Technical Note

All-Inside Knotless Remplissage Technique

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Abstract: Remplissage decreases the risk of recurrence after arthroscopic stabilization for recurrent anterior instability. Traditionally, the procedure requires accessing the subacromial space, which adds time and morbidity to the procedure. This Technical Note describes an all-inside technique for knotless remplissage with 2 interconnected anchors. By avoiding knot tying or accessing the subacromial space, the efficiency of the procedure is improved.

The ideal management of recurrent anterior glenohumeral instability continues to evolve. It is well established that glenoid bone loss increases the risk of recurrence after isolated Bankart repair.[1] Whereas the Latarjet procedure is required for critical bone loss, remplissage has emerged as an arthroscopic technique to decrease the risk of recurrence in the setting of an off-track lesion with subcritical glenoid bone loss. The efficacy of remplissage has been supported in both biomechanical and clinical investigations. Hartzler et al.[2] performed a biomechanical study on the effect of Bankart repair in a bipolar bone loss model and found that for shoulders with off-track lesions and at least 15% glenoid bone loss, adding remplissage prevented engagement of the lesion in all shoulders. Di Giacomo et al.[3] developed a paradigm for anterior instability and found that with less than 25% glenoid bone loss and an off-track HSL, Bankart repair plus remplissage adequately restored stability and prevented engagement of the HSL.

One limitation in the adoption of remplissage is the technical difficulty of the procedure. The original procedure, as described by Purchase et al.,[4] was performed with 2 anchors placed into the defect to tie down the posterior capsule and infraspinatus tendon in a mattress fashion. More recent methods have suggested interconnected knotless anchors to improve fixation and minimize the risk of knot failure.[5] However, both techniques require accessing the subacromial space after Bankart repair. This step adds time to the procedure and can be technically difficult given that the inferior anchor is often at the level of the teres minor.[6] This report describes a technique for an all-inside knotless remplissage that may be performed without the need to access the subacromial space.

Technique

The patient is placed in the lateral decubitus position. A low posterior portal is first created in standard fashion, and a diagnostic examination is performed. Standard portals for instability repair are also placed, consisting of an anterior portal just above the subscapularis tendon, as well as an anterosuperolateral portal. Once the presence of a Bankart lesion and Hill-Sachs lesion (HSL) is identified, the arthroscope is moved to the anterosuperolateral portal to obtain an en face view of the lesions. Glenoid bone loss and the HSL width are estimated with a calibrated probe. A dynamic examination can also be performed while visualizing through this portal. However, the primary decision making is based on glenoid bone loss and the glenoid track using the paradigm described by Di Giacomo et al.[3] In general, patients with less than 25% glenoid bone loss are managed arthroscopically and those with 25% or greater are managed with the Latarjet procedure. Among the former patients, those with on-track HSLs are managed with isolated Bankart repair whereas those with off-track HSLs are managed with combined Bankart repair and remplissage (Fig 1). As

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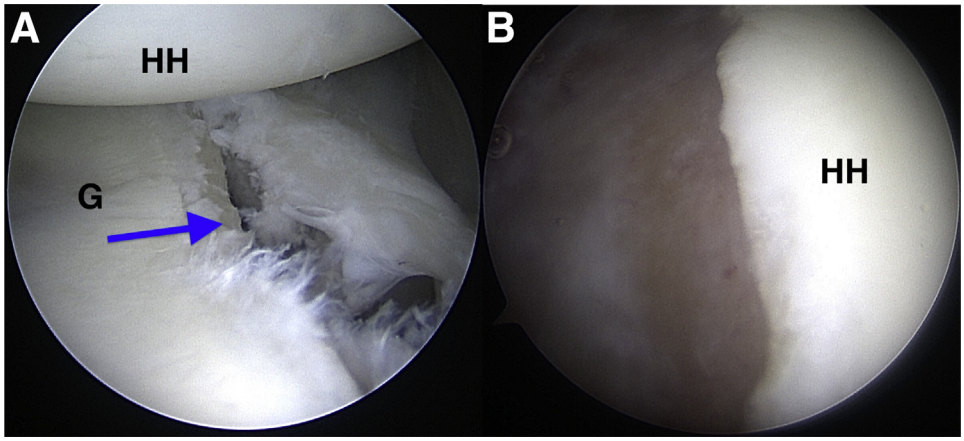

Fig 1. Arthroscopic view of left shoulder from posterior viewing portal with patient in lateral decubitus position. (A) Bankart tear (arrow) requiring repair. (B) Large Hill-Sachs lesion amenable to remplissage. (G, glenoid; HH, humeral head.)

our comfort with remplissage has grown and the current technique has simplified the procedure, the application of remplissage has broadened to include patients with borderline off-track lesions or patients with a high risk of recurrence despite having on-track lesions (e.g., young contact athletes).

After the diagnostic examination is completed, the next step is to prepare the HSL and place anchors for the remplissage. The humeral bone defect is prepared with an angled ring curette through the posterior portal. A spinal needle is then used to triangulate the center of the defect. The location is typically 1 to 2 cm lateral to the low posterior portal (Fig 2). The angle of approach is such that the posterior capsule and tendon can be inset into the defect through this portal without excessive medial or lateral tension. A switching stick is inserted until it can be seen to indent the capsule without advancing through the capsule. An 8.25-mm threaded cannula is then inserted over the switching stick without penetrating the capsule. This brings the cannula through the posterior deltoid down to the posterior capsule and tendon but not into the glenohumeral joint. The cannula is rotated in a circle to bluntly clear the subacromial space (Fig 3).

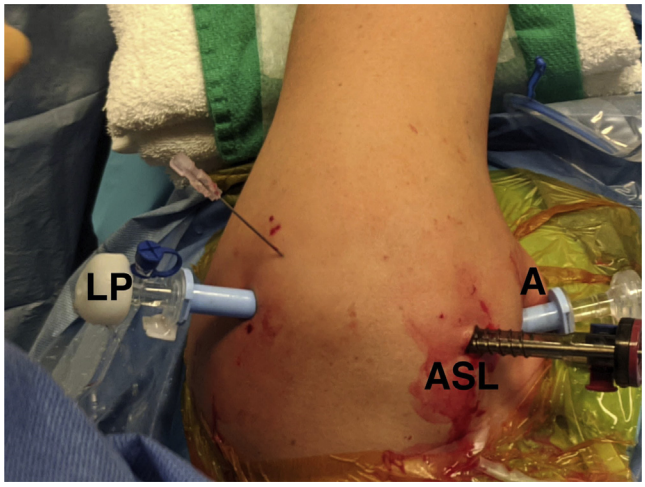

Fig 2. Outside view of left shoulder with patient in lateral decubitus position. A spinal needle is used to establish the angle of approach for the cannula that will be used for remplissage. This portal is typically 1 to 2 cm directly lateral to the low posterior portal (LP). (A, anterior portal; ASL, anterosuperolateral portal.)

A knotless interconnected anchor technique is used for the remplissage.[5] Two anchors are placed through the aforementioned cannula, one inferior and one superior. A guide is placed in the cannula, and a knotless all-suture anchor (2.6-mm Knotless FiberTak; Arthrex, Naples, FL) is passed through the capsule (Figs 4 and 5). Internal and external rotation of the shoulder can be adjusted slightly prior to advancing through the capsule to facilitate appropriate tension, which should be directly in line with the capsule and medial edge of the defect. The inferior anchor is placed first, at the bottom of the defect, because visualization of the inferior anchor is limited once the superior anchor is placed. While the cannula is maintained just superficial to the capsule, the guide is withdrawn and then reinserted through the capsule more superiorly at the top of the defect. At this point, both anchors have been passed through the posterior capsule. However, they are not interconnected because doing so closes down the glenohumeral joint space and may limit visualization. A hemostat is applied to the sutures from the respective anchors so that they can be properly identified when it is time to interconnect the anchors.

Next, the Bankart repair is performed. The labrum is prepared in the standard fashion. A knotless technique with 3 to 4 anchors (1.8-mm Knotless FiberTak; Arthrex) placed from inferior to superior is preferred. A curved guide facilitates placement of the inferior anchors through an anterior portal.[7] Alternatively, a percutaneous trans-subscapularis portal may be used to obtain a proper angle of approach to the inferior

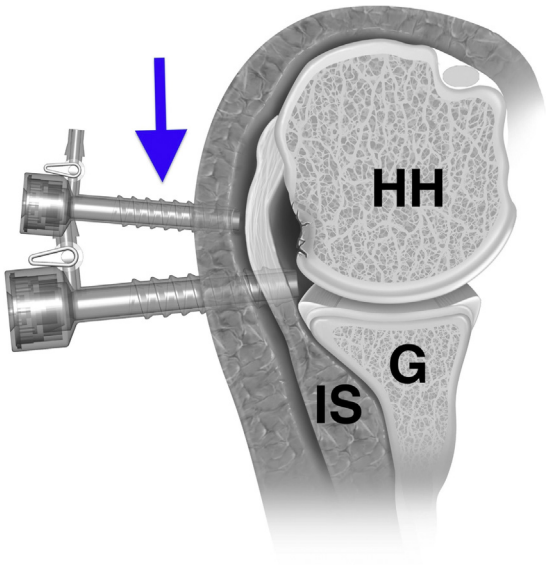

Fig 3. Cannula placement. The cannula for the remplissage anchors is centered over the Hill-Sachs lesion just lateral to the low posterior portal. It should be noted that this cannula (blue arrow) is passed through the deltoid but not advanced through the posterior capsule. (G, glenoid; HH, humeral head; IS, infraspinatus.)

glenoid. We prefer mattress configurations for these sutures.[8,9]

Once the Bankart repair is completed, the previously placed remplissage sutures are interconnected to inset the posterior capsule and tendon into the Hill-Sachs defect in a knotless double-mattress suture configuration. The repair suture from the inferior anchor is shuttled into the body of the superior anchor, which contains a knotless sheath. Likewise, the repair suture from the superior anchor is shuttled into the inferior anchor. The sutures are sequentially tightened until the posterior capsule and tendon are firmly compressed into the Hill-Sachs defect (Fig 6). Finally, the sutures limbs are cut with a closed knot cutter. Video 1 provides an overview of the full technique.

Postoperatively, patients are placed in a sling for 6 weeks with hand, wrist, and elbow motion only. At 6 weeks postoperatively, the sling is removed and passive range of motion (ROM), as well as strengthening, is allowed. External rotation is limited to half of that on the opposite side until 12 weeks postoperatively. Full activity including contact sports is allowed at 6 months postoperatively. Table 1 highlights pearls and pitfalls of the procedure.

Discussion

Remplissage has emerged as a powerful technique to reduce recurrence after arthroscopic stabilization for anterior glenohumeral instability. Both biomechanical and clinical studies support its use in patients with subcritical glenoid bone loss. The described technique may optimize the procedure by limiting complexity and surgical time.

Di Giacomo et al.[3] developed a paradigm for quantifying the glenoid track and determining whether an HSL will engage with the glenoid. An HSL that engages with the glenoid is noted as an "off-track" lesion. For an off-track lesion, remplissage can be used as a treatment option to reduce recurrent instability.[3] Tokish et al.[10] showed that the presence of an off-track lesion is associated with failure after an isolated Bankart repair. In a biomechanical study, Hartzler et al.[2] reported that the addition of remplissage to Bankart repair for off-track lesions with moderate bone loss (15%) prevented engagement in all specimens and restored stability. Among the specimens with off-track lesions in which an isolated Bankart repair was performed, all continued to show engagement at 90° of external rotation.

Conversely, several studies have reported that remplissage reduces the risk of recurrent instability.[11]

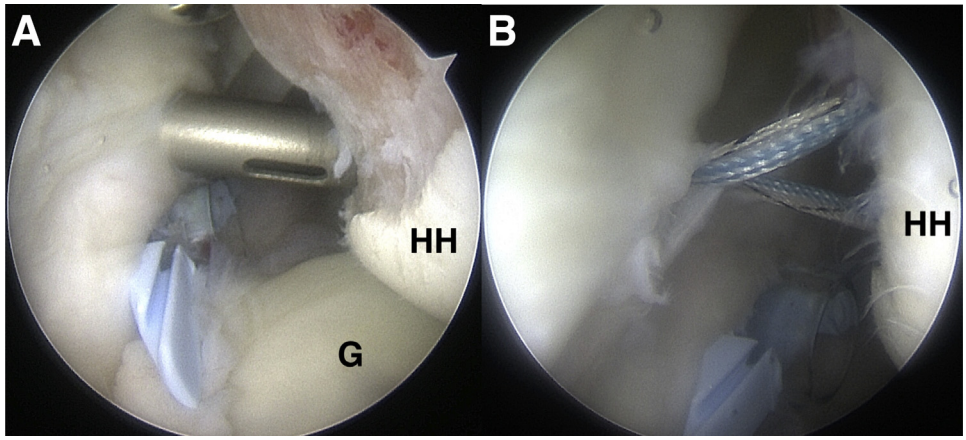

Fig 4. Arthroscopic view of left shoulder from anterosuperolateral portal with patient in lateral decubitus position. (A) The inferior anchor is placed first. (B) Viewing after placement of both anchors. (G, glenoid; HH, humeral head.)

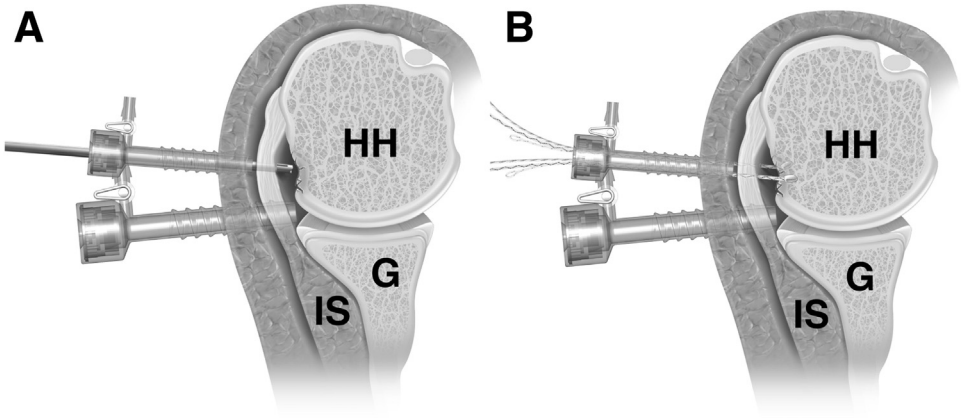

Fig 5. Anchor placement. (A) The guide is placed through the posterior cannula and through the capsule into the Hill-Sachs defect. (B) Two anchors are placed from inferior to superior, both at the medial edge of the defect. (G, glenoid; HH, humeral head; IS, infraspinatus.)

In a systematic review by Haroun et al.[12] comparing Bankart repair with remplissage versus the Latarjet procedure for engaging HSLs with subcritical bone loss, comparable clinical outcomes were found between the 2 procedures. There were no notable differences in recurrent instability with remplissage versus the Latarjet procedure, but a higher complication rate was found for the Latarjet procedure. Although some authors have suggested that the Latarjet procedure can be successfully used to treat all off-track HSLs, this procedure has shown higher complication rates in multiple studies.[2,13] Shah et al.[14] reported on the complication rate after the Latarjet procedure and found a rate of 25%, with complications including infection (6%), recurrent instability (8%), and neurologic injury (10%). In a clinical evaluation of 189 patients, Yang et al.[13] compared arthroscopic Bankart repair with remplissage versus the Latarjet procedure. In patients with subcritical bone loss (<25%), no difference in revision rate or recurrent instability was found between the 2 groups. However, the Latarjet group had a higher rate of complications (12.1% vs 1%).

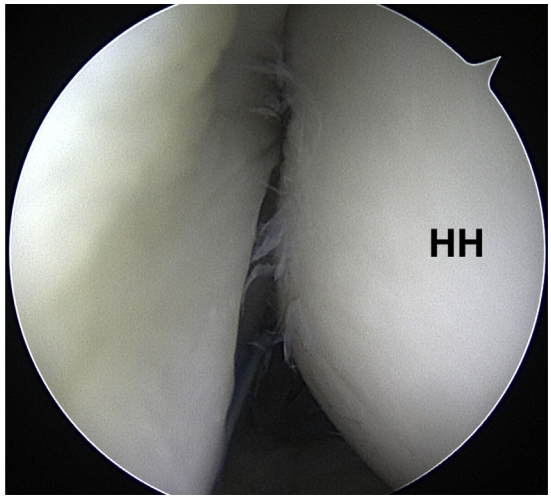

Fig 6. Arthroscopic view of left shoulder from anterosuperolateral portal with patient in lateral decubitus position showing completed remplissage construct. (HH, humeral head.)

Initially, descriptions of remplissage required tying knots. A double-pulley technique was often used to link 2 anchors to create a broad mattress configuration.[15] More recently, knotless anchors have been developed in which the knotless mechanism is within the anchor body or sheath itself. With these anchors, the repair suture can be passed through the tissue and then locked into the anchors themselves (as used for Bankart repair).[16] Alternatively, the repair sutures of 2 separate anchors can be interconnected to create a knotless mattress or double-pulley configuration.[17] Biomechanically, this type of construct for remplissage has been shown to improve load to failure compared with a knotted construct. In a biomechanical study of 7 matched pairs of cadavers, remplissage with a knotted versus knotless technique was compared.[5] The knotless constructs showed a higher load to failure (1,080 N vs 591 N), as well as a higher loading force to create up to 5 mm of displacement (788 N vs 488 N).

Despite initial theoretical concerns about a loss of external rotation with remplissage, clinical reports have failed to confirm this. In the study by Yang et al.[13] comparing arthroscopic Bankart repair with remplissage versus the Latarjet procedure, no significant differences in external rotation ROM were noted. In a systematic review of arthroscopic remplissage in 157 patients, Buza et al.[18] identified a 2.6° loss of external rotation. Omi et al.[19] performed an in vitro biomechanical study comparing remplissage for small (50%) and large (100%) HSLs. No differences in external rotation ROM were found in the small lesions in contrast to a large decrease in external rotation ROM in the large lesions. A systematic review by Liu et al.[20] looked at the effect of combined Bankart repair and remplissage for traumatic anterior shoulder instability

Table 1. Pearls and Pitfalls of All-Inside Knotless Remplissage

The cannula for remplissage anchor placement is just lateral to the standard posterior viewing portal and is established with a spinal needle to obtain the proper trajectory.
Once the cannula is advanced to the capsule, an assistant holds the cannula in place to avoid having it withdraw into the deltoid.
The anchors are placed from inferior to superior into the Hill-Sachs defect to aid visualization.
Anchor placement should be in line with the margin of the defect with neutral rotation of the arm to achieve proper tension.
The surgeon should complete the Bankart repair prior to interconnecting the remplissage anchors; failing to do so may limit visualization in the glenohumeral joint.

on recurrence rates and outcomes. They found minor decreases in external rotation ROM, with a range of −11.3° to −1.0° in 90° of external rotation and −8.0° to +4.5° of external rotation ROM with the arm adducted. In a systematic review of remplissage with Bankart repair, Alkaduhimi et al.[11] reported that multiple clinical studies failed to find a statistically significant difference in external rotation.

Our technique simplifies the approach to Hill-Sachs defects. Previous techniques have described a knotted double-pulley or knotless interconnected technique that requires access to the subacromial space. This step not only increases the length of the procedure but also carries the risk of suture damage while exposing the subacromial space. It is also notable that such exposure of the subacromial space is more difficult than a traditional exposure because the inferior sutures for remplissage typically pass through the teres minor. It is possible that these drawbacks have limited the adoption of remplissage for some surgeons. Disadvantages may include a lack of familiarity with the technique and difficult visualization when placing anchors into the Hill-Sachs defect, especially when placing the superior anchor first. The current technique provides a safe alternative for remplissage without accessing the subacromial space.

In conclusion, an all-inside remplissage procedure can be used to place a knotless interconnected double-pulley mattress construct and avoids tying sutures in the subacromial space. This saves time by avoiding knot tying and suture damage when clearing the subacromial space.

References

1. Burkhart S, De Beer J. Traumatic glenohumeral bone defects and their relationship to failure of arthroscopic Bankart repairs: Significance of the inverted-pear glenoid and the humeral engaging Hill-Sachs lesion. *Arthroscopy* 2000;16:677-694.
2. Hartzler RU, Bui CNH, Jeong W, et al. Remplissage of an off-track Hill-Sachs lesion is necessary to restore biomechanical glenohumeral joint stability in a bipolar bone loss model. *Arthroscopy* 2016;32:2466-2476.
3. Di Giacomo G, Itoi E, Burkhart SS. Evolving concept of bipolar bone loss and the Hill-Sachs lesion: From "engaging/non-engaging" lesion to "on-track/off-track" lesion. *Arthroscopy* 2014;30:90-98.
4. Purchase RJ, Wolf EM, Hobgood ER, Pollock ME, Smalley CC. Hill-Sachs "remplissage": An arthroscopic solution for the engaging Hill-Sachs lesion. *Arthroscopy* 2008;24:723-726.
5. Funakoshi T, Hartzler R, Stewien E, Burkhart S. Remplissage using interconnected knotless anchors: Superior biomechanical properties to a knotted technique? *Arthroscopy* 2018;34:2954-2959.
6. Lädermann A, Arrigoni P, Barth J, et al. Is arthroscopic remplissage a tenodesis or capsulomyodesis? An anatomic study. *Knee Surg Sports Traumatol Arthrosc* 2016;24:573-577.
7. Liu JN, Gowd AK, Garcia GH, Cvetanovich GL, Cabarcas BC, Verma NN. Recurrence rate of instability after remplissage for treatment of traumatic anterior shoulder instability: A systematic review in treatment of subcritical glenoid bone loss. *Arthroscopy* 2018;34:2894-2907.
8. Moran CJ, Fabricant PD, Kang R, Cordasco FA. Arthroscopic double-row anterior stabilization and Bankart repair for the "high-risk" athlete. *Arthrosc Tech* 2014;3:65-71.
9. Nolte P, Midtgaard K, Ciccotti M, et al. Biomechanical comparison of knotless all-suture anchors and knotted all-suture anchors in type II SLAP lesions: A cadaveric study. *Arthroscopy* 2020;36:2094-2102.
10. Tokish JM, Shaha JS, Cook JB, et al. Predictive value and clinical validation of the "on-track" vs. "off-track" concept in bipolar bone loss in anterior glenohumeral instability. *J Shoulder Elbow Surg* 2016;25:23-31.
11. Alkaduhimi H, Verweij L, Willigenburg N, van Deurzen D, van den Bekerom M. Remplissage with Bankart repair in anterior shoulder instability: A systematic review of clinical and cadaveric literature. *Arthroscopy* 2019;35:1257-1266.
12. Haroun HK, Sobhy MH, Abdelrahman AA. Arthroscopic Bankart repair with remplissage versus Latarjet procedure for management of engaging Hill-Sachs lesions with subcritical glenoid bone loss in traumatic anterior shoulder instability: A systematic review and meta-analysis. *J Shoulder Elbow Surg* 2020;29:2163-2174.
13. Yang JS, Mehran N, Mazzocca A, Pearl M, Chen V, Arciero R. Remplissage versus modified Latarjet for off-track Hill-Sachs lesions with subcritical glenoid bone loss. *Am J Sports Med* 2018;46:1885-1891.
14. Shah A, Butler RB, Romanowski J, Goel D, Karadagli D, Warner JP. Short-term complications of the Latarjet procedure. *J Bone Joint Surg Am* 2012;94:495-501.
15. Arrigoni P, Brady PC, Burkhart SS. The double-pulley technique for double-row rotator cuff repair. *Arthroscopy* 2007;23:675.e1-675.e4.
16. Ratner D, Rogers J, Tokish J. Use of a knotless suture anchor to perform double-pulley capsulotenodesis of infraspinatus. *Arthrosc Tech* 2018;7:485-490.

17. Woodall B, Elena N, Paborji D, et al. Arthroscopic remplissage using a double-pulley system for Hill-Sachs lesions for recurrent shoulder instability. *Arthrosc Tech* 2018;7:773-777.
18. Buza JA III, Iyengar JJ, Anakwenze OA, Ahmad CS, Levine WN. Arthroscopic Hill-Sachs remplissage—A systematic review. *J Bone Joint Surg Am* 2014;96:549-555.
19. Omi R, Hooke A, Zhao K, et al. The effect of the remplissage procedure on shoulder range of motion: A cadaveric study. *Arthroscopy* 2014;30:178-187.
20. Liu T, Yamamoto N, Shinagawa K, Hatta T, Itoi E. Curved-guide system is useful in achieving optimized trajectory for the most inferior suture anchor during arthroscopic Bankart repair. *J Shoulder Elbow Surg* 2019;28:1692-1698.