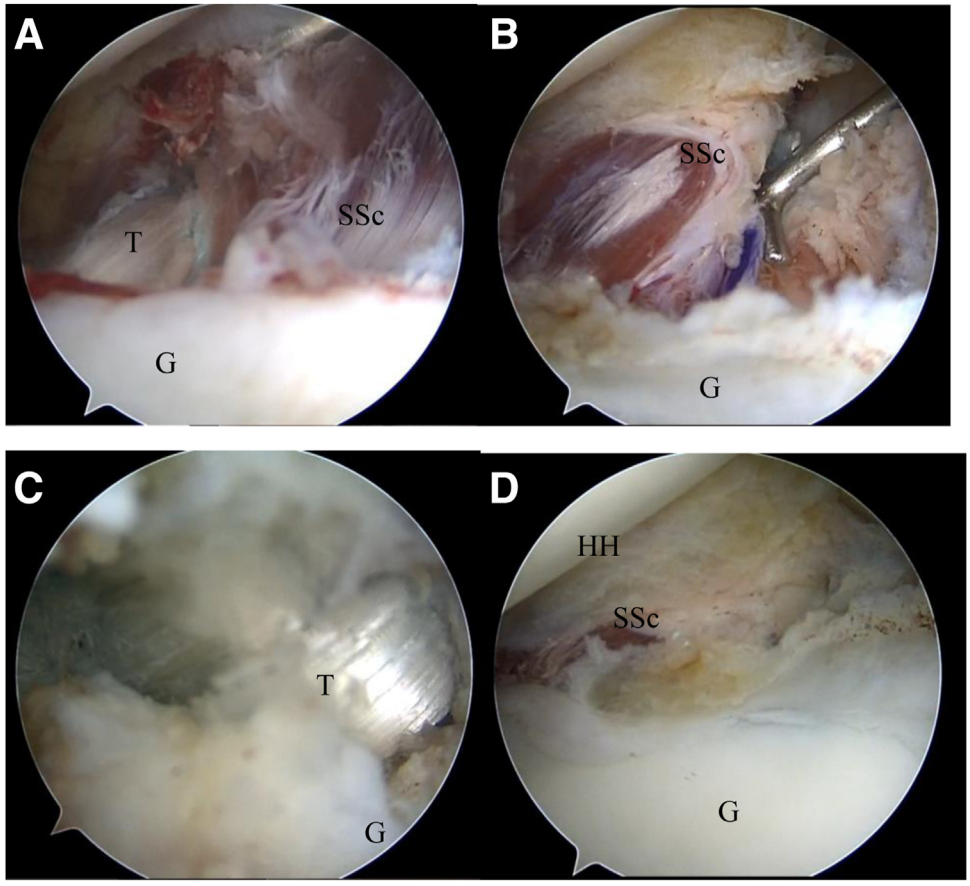

Fig 6. (a) The inferior suspensory fixation devices is tensioned, tendon is passing through the SSc, left shoulder from the posterior portal viewing. (b) The loop of the upper suspensory fixation devices is over the SSc before it is tensioned, left shoulder from the posterior portal viewing. (c) The upper tendon bypasses the superior border of the subscapularis tendon after the upper suspensory fixation devices is tensioned, viewed from the anterosuperior portal. d. Both TightRopes are tensioned (the inferior tendon is tensioned before the upper tendon), and the subscapularis tendon is brought tightly back to the anterior rim of the glenoid, left shoulder from the posterior portal viewing. (G, glenoid; HH, humeral head; SSc, subscapular tendon; T, tendon.)

reconstruction, and reconstruction of the anterior band of the inferior glenohumeral ligament with tendon grafts (allografts or autografts).

It has been confirmed that upper subscapularis tenodesis, as an anterior barrier, has a good biomechanical effect in recentering the humeral head.[9,15,24] In the technique presented herein, a sling with 2 legs attached to the glenoid is created, which prevents inferior movement better than the Latarjet sling with one leg fixed to the glenoid rim.[6,9] The 2-legged sling prevents the subscapularis muscle from being pulled inferiorly, and the subscapular muscle is used as a

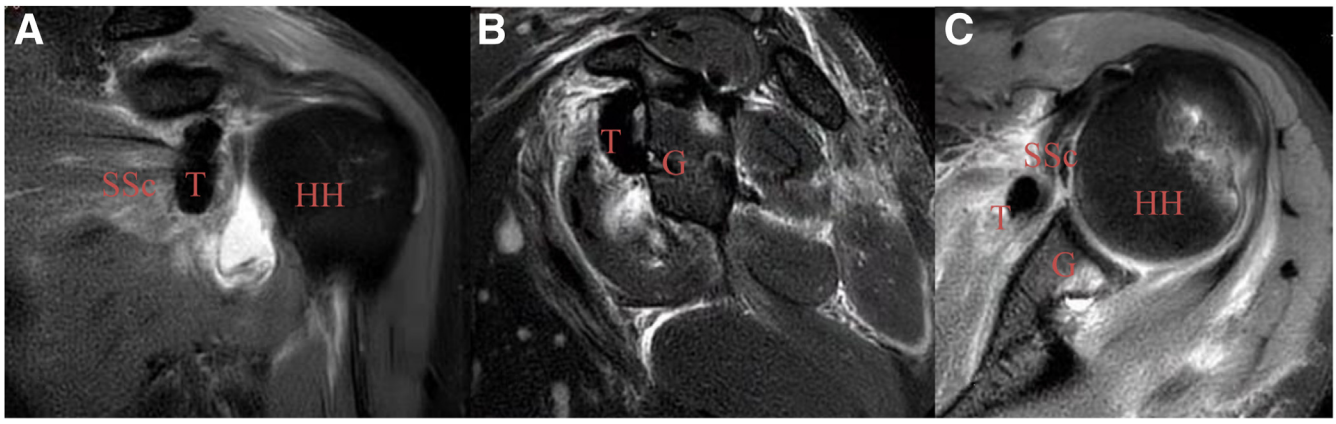

Fig 7. MRI showing use of the transplant graft in front of the subscapularis tendon as a sling, placed around the upper part of the subscapularis. (a) The tendon is in front of the SSc, from coronal view. (b) The tendon loop and the upper third of the subscapularis tendon, from the sagittal view. (c) The subscapularis tendon is brought back to the anterior rim of the glenoid, from the cross-sectional view. (G, glenoid; HH, humeral head; MRI, magnetic resonance imaging; SSc, subscapular tendon; T, tendon.)

Table 2. Advantages and Disadvantages

Advantages	Disadvantages
Arthroscopic technique—easier learning curve	Donor-site morbidity is possible
Less risk of nerve injury	Potential for inappropriate graft length, which may cause excessive tension or laxity of the subscapularis
Graft compression is perpendicular allowing better healing—2 knotless TightRope devices offer a self-securing method that provides good fixation	Additional surgical time needed for tendon harvest
Less invasive and minimal change of anatomy—the coracoacromial arch is not modified, and the integrity of the subscapularis is not affected	Dependent on full integrity of the subscapular tendon
The posterior guide allows optimal placement of the tunnels, ensuring a good-distance between tunnels in the anterior glenoid	There is a risk of poor healing of the tendon grafts and bone without bone socket
The graft passes through the rotator interval easily with the help of a cannula	Improper length of the graft causes inadequate fixation of subscapularis muscle
The tenodesis has little effect on subscapular tendon slipping	No clinical evidence

mechanical barrier to prevent anterior instability, hampering inferior movement and providing additional stabilization.[11]

We consider the proposed technique to have several advantages (Table 2). We recommend controlling the direction of the bone tunnels with a specifically designed glenoid guide arm to avoid graft malpositioning. The risk of nerve injury is minimized by performing less work in the anterior compartment of the shoulder and creating a minimal incision in the anterior portal. However, this technique has some limitations. The graft is fixed to the bone tunnel surface on the glenoid without a bone socket. Therefore, there is a risk of poor healing of the tendon grafts and bone. In addition, harvest-site morbidity is also a concern, and autologous tendons are the gold standard compared with allografts. The length of the graft is very important, and a short graft might yield an inadequate surface area for graft−bone incorporation; however, a long graft might result in the graft "bottoming out," resulting in inadequate tension on the subscapularis tendon. Although long-term follow-up clinical studies are still needed, we believe that the proposed ASA technical variation is safe and easily reproducible, does not require a long learning curve, and restores joint stability. Therefore, we recommend its use in cases of chronic anterior shoulder dislocation without severe GBL (>20%).

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