Use of a Knotless Suture Anchor to Perform Double-Pulley Capsulotenodesis of Infraspinatus



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Abstract: In this Technical Note, we describe an arthroscopic remplissage procedure to treat anterior instability. Specifically, we use a technique to perform double-pulley capsulotenodesis of the infraspinatus tendon using a Knotless SutureTak Suture Anchor (Arthrex, Naples, FL). This is a modification of a previously described double-pulley technique. The primary advantage of our technique compared with the previous double-pulley techniques described is that knot tying is not required.

Posterosuperior humeral head bone defects are commonly known as Hills-Sachs lesions. A total of 47% of first-time dislocators and up to 90% of those with recurrent anterior instability will have a Hill-Sachs lesion.¹ Filling of the humeral head defect with the posterior capsule and infraspinatus was first described in 1972 by Connolly² as a way to decrease instability. In 2004, Wolf and Pollack³ developed the arthroscopic "remplissage" procedure combined with a Bankart repair as a means for addressing anterior shoulder instability with a large, engaging Hill-Sachs lesion and a bony Bankart lesion involving <25% of the glenoid.

Subsequently, in 2009, Koo et al.⁴ described a modification of this procedure termed the "double-pulley remplissage." In this modification, one suture anchor was placed anteriorly and the other posteriorly in the Hill-Sachs defect, the sutures were then passed through

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the tendon of the infraspinatus, and finally, one suture from the anterior suture anchor was tied to a suture from the posterior anchor, allowing the eyelets of the 2 suture anchors to be used as pulleys. This creates a double-mattress suture that has a few advantages over the previously described technique. First, it creates a large footprint of fixation, insets the infraspinatus tendon into the defect as opposed to muscle, and leads to less necrosis of the infraspinatus muscle because the knots are tied over a broader area.

In this Technical Note, we describe a modification of the double-pulley technique described by Koo et al.⁴ In our technique, we use a Knotless SutureTak Suture Anchor (Arthrex, Naples, FL) to perform capsulotenodesis. This has the advantage of creating a double-pulley repair without needing to tie arthroscopic knots.

Surgical Technique

Preoperative Workup

A thorough shoulder instability history needs to be performed, which includes number of dislocations, age at first dislocation, direction of dislocation, and time of most recent dislocation. Then a thorough instability examination needs to be performed that includes evaluating the Beighton score for ligamentous laxity, sulcus sign, load and shift test to confirm the direction of instability, and an apprehension and relocation test.

Standard shoulder radiographs including an anteroposterior, internal rotation view, and axillary view are first obtained. A magnetic resonance imaging scan will need to be obtained to further analyze glenoid and

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Fig 1. (A and B) Right shoulder: the view from the posterior portal after fixation of the labrum. This was fixed with 1 knotted suture and 2 knotless PushLock suture anchors (Arthrex). (G, glenoid; HH, humeral head; L, labral repair.)

humeral bone loss, as well as rotator cuff pathology. Our criteria for performing arthroscopic remplissage with a Bankart repair are bipolar lesions that are "off track" or just slightly "on track" as defined by Di Giacomo et al.,⁵ and glenoid bone loss of less than 25%.^{6,7}

Surgical Positioning, Diagnostic Arthroscopy, and Labral Repair

After the induction of general anesthesia, the patient undergoes physical examination in a supine position, comparing the injured side with the contralateral side, which is standard of all arthroscopic procedures (Video 1). This examination includes a load and shift for instability to gain a sense for direction, degree, and arm position during instability. The patient is then positioned in a lateral decubitus position on a beanbag with the use of a padded arm sleeve and balanced suspension traction (STAR Sleeve, Arthrex). A standard posterior viewing portal is established approximately 1 cm medial and 2 cm inferior to the posterolateral edge of the acromion. Additional portals are established under direct arthroscopic visualization by an outside-in technique. First, a standard mid glenoid, anterior portal is established superior to the rolled border of the upper half of the subscapularis. Then an anterosuperolateral portal is established 1 cm below the clavicle and lateral to the coracoid. This portal should enter the rotator interval at the level of the long head of the biceps tendon. An additional accessory portal is placed superolateral to the posterior portal, which will be used for the transtendon sutures, and should grant access to the lateral and medial aspects of the Hill-Sachs lesion. A standard diagnostic arthroscopy is performed within the glenohumeral



Fig 2. (A) The Hill-Sachs preparation with the burr. (B) Bony preparation with the shaver. These instruments are used to remove all fibrocartilage from the posterior humeral head to prepare for suture anchor palcement. (HH, humeral head; HS, Hill-Sachs lesion.)



Fig 3. Spinal needle being used to locate the center of the Hill-Sachs lesion. The humeral head rotation is controlled so that the needle arrives perpendicular to the bone defect. (HH, humeral head; HS, Hill-Sachs lesion.)

joint, and pathology is appropriately addressed. Labral pathology is addressed with a standard suture anchor technique, reapproximating the inferior and middle glenohumeral ligaments to their normal position (Fig 1). Care is taken to adequately liberate the labrum from the glenoid and to sufficiently biologically prepare the bony glenoid for healing. Each capsulolabral bite of tissue is reduced "one hour" up the clock face for adequate shift and reduction. We typically use a combination of knotless and knotted suture anchors depending on trajectory of placement. When knots are used, care is taken to keep the suture knots away from the articular cartilage.

Repairing the Hill-Sachs Lesion With Remplissage

Throughout fixation, care is taken to ensure that no excessive tension is put on the Bankart repair. The arm is brought to an abducted position to visualize the Hill-Sachs lesion. With the arthroscope in the posterior portal, the Hill-Sachs lesion is first biologically prepared, working through the accessory posterior portal, using a combination of curette, burr, and shaver to create bleeding bone to accept the tendon (Fig 2). Then the rotation of the humeral head is controlled and a spinal needle is localized central and perpendicular to the center of the Hill-Sachs lesion (Fig 3). The arthroscope is placed in the subacromial space and bursal tissue is cleared out around the spinal needle. A cannula is placed in the subacromial space. This cannula should dock against the posterior cuff tendon but not enter the joint. This ensures that deltoid will not be iatrogenically injured or strangulated during anchor placement and capsulotenodesis of the posterior cuff.

With our remplissage technique, we aim to pass the sutures just lateral to the musculotendinous junction. Two 3.0-mm SutureTak Anchors (Arthrex) are placed in the Hill-Sachs lesion; one is placed laterally and the other medially in the lesion (Fig 4). The free suture from one knotless SutureTak is threaded into the looped suture of the other, and tensioned while viewing from inside the joint to see the reduction. This allows for partial reduction of the infraspinatus into the lesion (Figs 5 and 6). Next, the remaining free suture from one anchor is passed through the remaining looped suture of the other knotless SutureTak to allow complete reduction of the infraspinatus tendon into the Hill-Sachs lesion in a reinforced double-pulley mattress technique (Fig 7). Finally, the sutures are cut. The fixation can be visualized through both the intra-articular and subacromial spaces.



Fig 4. (A) Placement of the first SutureTak anchor on the medial aspect of the Hill-Sachs lesion. (B) Drilling for the second suture anchor. (C) Placement of both suture anchors in the bony defect. At this point, the cannulas are at the level of the infraspinatus, so when the suture is tightened, the infraspinatus will cinch down into the defect. (HS, Hill-Sachs lesion; IS, infraspinatus.)



Fig 5. (A) The looped end of the Arthrex SutureTak that is in the medial aspect of the Hill-Sachs lesion. (B) The placement of the white end of the SutureTak taken from the lateral suture anchor going through the loop from the medial suture anchor. (C) The pulling of the white end of the suture that will then cinch down to reduce the infraspinatus into the lesion. The same steps are performed with the loop from the lateral suture anchor and the white end of the suture from the medial anchor to complete the knotless double pulley. (APP, accessory posterior portal.)

Postoperative Rehabilitation

Our postoperative protocol requires the patient to use a sling for first 6 weeks; during this time, only passive motion is allowed under the supervision of a physical therapist. Weeks 1 through 3 allow for passive supine external rotation to 0° , forward elevation to 90° , and no internal rotation. Beginning at 4 weeks postop, passive external rotation to 30° is allowed with progression to full forward elevation. At week 6, active motion is begun with progression to full forward elevation and full external rotation by week 12. Internal rotation is allowed at this stage. At week 8, resisted exercises are begun with seated rows, shoulder shrugs, bear hugs, and forward punch. At week 10, light weight training can begin, avoiding anterior capsular stress. Hands are kept in eyesight and elbows are bent to avoid lever arms. Overhead activity is minimized at this stage. Military press, latissimus pulls behind the head, and wide grip bench are avoided at this stage.

Patients are allowed to return to computer early on. Return to golf for chipping and putting is at 12 weeks. Tennis without overheads is allowed at 16 weeks. Contact sport is allowed at 6 months.

Discussion

The purpose of this Technical Note is to describe a modification to the arthroscopic remplissage procedure using the double-pulley technique described by Koo et al.,⁴ with the use of the SutureTak (Arthrex) to perform the infraspinatus tenodesis without tying knots.

Arthroscopic remplissage with a concomitant Bankart repair has been well outlined in the literature as a useful technique to address anterior humeral instability with an engaging Hill-Sachs lesion. At this point, it is unclear in the literature as to the exact amount of glenoid bone loss present that can still be addressed with this type of fixation without the need for bony work on the glenoid. Koo et al.⁴ and Bigliani et al.⁸



Fig 6. The image taken from the surgical technique guide for the Arthrex Knotless SutureTak, which shows how the self-locking technology works. (This image provided courtesy of Arthrex.)



Fig 7. (A) The view from the anterosuperolateral portal shows the capsulotenodesis after the first SutureTak is cinched down. (B) The final capsulotenodesis after the second SutureTak is cinched down. (HH, humeral head; IS, infraspinatus; PC, posterior capsule.)

require that glenoid bone loss be less than 25%. Burkhart and De Beer⁹ describe the inverted-pear glenoid, which is a bony Bankart lesion that narrows the inferior half of the glenoid to a width that is less than that of the superior half of the glenoid. This type of glenoid bone loss is a contraindication to arthroscopic repair and requires an open procedure, whether the Latarjet or Bankart procedure. Finally, Di Giacomo et al.⁷ separated shoulders with anterior instability into 4 categories based on glenoid defect and an "on/off track" Hill-Sachs lesion. If the glenoid defect is less than 25% and the Hill-Sachs lesion is on track, then an arthroscopic Bankart repair will address the instability. If the glenoid defect is less than 25% and Hill-Sachs is off track, then a remplissage needs to be added to the arthroscopic Bankart. If the glenoid defect is greater than 25%, then a Latarjet must be performed regardless of whether the Hill-Sachs lesion is on or off track.

Boileau et al.¹⁰ had at least 2-year follow-up on 47 patients undergoing arthroscopic Hill-Sachs remplissage using 2 mattress sutures to create the capsulotenodesis. Ninety percent of those involved in sports were able to return to sport postoperatively and 68% returned to the same level of sports. Ninety-eight percent had a stable shoulder at the time of the last follow-up, and they only showed an external rotation deficit of 8° with the arm at the side and 9° with the arm in abduction. They mentioned that during this time period, 459 patients were operated on for recurrent traumatic anterior shoulder instability, but only these 47 patients were candidates for the arthroscopic remplissage because they had no glenoid bone loss. Merolla et al.¹¹ also looked retrospectively at their arthroscopic remplissage with anterior Bankart repairs with minimum 2-year follow-up. In their cohort, they too found loss of external rotation and some internal rotation that was significant but not functionally deficient. In their study, they also evaluated, via ultrasound, healing of the remplissage capsulotenodesis. All of their 61 patients showed healed remplissage on dynamic ultrasound at a median follow-up of 39.5 months.

The "pearls and pitfalls" and "advantages and disadvantages" are shown in Tables 1 and 2, respectively. Our only caution for application to this technique is in the revision setting. For bipolar bone lesions in a traumatic anterior instability patient, the technique we described works well in the primary setting. We would recommend open surgery for the revision scenario. This

Table 1.	Pearls	and Pitfall	s for	Knotless	Double-Pulley	Rem	plissage

Pearls	Pitfalls			
Use a spinal needle to localize the single portal that can reach the front and back of the Hill-Sachs defect	Ensure that bone quality is adequate to hold the anchor			
Use a "skinny" switching stick to allow simple passage of the cannulated drill guide with minimal damage to the rotator cuff	Ensure that the angle of insertion is appropriate to pierce the tendon and avoid skiving off bone			
Can use a separate tensioning device for the SutureTak to obtain more tension before cutting the suture	Ensure that an adequate leader of suture is placed through the loop of the recipient anchor to avoid unloading the anchor during suture retrieval			

Table 2. Advantages and Disadvanatge	s of Double-Pulley Remplissage
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Disadvantages
This technique does not require viewing the subacromial space, so care must be taken to ensure adequate linear spacing between the cuff insertion points

was shown by McCabe et al.¹² in 2014 when their results of arthroscopic Bankart repair with remplissage for engaging a Hill-Sachs lesion were reviewed. On their analysis, a failure rate of 36% was noted when used for revision instability cases.

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