Technical Note

Knotless Arthroscopic Glenoid Labral Stabilization for a 270° Tear With Concurrent Remplissage in the Lateral Decubitus Position

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Abstract: Labral tears resulting in 270° near-circumferential pathology predispose patients to recurrent instability and are technically challenging to repair. Furthermore, when such lesions are associated with Hill-Sachs lesions, recurrent instability risk is significantly increased and can result in substantially lower clinical outcomes. When determining a surgical treatment algorithm for shoulder stabilization, it is important to consider both humeral- and glenoid-sided pathology because subtle defects can have significant influence on recurrence and patient reported outcomes. In this Technical Note and accompanying video, we discuss our surgical technique for knotless arthroscopic stabilization for a 270° labral tear with concurrent remplissage in the setting of recurrent shoulder instability.

The shoulder depends on soft-tissue structures for inherent stability, given the lack of bony stability the glenohumeral joint provides. These stabilizers can be dynamic, such as the rotator cuff or static, as in the case of the capsule, labrum, and the glenohumeral ligaments.[1,2] The labrum is a fibrocartilaginous structure anchoring the joint capsule and shoulder ligaments that encircles the glenoid and adds volumetrically to the concavity of the shoulder. Despite its supporting dynamic and static stabilizers, the glenoid labrum is often injured during shoulder instability events.[3,4]

Young males aged 16 to 20 years have the highest risk for acute traumatic anterior dislocation,[5] with this incidence increasing with contact sport participation.[6,7] Risk factors for recurrent instability include the age, severity of index trauma, hyperlaxity, associated greater tuberosity fracture, large and engaging Hill-Sachs defects, and associated glenoid fracture or bone loss.[8-10] The classic mechanism of anterior shoulder dislocation involves a trauma with the arm at 90°of abduction, extension, and maximum external rotation.[2,3] This position results in maximal tension on the anterior band of the inferior glenohumeral ligament, and dislocations in this position often result in a Bankart lesion with associated anteroinferior detachment of the capsulolabral complex.[11,12] Large labral

tears can predispose patients to instability in the anterior and posteroinferior directions of the glenohumeral joint and can be technically demanding to repair.[13-15] Hill-Sachs lesions (HSL) are associated with recurrent instability and can compromise isolated soft tissue Bankart repairs even in cases where the HSL is small but there is ≥ 4 mm of glenoid bone loss.[16,17]

Recurrent dislocation has a high potential to result in cumulative bone loss, both on the glenoid and also in the form of a HSL.[8,9] When an HSL engages at the anterior glenoid rim, it is defined as an "off-track" lesion and has been postulated to lead to higher risk of recurrence as compared to on-track lesions.[18] In patients involved in contact sports participation, arthroscopic Bankart repair has demonstrated 7 times lower dislocation recurrence rates and a higher rate of return to play compared to conservative, nonoperative management.[19] Additionally, studies have supported that for patients with an engaging HSL and 20% to 25% glenoid bone loss, Bankart repair performed in conjunction with remplissage results in lower recurrent instability and improved functional outcome scores, as compared to isolated Bankart repair.[20,21] Furthermore, performing arthroscopic Bankart repair with remplissage for "off-track" HSL with subcritical glenoid bone loss has the potential benefit of a lower complication rate and greater overall safety profile compared to open Latarjet procedures.[22,23] In this technical note and
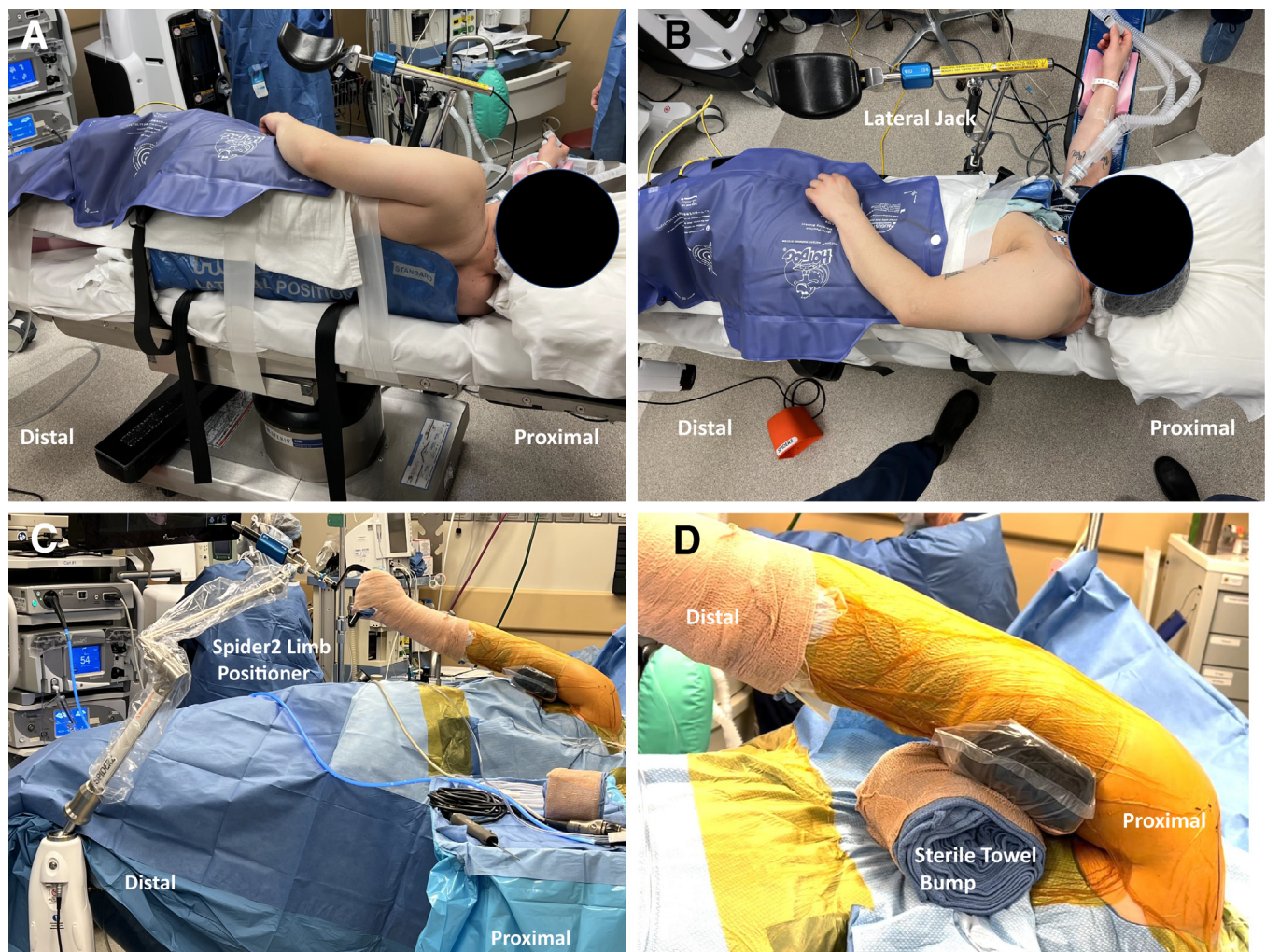
Fig 1. Setup for a lateral decubitus arthroscopic stabilization procedure of the left shoulder. (A) Posterior view of the patient in the right decubitus position with an inflated beanbag in place and with additional taping to ensure adequate security. An axillary roll is placed under the right axilla to prevent compression of the right shoulder axillary nerve. Padding is placed under the downfacing fibular head and between the legs to prevent pressure on bony prominences and the peroneal nerve. (B) Over-the-top view of a patient in the lateral decubitus position. (C) View from the posterior aspect of the patient after sterile draping showing the left arm in suspension with application of a pneumatic limb positioner on the surgical side of the bed and an arm holder in the left axilla attached on the nonoperative side of the bed. (D) A series of rolled sterile towels are then placed under the arm jack to assist with lateral distraction and maximize circumferential visualization.

accompanying video, we discuss our surgical technique for knotless arthroscopic stabilization for a 270° glenoid labrum tear with concurrent knotless Hill-Sachs remplissage in the setting of recurrent anterior shoulder instability (Video 1).

Technique

Patient Positioning and Anesthesia

The patient is positioned in standard lateral position for shoulder arthroscopy, ensuring placement of an axillary roll and padding of the downward facing fibular head in order to protect the peroneal nerve (Fig 1 A and B). General or laryngeal mask airway anesthesia is used in addition to an interscalene block performed before surgery. An examination with the patient under anesthesia is performed.

The shoulder is then prepared and draped in standard fashion for arthroscopy in the lateral decubitus position. A pneumatic limb positioner (Spider2; Smith & Nephew, Andover, MA) is used to hold and provide primary suspension to the operative arm throughout the procedure. Secondary humeral head distraction is achieved with a lateral jack (Lateral Jack; Smith & Nephew) placed in the axilla, as well as a "bump" consisting of stacked sterile towels placed underneath the jack (Fig 1 C and D). Standard portals are marked out for shoulder arthroscopy including 5 and 7 o'clock portals (Fig 2 A and B).

Surgical Approach

Portal Placement and Diagnostic Arthroscopy

A high lateral posterior portal is made, and the joint is entered. Diagnostic arthroscopy is performed to confirm a 270° labral tear (Fig 3 A-C). A mid-glenoid portal is then made. A spinal needle is used to establish a trajectory just superior to the subscapularis that allows for anchor placement into the glenoid and suture passing through the labrum (Fig 4 A and B). A skin incision is made, and mid-glenoid access is obtained with a switching stick, sequential dilation, and placement of an 8.25 mm cannula (Twist-In Cannula; Arthrex, Naples, FL). An anterosuperior portal is then established just posterior to the biceps tendon (Fig 4C). This is localized with a spinal needle, and a small skin incision is used given that this portal is used for camera visualization without a cannula. The camera is switched to the anterosuperior portal, and the labrum is debrided with a 3.8 mm shaver.

Knotless Hill-Sachs Remplissage

The posteriorly based engaging Hill-Sachs lesion is then visualized (Fig 5A). Our preference is to proceed with remplissage preparation before labral fixation and then tighten our remplissage at the end of the case. An accessory posterior portal is localized with a spinal needle to provide perpendicular access to the Hill-Sachs lesion. An arthroscopic elevator is then used percutaneously to prepare the bony bed. Subsequently, a 5 mm cannula is placed through the accessory posterior
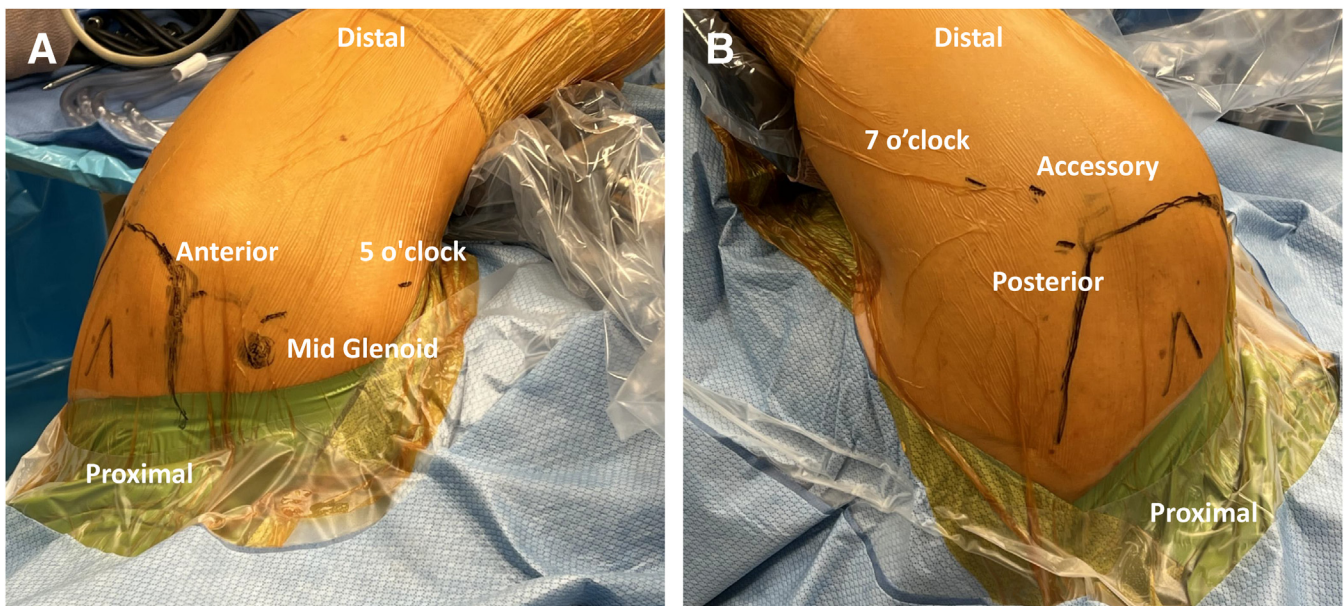
Fig 2. Anterior and posterior views of the left shoulder with portal placement marked. Standard outlines of the clavicle, acromion, coracoid, and acromioclavicular joint are drawn after first palpating the landmarks. (A) Anterior view of the left shoulder with the anterior superior portal, mid-glenoid, and 5 o'clock position portal. (B) Posterior view of the left shoulder with a standard posterior portal, as well as an accessory and 7 o'clock portal.
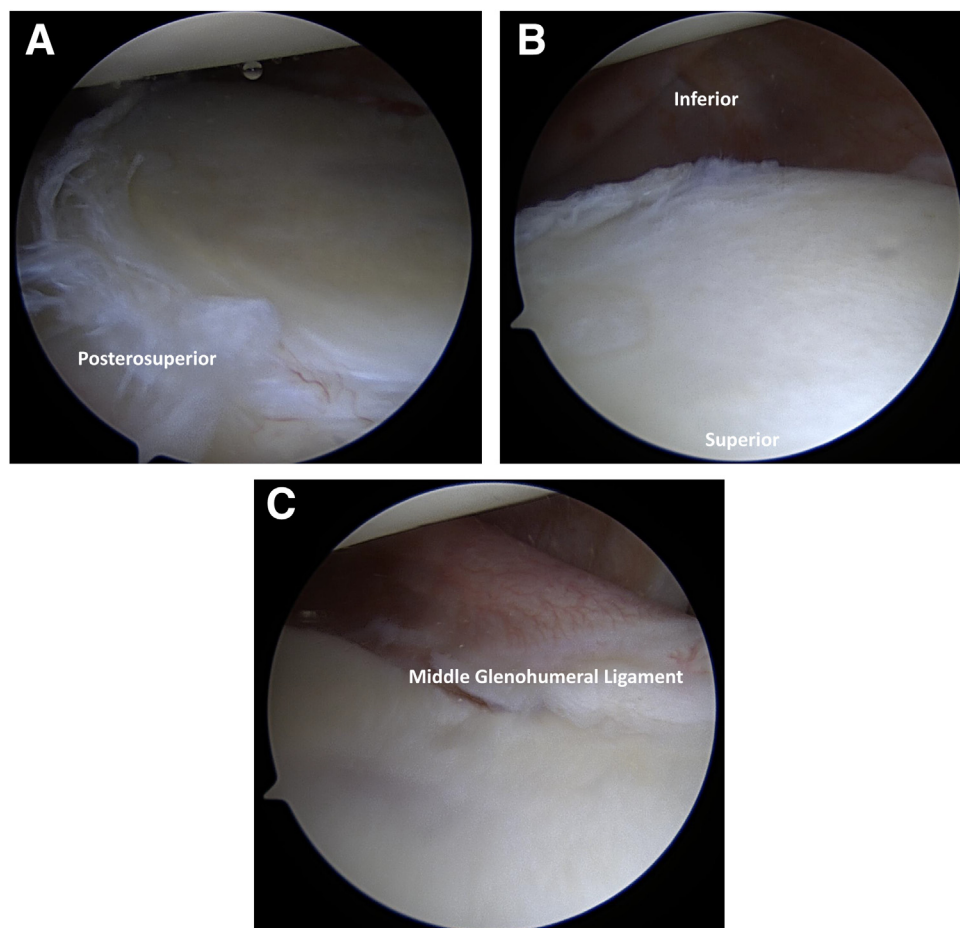
Fig 3. Anterior superior viewing portal of a left shoulder during diagnostic evaluation of the glenohumeral joint. (A) Posterosuperior, (B) inferior, and (C) anterior aspects of the labrum showing evidence of tearing and fraying of the labrum. No evidence of arthritic changes at the glenoid or humeral head is noted.

portal. The cannula tip is swept back and forth to create a pocket in the subdeltoid space for subsequent suture passing. A drill guide is introduced and penetrates the capsule and rotator cuff at the inferior position in the HSL, and the first 1.8 mm knotless all-suture anchor (Knotless FiberTak Soft Anchors; Arthrex) is placed into the defect (Fig 5 B and C). The tip of the cannula is kept within the subdeltoid space. A second penetration with the insertion guide is made in the capsule and rotator cuff in a more superior position at the top of the defect, and a second anchor is placed. The repair suture from each anchor is then passed through the looped shuttle suture of the other anchor, creating 2 tensionable loops through the rotator cuff and capsule. This essentially creates a suture staple that can be used to tension the capsule and rotator cuff into the Hill-Sachs defect. The loops are gently shortened but not tightened so as not to close down the working space until the end of the case.

270° Knotless Arthroscopic Labral Repair

Attention is turned back to the labral repair. An arthroscopic elevator is then used to elevate the torn labrum. Next, the bony glenoid rim is gently prepared with a bone cutter. A 7 o'clock portal is established using a spinal needle to ensure appropriate trajectory for drilling and suture passing. A 1.8 mm knotless all-suture anchor is first placed at the 6:30 position (Knotless FiberTak Soft Anchors; Arthrex). A 45° curved suture passer (Spectrum II Suture Passer; ConMed, Utica, NY) is then used through the 7 o'clock portal to pass a no. 1 PDS suture through the labrum. This is retrieved anteriorly together with the repair suture. The shuttling and repair sutures are then retrieved posteriorly, and the repair suture is shuttled through the anchor and tightened (Fig 6A). Of note, the suture is not cut so that the repair can be further tensioned later in the case. This process is repeated from the 7 o'clock portal to the posterior superior extent of the labral tear, placing additional 1.8 mm knotless all-suture anchors as necessary (Fig 6B).

To address the anteroinferior aspect (5:30 location) of the tear, we prefer to use a 5 o'clock portal, localized with a spinal needle. We would like to highlight the utility of a 5 o'clock portal in this setting, namely demonstrating that the trajectory of drilling from the

Fig 4. Arthroscopic view of establishing anterosuperior and mid glenoid portals of the left shoulder while viewing from the posterior portal. (A, B) A spinal needle is used to establish a trajectory just superior to the subscapularis, with an angle that will allow for perpendicular drilling into the glenoid and suture passing through the labrum. This will serve as the mid glenoid portal. (C) An anterosuperior portal is established using spinal needle localization, just posterior to the biceps tendon that is used for visualization throughout the case.
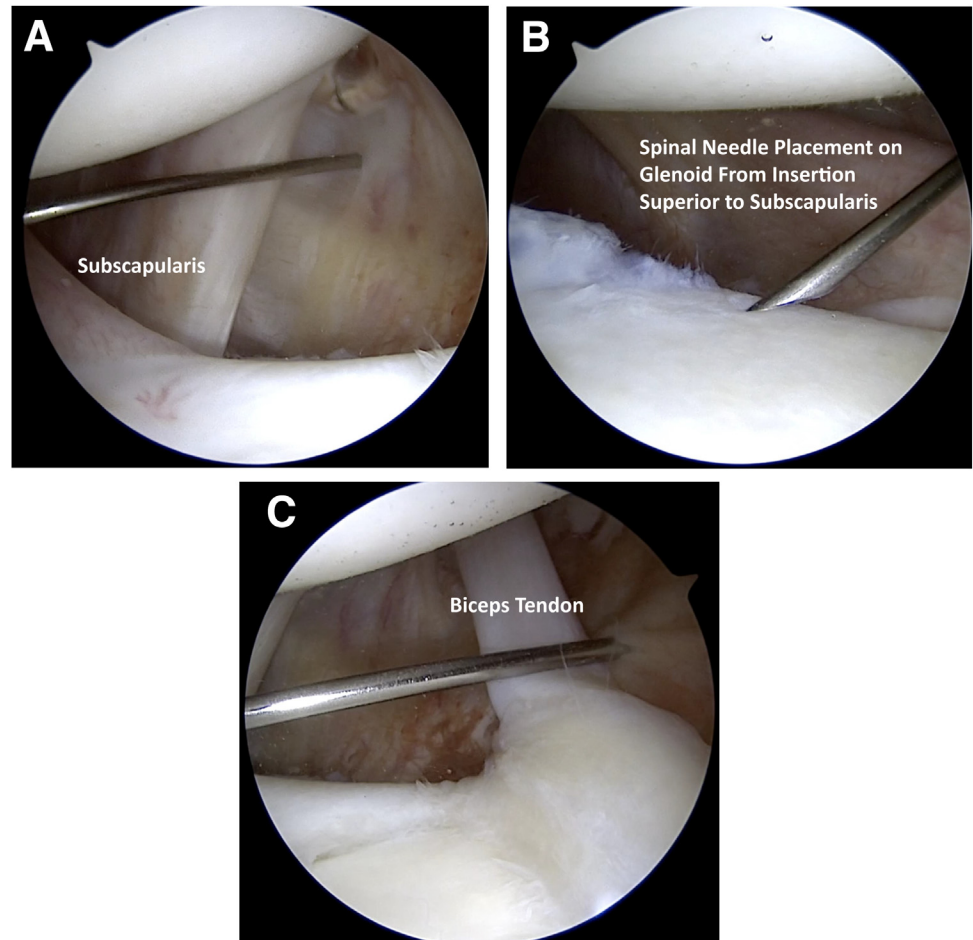
mid-glenoid portal is sub-optimal and not perpendicular to the glenoid rim in comparison to the 5 o'clock portal (Fig 7 A and B).

The portal position is first created with a spinal needle. A drill guide is then placed percutaneously through the 5 o'clock portal. A 1.8 mm knotless all-suture anchor is placed at the 5:30 position. To appropriately tension the inferior glenohumeral ligament complex and provide an anterior and superior capsular shift, suture passage through the labrum is performed from the 7 o'clock portal, passing through the capsule-labrum complex at the 6 o'clock location (Fig 8 A-C). The suture is then retrieved anteriorly and tightened (Fig 8 D-E). It can be helpful to use a grasper via the anterior portal to reduce the labrum anatomically, thereby ensuring anatomic tensioning of the capsule during final suture seating. The sutures for subsequent more superior knotless anchors are drilled and passed from the 5 o'clock portal as the steps are repeated.

Once all anchors have been successfully placed, the sutures are final tensioned (Fig 6 C and D), and attention is returned to the Hill-Sachs lesion. The previously loosely placed 2 knotless suture loops are tightened and cut, completing the remplissage. Wounds are closed in standard fashion with nonabsorbable 3-0 Prolene portal sutures. A sterile dressing is applied, and an abduction sling is placed.

Rehabilitation

Patients are placed in an abduction sling for the first 4 weeks after surgery. Passive range of motion (ROM) can begin at 10 to 14 days after surgery with supine forward elevation in the scapular plane to 90° and external rotation with the arm at the side to 30°. Codman exercises are not allowed during the first 4 weeks. At 4 to 8 weeks after surgery, the sling is discontinued, and there is advancement from active assist ROM to active ROM (forward flexion maximum to 140° and external rotation at side maximum to 40°). Isometric exercises are continued, and introduction of scapular stabilizer strengthening is initialed. At 8 to 12 weeks, advancement to full painless ROM is the goal, and abduction is introduced at 10 to 12 weeks after surgery. All strengthening exercises at 8 to 12 weeks after surgery should be done below the horizontal plane. At 3 to 12 months after surgery, focus is
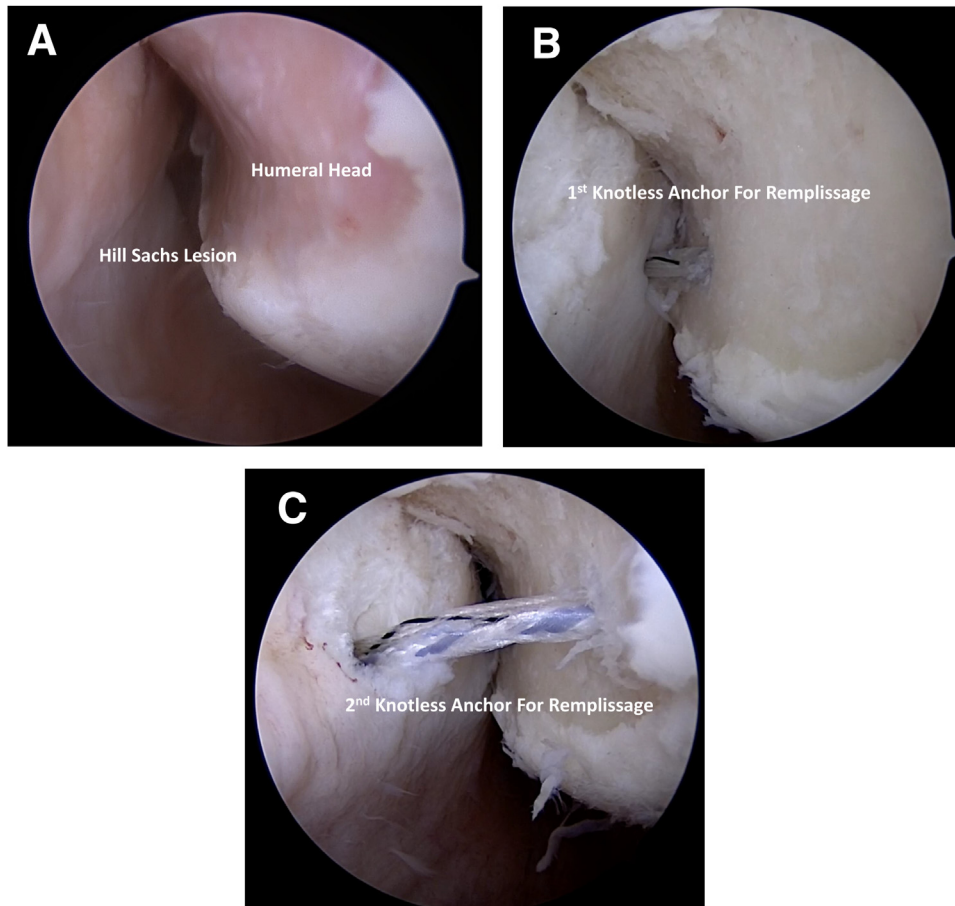
Fig 5. Knotless remplissage procedure of the left shoulder for a Hill-Sachs deformity while viewing from the anterior superior portal. (A) Hill-Sachs deformity of the left shoulder during diagnostic arthroscopy. (B, C) Placement of 2 all-suture knotless anchors in the defect site of the Hill-Sachs deformity that are placed through the posterior rotator cuff and capsule and passed through a cannula in the subdeltoid space.

on aggressive scapular stabilization and an eccentric strengthening program. Progressive resistive exercises are continued below the horizontal plane for non-throwers.

Discussion

In general, there is a consensus among shoulder surgeons that glenoid bone loss greater than 20% of the anteroinferior glenoid diameter should be treated with a bony procedure such as the Latarjet.[18,24] However, guidelines to address patients with lesser degrees of bipolar bone loss of the glenoid and proximal humerus defects are unclear. When determining a surgical treatment algorithm for effective shoulder stabilization, it is important to take into consideration the geometric interplay of these bipolar lesions because subtle defects can have significant influence on shoulder stability.[18]

In an attempt to further understand bipolar lesions, Yamamoto et al.[25] introduced the concept of the glenoid track. The glenoid track describes the zone of contact between the glenoid and the humeral head when the arm is raised (in abduction-external rotation), which is observed to shift from the inferomedial to the superolateral portion of the posterior articular surface.[25] Studies have demonstrated that an intact glenoid track without significant bony defect is critical for stability. This makes identification of the location of a Hill-Sachs lesion in bipolar defects important; where an "off-track" Hill-Sachs lesion engages with the anterior glenoid rim, and an "on-track" Hill-Sachs lesion does not engage.[18,25,26] Yamamoto et al.[25] demonstrated that engaging Hill-Sachs lesions increase the risk of shoulder dislocation. Consequently, both the degree of glenoid bone loss and the distinction between an "on-track/off-track" Hill-Sachs lesion is relevant when considering treatment recommendations for shoulder instability. Specifically, Di Giacomo et al.[18] developed a treatment algorithm for anterior shoulder instability in which bipolar lesions with less than 20% glenoid bone loss and an off-track Hill-Sachs lesion can be successfully treated with a Bankart repair with remplissage to restore stability and prevent engagement of the Hill-Sachs. In our experience, we identify the amount of glenoid bone loss while also taking into consideration the patient factors such as age, activity level, and number of dislocations. Our threshold for bony reconstruction can be anywhere from 10% to 25% depending on the individual. If we deem that the glenoid bone

Fig 6. Knotless 270° labral repair of the left shoulder while viewing from the anterior superior portal position. (A, B) Placement of two posteroinferior knotless tensionable anchors in the left shoulder. (C) View of the anterior and inferior portions of the labrum after all knotless anchors have been placed prior to final tightening and cutting of the sutures. (D) Final construct of the anterior and inferior labral repair.
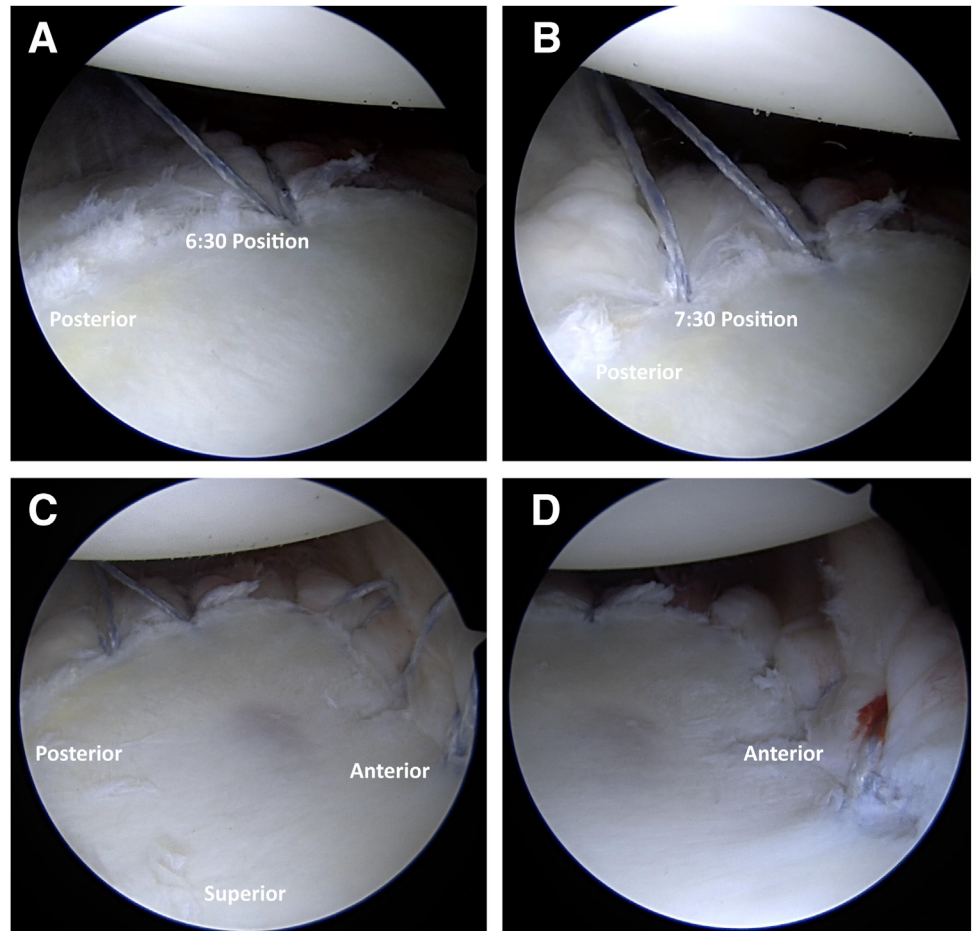
loss is "subcritical" then we evaluate the Hill-Sachs lesion. If the Hill-Sachs lesion is engaging, a remplissage is added to the arthroscopic procedure.

Because the main complication of anterior shoulder stabilization surgery is recurrent instability, the authors have attempted to identify patients who are at risk of
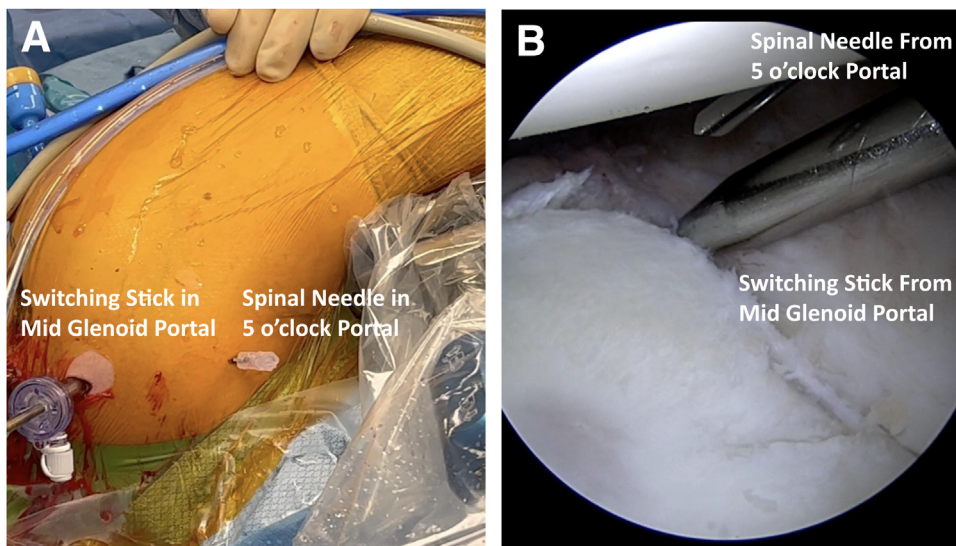
Fig 7. Illustration of the left shoulder arthroscopic trajectory of mid glenoid and 5 o'clock portals for reaching 5:30 position while viewing from the anterior superior portal position. (A) External anterior view of the shoulder with a switching stick in the cannula of the mid glenoid portal and a spinal needle placed at the 5 o'clock position. (B) Arthroscopic view of the same switching stick coming into the joint from the mid glenoid portal and a spinal needle coming into the joint through the 5 o'clock portal. This photo highlights how the mid-glenoid portal is suboptimal and not perpendicular to the glenoid rim as compared to a 5 o'clock portal for placement of a 5:30 position anchor.

Fig 8. Left shoulder placement of the 5:30 position knotless suture anchor while viewing from the anterior superior portal position. (A) To appropriately tension the inferior glenohumeral ligamentous complex, a spinal needle is first inserted from the 7 o'clock portal to en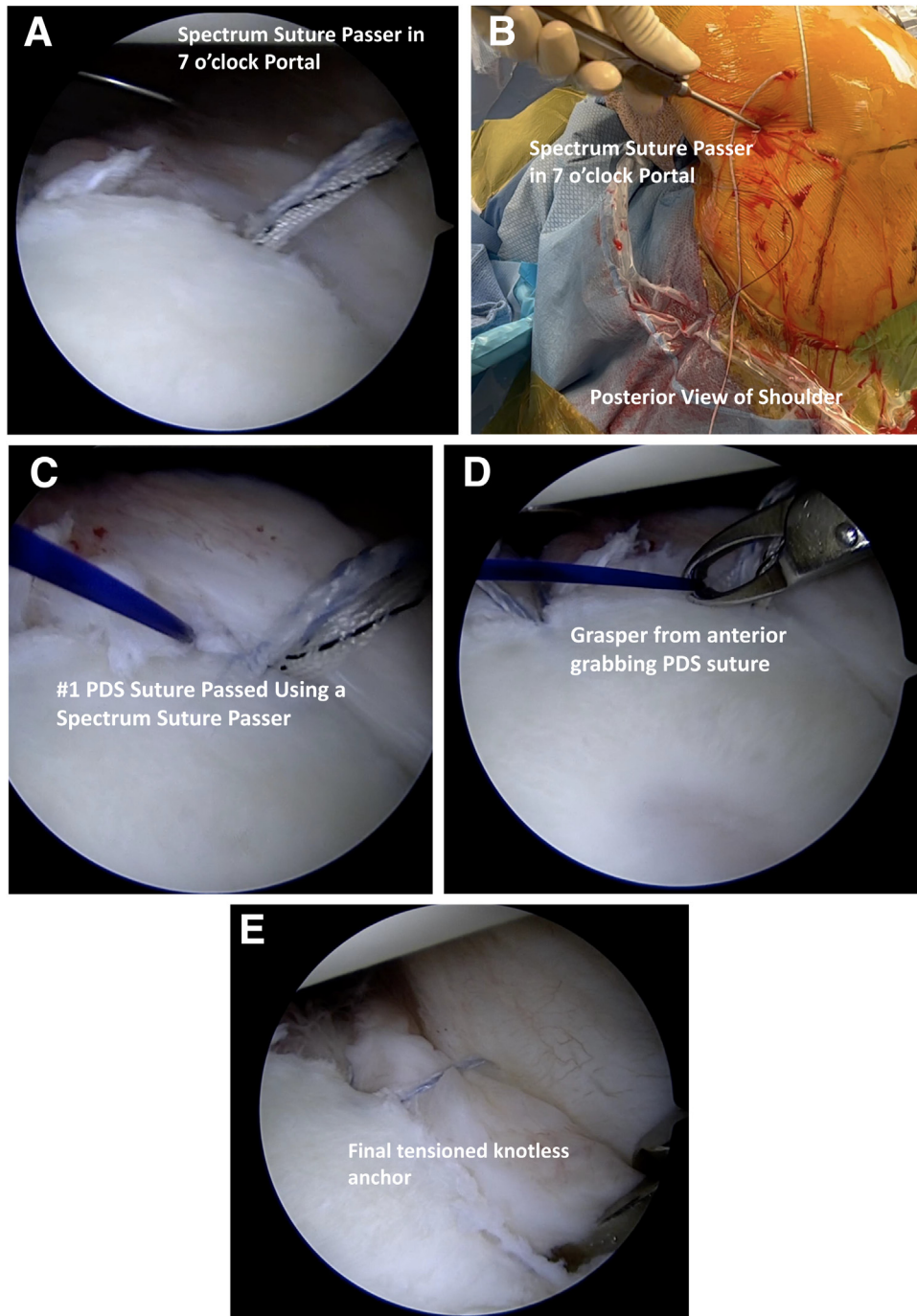sure correct trajectory, and the repair stitch is then shuttled by a spectrum suture passer. (B, C) Suture is passed with a spectrum suture passer from the 7 o'clock portal and (D) then retrieved anteriorly with a grasper. (E) The knotless anchor is tensioned to reduce the labrum back to the glenoid.

recurrent instability and who may benefit from an open stabilization procedure rather than arthroscopic intervention. The Instability Severity Index Score (ISIS), developed by Balg and Boileau,[27] has traditionally been used to identify patients at increased risk of recurrent instability using the following risk factors: (1) patient age <20 years old at time of surgery, (2) involvement in contact sports or sports involving rigorous overhead activity, (3) shoulder hyperlaxity, and (4) radiographically identifiable bone defects. This score explicitly

highlighted the notion that humeral and glenoid bone loss may comprise a relative contraindication to arthroscopic stabilization techniques.[27] However, a more modern glenoid track instability management score (GTIMS) has gained popularity in recent years, incorporating the glenoid track concept into the ISIS.[28] A retrospective study of 261 patients comparing the GTIMS and ISIS demonstrated improved outcomes in patients indicated for arthroscopic stabilization according to the GTIMS and on-track/off-track computed

Table 1. Pearls and Pitfalls

Pearls

    Meticulous patient positioning should be performed before the case because repositioning in the lateral decubitus position once the patient is prepped and draped is challenging.

    Placement of remplissage anchors and subsequent suture passage is most readily performed before labral repair.

    Use a 5 mm cannula to sweep and create a potential space just superficial to the posterior cuff in the subdeltoid space for remplissage suture shuttling.

    The use of 7 and 5 o'clock portals allows for ideal drilling and anchor trajectory at the inferior glenoid.

    Repair suture passage for the 5:30 anchor should be passed from the 7 o'clock portal, from posterior to anterior, to create an anterior and superior shift and recreate the capsulolabral sling.

Pitfalls

    Avoid tightening remplissage sutures until labral repair is complete because this will otherwise close down the working space.

    Not using a cannula at the time of remplissage suture shuttling and passage may lead to soft tissue bridge formation.

    Avoid use of limited portals (i.e., 3 portal repair of large labral tear) if this creates suboptimal drilling and suture shuttling trajectory.

tomography scanning indications.[28] As such, remplissage has emerged as an effective strategy to prevent recurrent instability after arthroscopic shoulder stabilization procedures.[29]

Arthroscopic capsulolabral repair performed concurrently with remplissage of an engaging Hill-Sachs defect have demonstrated excellent clinical results. A recent meta-analysis by Camus et al.[20] identified 3 studies comprised of 146 patients comparing Bankart repair and remplissage versus isolated Bankart repair in the treatment of anterior shoulder instability. The authors concluded that a Bankart repair with remplissage was superior to an isolated Bankart repair when evaluating recurrent instability and functional scores (Rowe and UCLA scores), whereas no significant differences were observed in the rates of reoperation and time to return to sport. A similar systematic review and meta-analysis performed by Hurley et al. included 12 clinical trials comparing Bankart repair with remplissage versus isolated Bankart repair.[30] The findings were consistent with Camus et al.'s[20] review and demonstrated Bankart repair with remplissage resulted in a significant reduction in recurrent instability as compared to treatment with isolated Bankart repair.[30]

With regard to the remplissage technique, early descriptions of the procedure involved the use of tying knots to link 2 anchors together via a broad mattress configuration.[29,31] More recently, knotless anchors have been applied to remplissage procedures, obviating the need to do an extensive subdeltoid dissection to tie arthroscopic knots.[32] The repair ends of the knotless mechanism are passed into the other anchor, respectively, and a suture staple is created with excellent fixation and compression. These knotless anchors are familiar to many surgeons as they are also routinely used for Bankart/labral repairs. In fact, it has been shown that knotless suture anchor configurations are biomechanically superior to knotted constructs. For example, a study by Funakoshi et al.[33] tested 7 cadaveric matched pairs that were randomly selected to receive remplissage with either a knotted or knotless double mattress construct. The results showed that the knotless construct demonstrated a higher load to failure (1080 N vs 591 N) and a higher loading force to create 5 mm of displacement (788 N vs 488 N) as compared to the knotted construct.[33]

Table 1 lists the salient pearls and pitfalls of the presented technique, and Table 2 lists the major advantages and disadvantages of the presented surgical technique. The evaluation of patients with shoulder instability is under constant evolution and must consider the glenoid track, glenoid bone loss, humeral sided bone loss, as well as patient functional limitations as a result of instability pathology.

Table 2. Advantages and Limitations

Advantages

    Lateral decubitus position provides circumferential surgical access to glenoid.

    Knotless anchors provide superior suture strength and mitigate knot-based complications such as knot failure or impingement.

    Remplissage and labral repair can be retensioned as needed throughout the case.

    The 5 and 7 o'clock portals provide satisfactory access for optimal drilling and suture passing trajectories.

Limitations

    Lateral decubitus positioning requires dedicated equipment and may be less familiar to some surgical teams.

    Knotless anchors may be associated with additional expense over historic fixation methods.

    Some cases may have large (>25%) glenoid bone loss or Hill-Sachs lesions that are more appropriately indicated for an open bony procedure.

References

1. Bakhsh W, Nicandri G. Anatomy and physical examination of the shoulder. *Sports Med Arthrosc Rev* 2018;26(3): e10-e22.
2. Rossi LA, Frank RM, Wilke D, et al. Evaluation and management of glenohumeral instability with associated bone loss: An expert consensus statement using the modified delphi technique. *Arthroscopy* 2021;37: 1719-1728.
3. Ladd LM, Crews M, Maertz NA. Glenohumeral joint instability: A review of anatomy, clinical presentation, and imaging. Clin Sports Med. *Oct* 2021;40(4):585-599.
4. Clavert P. Glenoid labrum pathology. *Orthop Traumatol Surg Res* 2015;101(1 Suppl):S19-S24.
5. Shah A, Judge A, Delmestri A, et al. Incidence of shoulder dislocations in the UK, 1995-2015: A population-based cohort study. *BMJ Open* 2017;7(11):e016112.
6. Gibbs DB, Lynch TS, Nuber ED, Nuber GW. Common shoulder injuries in American football athletes. *Curr Sports Med Rep* 2015;14:413-419.
7. Kawasaki T, Ota C, Urayama S, et al. Incidence of and risk factors for traumatic anterior shoulder dislocation: An epidemiologic study in high-school rugby players. *J Shoulder Elbow Surg* 2014;23:1624-1630.
8. Lee SH, Lim KH, Kim JW. Risk factors for recurrence of anterior-inferior instability of the shoulder after arthroscopic bankart repair in patients younger than 30 years. *Arthroscopy* 2018;34:2530-2536.
9. Arner JW, Peebles LA, Bradley JP, Provencher MT. Anterior shoulder instability management: Indications, techniques, and outcomes. *Arthroscopy* 2020;36: 2791-2793.
10. Brilakis E, Avramidis G, Malahias MA, et al. Long-term outcome of arthroscopic remplissage in addition to the classic Bankart repair for the management of recurrent anterior shoulder instability with engaging Hill-Sachs lesions. *Knee Surg Sports Traumatol Arthrosc* 2019;27: 305-313.
11. Etoh T, Yamamoto N, Shinagawa K, Hatta T, Itoi E. Mechanism and patterns of bone loss in patients with anterior shoulder dislocation. *J Shoulder Elbow Surg* 2020;29:1974-1980.
12. Owens BD, Duffey ML, Nelson BJ, DeBerardino TM, Taylor DC, Mountcastle SB. The incidence and characteristics of shoulder instability at the United States Military Academy. *Am J Sports Med* 2007;35:1168-1173.
13. Ernat JJ, Yheulon CG, Shaha JS. Arthroscopic repair of 270- and 360-degree glenoid labrum tears: A systematic review. *Arthroscopy* 2020;36:307-317.
14. Alpert JM, Verma N, Wysocki R, Yanke AB, Romeo AA. Arthroscopic treatment of multidirectional shoulder instability with minimum 270 degrees labral repair: Minimum 2-year follow-up. *Arthroscopy* 2008;24:704-711.
15. Aman ZS, Peebles LA, Johnson DW, Hanson JA, Provencher MT. Multidirectional shoulder instability with circumferential labral tear and bony reverse hill sachs: Treatment with 270° labral repair and fresh talus osteochondral allograft to the humeral head. *Arthrosc Tech* 2021;10(3):e781-e787.
16. Provencher MT, Frank RM, Leclere LE, et al. The Hill-Sachs lesion: Diagnosis, classification, and management. *J Am Acad Orthop Surg* 2012;20:242-252.
17. Arciero RA, Parrino A, Bernhardson AS, et al. The effect of a combined glenoid and hill-sachs defect on glenohumeral stability: A biomechanical cadaveric study using 3-dimensional modeling of 142 patients. *Am J Sports Med* 2015;43:1422-1429.
18. 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.
19. Hurley ET, Manjunath AK, Bloom DA, et al. Arthroscopic bankart repair versus conservative management for first-time traumatic anterior shoulder instability: A systematic review and meta-analysis. *Arthroscopy* 2020;36:2526-2532.
20. Camus D, Domos P, Berard E, Toulemonde J, Mansat P, Bonnevialle N. Isolated arthroscopic bankart repair vs. Bankart repair with "remplissage" for anterior shoulder instability with engaging hill-sachs lesion: A meta-analysis. *Orthop Traumatol Surg Res* 2018;104:803-809.
21. 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.e2.
22. Yang JS, Mehran N, Mazzocca AD, Pearl ML, Chen VW, Arciero RA. Remplissage versus modified latarjet for off-track Hill-Sachs lesions with subcritical glenoid bone loss. *Am J Sports Med* 2018;46:1885-1891.
23. 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.
24. Gerber C, Nyffeler RW. Classification of glenohumeral joint instability. *Clin Orthop Relat Res* 2002;400:65-76.
25. Yamamoto N, Itoi E, Abe H, et al. Contact between the glenoid and the humeral head in abduction, external rotation, and horizontal extension: A new concept of glenoid track. *J Shoulder Elbow Surg* 2007;16:649-656.
26. Burkhart SS, De Beer JF. 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.
27. Balg F, Boileau P. The instability severity index score. A simple pre-operative score to select patients for arthroscopic or open shoulder stabilisation. *J Bone Joint Surg Br* 2007;89:1470-1477.
28. Di Giacomo G, Peebles LA, Pugliese M, et al. Glenoid track instability management score: Radiographic modification of the instability severity index score. *Arthroscopy* 2020;36: 56-67.
29. Callegari JJ, Phillips CJ, Denard PJ. All-inside knotless remplissage technique. *Arthrosc Tech* 2021;10(6): e1479-e1484.

30. Hurley ET, Toale JP, Davey MS, et al. Remplissage for anterior shoulder instability with hill-sachs lesions: A systematic review and meta-analysis. *J Shoulder Elbow Surg* 2020;29:2487-2494.

31. Arrigoni P, Brady PC, Burkhart SS. The double-pulley technique for double-row rotator cuff repair. *Arthroscopy* 2007;23(6):675.e1-675.e4.

32. Ratner DA, Rogers JP, Tokish JM. Use of a knotless suture anchor to perform double-pulley capsulotenodesis of infraspinatus. *Arthrosc Tech* 2018;7(5):e485-e490.

33. 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.