



Arthroscopic Knotless Subscapularis Bridge Technique for Reverse Hill-Sachs Lesion With Posterior Shoulder Instability

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Abstract: Posterior shoulder dislocations are an uncommon cause of glenohumeral instability; they are frequently missed and are associated with humeral head defects and capsulolabral lesions. Despite surgical treatment often being mandatory, there is still no standardized treatment for anterior impaction fractures of the humeral head (reverse Hill-Sachs lesions). Arthroscopic surgery is typically indicated, with a tendency toward resorting to knotless techniques in recent years. We present a method for the treatment of posterior shoulder dislocations with engaging reverse Hill-Sachs lesions that achieves full defect coverage using an arthroscopic all-in-the-box knotless subscapularis bridge technique with 2 anchors—with one crossing the subscapularis tendon and the other embracing it—along with posterior capsulolabral complex restoration. This promising technique is a potentially superior alternative for the treatment of these lesions that can also be used in the presence of concomitant partial subscapularis tears.

Posterior shoulder dislocations constitute nearly 4% of the total number of shoulder dislocations and are less common than their anterior counterparts.¹ Additionally, nearly 80% of them are misdiagnosed on initial examination.^{2,3} For this reason, a high grade of suspicion must be maintained in patients with a history of seizures, electroshocks, high-energy trauma, or indirect trauma with the shoulder in a flexed, adducted, and internally rotated position.²

Traumatic posterior shoulder dislocations can produce impression fractures of the anteromedial aspect of the

humeral head when it engages the posterior glenoid rim, which is known as the “reverse Hill-Sachs lesion” (RHSL). This lesion can be observed in 30% to 90% of cases⁴ and carries a risk of re-engagement that leads to posterior instability.^{4,5}

A great number of techniques have been described to treat the RHSL; they are divided into anatomic, nonanatomic, and substitution techniques.^{6,7} Historically, most of the current treatments for posterior shoulder instability were based on the humeral head defect size. However, consensus on a specific treatment is yet to be established.⁸

McLaughlin⁹ described his technique involving the transfer of the subscapularis tendon into the anterior humeral defect for the first time in 1952. Thereafter, Hawkins et al.¹⁰ modified this procedure by transferring the lesser tuberosity along with the subscapularis tendon instead of transferring the tendon on its own. Later, Krackhardt et al.¹¹ proposed the first arthroscopic technique based on fixation of the subscapularis tendon into the RHSL, commonly known as the “reverse remplissage” technique. Since then, many variations of this arthroscopic procedure have been proposed. In this Technical Note, we present an arthroscopic knotless subscapularis bridge technique for the treatment of RHSLs with posterior shoulder instability.

Preoperative Evaluation and Indications

Post-traumatic shoulder dislocations with recurrent episodes of atraumatic posterior subluxation caused by

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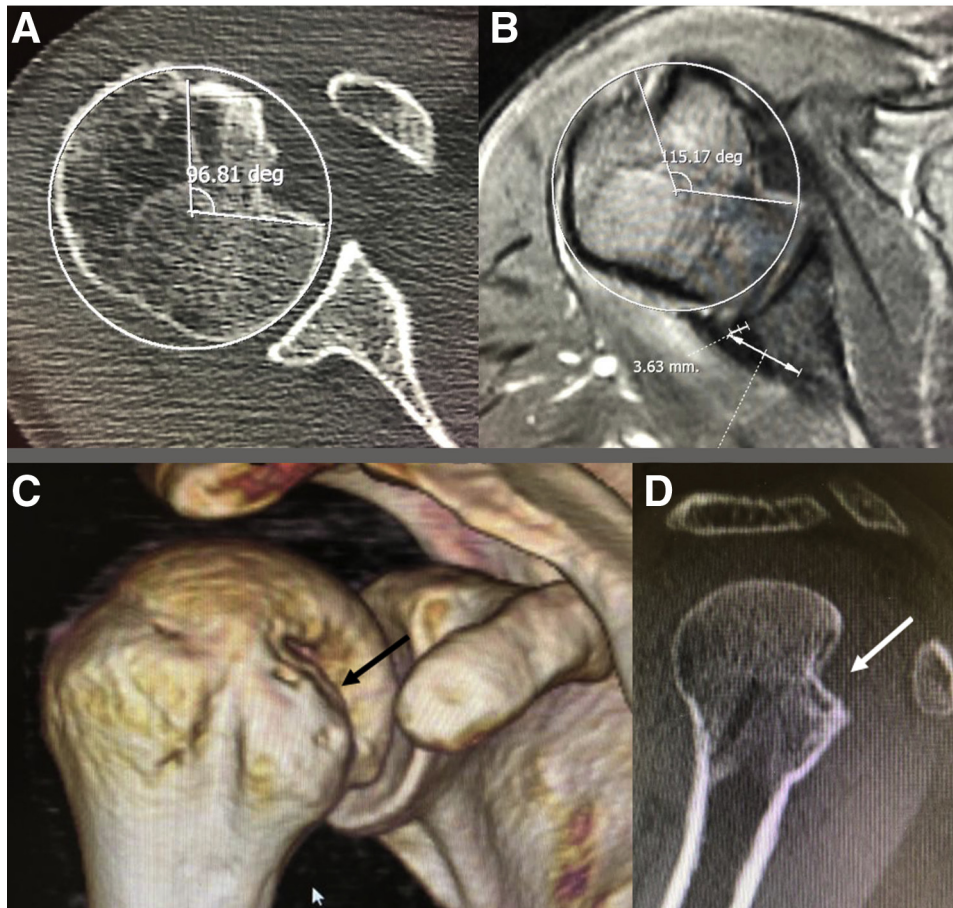


Fig 1. Right shoulder. Computed tomography (CT) scan and/or magnetic resonance imaging (MRI) is mandatory for decision making in patients with posterior shoulder instability. (A) CT scan, axial view at the coracoid level, showing the gamma angle. This angle is defined using the best-fit circle technique while measuring the angle between the posterior edge of the reverse Hill-Sachs lesion (RHSL) and the bicipital groove. When this angle is greater than 90° , the lesion is considered an engaging RHSL. (B) MRI scan, axial view under the coracoid level, revealing that the gamma angle—measured with the same references as the CT scan—is greater than 90° . The posterior glenoid rim presents a 3.63-mm defect at this level of the axial segment. This is a bipolar lesion (RHSL plus glenoid defect) that results in an engaging RHSL. The measured gamma angle at a different level of the axial view, on CT or MRI scans, shows an engaging RHSL using the “gamma concept angle” described by Moroder et al.²¹ The white circle indicates the best-fit circle to the humeral head passing through the cartilage, and the double arrow indicates the posterior cartilage line to calculate the posterior glenoid defect. (C) CT scan with 3-dimensional reconstruction, coronal oblique view, showing the superior-to-inferior dimension of the anteromedial lesion at the humeral head (arrow), known as an RHSL. (D) Two-dimensional CT scan, sagittal view, showing the width of the RHSL (arrow) close to the coracoid process.

placing the shoulder in flexion, adduction, and internal rotation need to be assessed through a meticulous physical examination, which should include searching for signs of hyperlaxity, assessing passive and active range of motion, checking for apprehension in forward flexion and internal rotation, and performing the posterior stress test and the Kim and jerk tests. Radiographic evaluation using computed tomography and magnetic resonance imaging (MRI) must be performed to assess for bone lesions associated with posterior shoulder instability. The RHSL can be seen (Fig 1), and a posterior glenoid rim defect can also be noted (Fig 1B). It is possible to encounter a difference in the estimated gamma angles obtained in each of the computed tomography and MRI scans (Fig 1 A and B); however, if this angle is greater than

90° , the lesion is considered to be an engaging RHSL regardless of any differences. This value helps to determine the appropriate course of management of the lesion. The treatment option described in this article is humeral defect coverage by an arthroscopic knotless subscapularis bridge and capsulolabral repair. The advantages and disadvantages of this technique are described in Table 1.

Surgical Technique

Step 1: Patient Positioning and Diagnostic Arthroscopy

The surgical technique is shown in Video 1. The patient is placed under general anesthesia in a lateral oblique position. After the skin is sterilely prepared and

Table 1. Advantages, Disadvantages, Limitations, and Risks of Technique

Advantages
All-inside-the-box technique is performed, with the camera crossing from the superior portal to the pre-subscapularis working space through an open rotator interval.
A knotless technique is performed with tapes to ensure that the obtained repair is of a low profile, avoiding bulky knots.
There is minimal subscapularis damage that does not affect its insertion, with no tenotomy or lesser tuberosity osteotomy required.
Potentially present concomitant subscapularis tendon lesions can simultaneously be repaired and included in the final construct.
Full coverage of the lesion is obtained.
The technique is fast and reproducible.
Disadvantages
The technique necessitates opening of the rotator interval.
The subscapularis tendon force vector is altered.
The technique may potentially lead to some loss of internal rotation.
Although only the inferior anchor is placed in a trans-subscapularis manner, a 4.75-mm screw is still used, causing some aggression to this tendon.
Risks
Potential risk of neurovascular injury to axillary nerve if anterior portals are placed too inferiorly or medially
Risk of axillary nerve injury when excessive abduction of arm is applied
Limitations
Requires experienced arthroscopic shoulder surgeon
Not indicated for defects > 30%
Requires specific materials, such as knotless anchors and suture tapes

draped in the usual fashion, a standard posterior portal is made for initial articular assessment of the glenohumeral joint; then, anterior and superior portals are added to complete the evaluation (Fig 2). From the standard posterior portal, a subscapularis tendon tear can be noted (Fig 3A). Here, it is important to confirm any lesion involving the subscapularis tendon insertion. The view is then changed to the superior portal, and the lesions are confirmed, including the RHSL (Fig 3B), as well as the posterior capsular (Fig 4) and labral lesions.

Step 2: Posterior Capsular and Labral Repair

Using the superior portal for vision, we use the standard posterior portal and posterior percutaneous accessory portals—placed inferiorly and laterally to the standard portal—as working portals. First, we always perform a repair of the labral lesions, regardless of the presence of a posterior capsular lesion in our initial assessment. A less frequently seen associated lesion is the posterior capsular lesion involving the posterior band of the inferior glenohumeral ligament without an avulsion of its labral or humeral insertions. It is repaired by the following technique: Using a Wissinger rod, we gently start to separate the infraspinatus from the capsule. Then, with a shaver, we perform a smooth debridement of the medial and lateral borders of the lesion and any capsular bridge

between them. Both ends of the capsular lesion are mobilized with a grasper, testing their proper reduction to the humeral bone. Here, we identify the true posterior capsular lesion, which can easily be mistaken for a reverse HAGL (humeral avulsion of the glenohumeral ligament) lesion (Fig 5).

An 8.25-mm threaded cannula is placed in the anterior portal. Afterward, a suture passer loaded with a nitinol wire is first passed through the accessory posterolateral portal and the inferior border of the capsular lesion. Then, it is recovered and replaced with a FiberWire suture (Arthrex, Naples, FL) (Fig 6). The suture passer with a nitinol loop wire is subsequently passed through the accessory posterior portal and, this time, through the superior border of the posterior capsular lesion. It is then replaced with the articular limb of the same FiberWire suture, making a mattress suture in the capsule (Fig 7A). Another mattress suture is made in the capsular defect, parallel to the first (Fig 7B). Both sutures are knotted through the accessory posterior portal while the correct capsular reduction is simultaneously checked intra-articularly with the arthroscope.

Next, the posterior labral lesion is identified (Fig 8A). The glenoid border—where the labrum will be reattached—is debrided with a curette and shaver. A loaded suture passer with a nitinol wire is passed through the capsule and beneath the labrum. The nitinol wire is then replaced with an Arthrex FiberLink suture that is subsequently loaded in a 2.9-mm Bio-PushLock knotless anchor (Arthrex) and inserted into its previously drilled hole on the glenoid border, completing the capsulolabral repair with 2 anchors (Fig 8B).

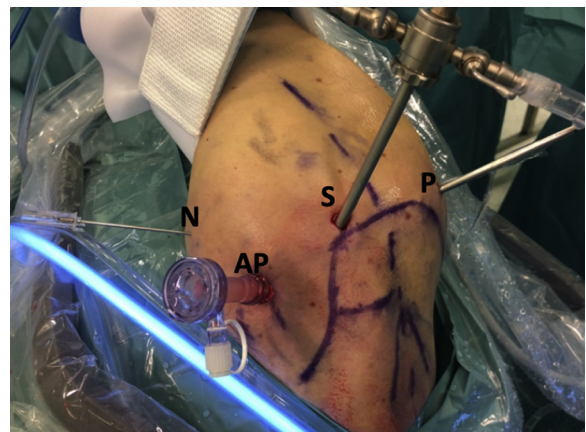


Fig 2. Right shoulder, in lateral oblique position, showing anterior portal with cannula (AP) and posterior portal (P). The needle (N) shows the anteroinferior portal, through which the inferior screw loaded with FiberTape is introduced percutaneously, for the subscapularis knotless bridge technique to treat a reverse Hill-Sachs lesion with posterior shoulder instability. (S, superior portal with camera.)

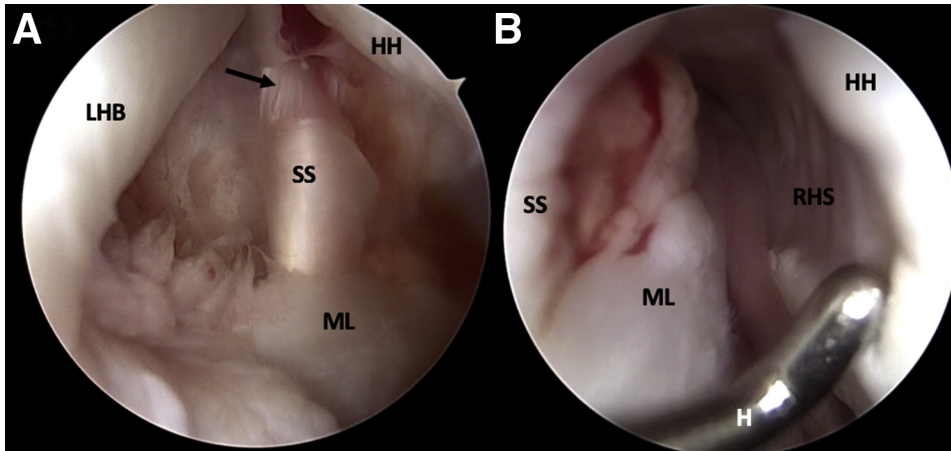


Fig 3. Arthroscopic view of right shoulder with posterior shoulder instability, in lateral oblique position. (A) View from posterior portal. The arrow indicates the partial subscapularis tendon tear. (B) View from superior portal. The reverse Hill-Sachs lesion (RHS) is identified and palpated using a hook (H) introduced from the standard anterior portal. (HH, humeral head; LHB, long head of biceps; ML, medial glenohumeral ligament; SS, subscapularis tendon.)

Step 3: Hill-Sachs Lesion Preparation and Pre-subscapularis Working Space Development

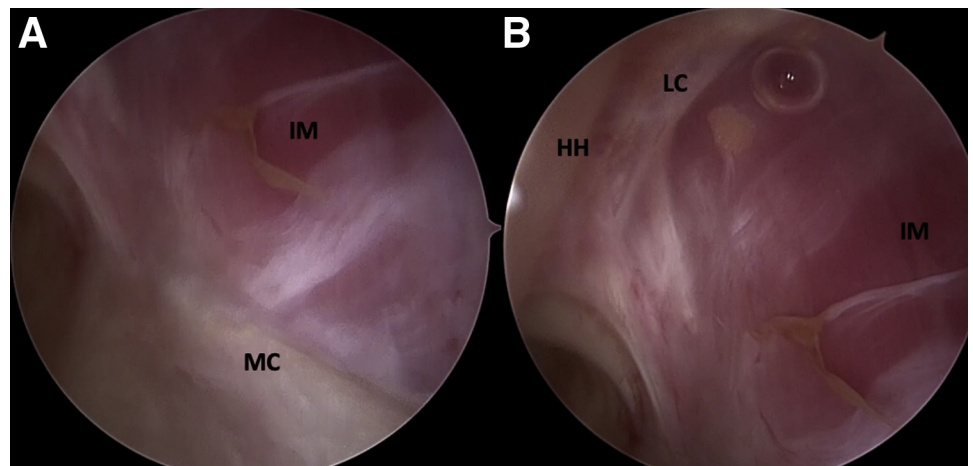
After the posterior capsule and labral lesions are repaired, with the arthroscope in the superior portal, our attention shifts to the Hill-Sachs lesion. With the aid of a needle, we determine the location of an accessory percutaneous anterior portal, distal and lateral to the anterior portal and just lateral to the conjoint tendon. By use of the cannula through the anterior portal, the surface of the Hill-Sachs lesion is debrided with a curette (Fig 9); then, a pre-subscapularis working space is developed with an electrocoagulation device between the anterior part of the superior third of the subscapularis tendon and the lateral aspect of the conjoint tendon and clavipectoral fascia, far from the axillary nerve (Fig 10). This working space is used for screw placement and suture management.

Step 4: Subscapularis Bridge Technique

By use of the accessory percutaneous anterior portal—lateral to the conjoint tendon—as the working

portal, an initial anchor hole is made in the inferior portion of the Hill-Sachs lesion. This hole is prepared through the trans-subscapularis using a puncher (Fig 11 A and B) and a tapper (Fig 11 C and D). A 4.75-mm Bio-SwiveLock anchor (Arthrex) loaded with FiberTape sutures (Arthrex) is introduced into the accessory anterior portal (Fig 12A) and then into the inferior hole passing through the subscapularis tendon (Fig 12B). A second anchor hole is made in the superior portion of the Hill-Sachs lesion (Fig 13), through the cannula in the anterior portal. The FiberTape sutures are retrieved from the anterior portal through the cannula from the previously developed pre-subscapularis working space. Next, these FiberTape sutures are reintroduced into the joint to be recovered from the posterior portal and pulled to assess the proper coverage of the defect with the subscapularis tendon (Fig 14 A-C). The FiberTape sutures are then loaded in the eyelet core screw of the second 4.75-mm Arthrex Bio-SwiveLock anchor (Fig 14D), which is screwed into the hole after passing over the superior border of the subscapularis tendon

Fig 4. Arthroscopic view of right shoulder with posterior shoulder instability, in lateral oblique position, from superior portal, showing posterior capsular lesion. (A) Posterior capsular lesion, medial portion of retracted capsule, and infraspinatus muscle (IM). (B) Infraspinatus muscle (IM) with underlying border of lateral capsular lesion. (HH, humeral head; LC, lateral border of posterior capsular defect; MC, medial border of posterior capsular defect.)



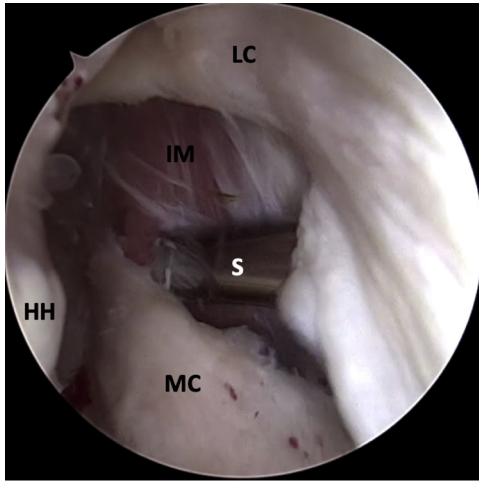


Fig 5. Arthroscopic view of right shoulder with posterior shoulder instability, in lateral oblique position, from superior portal, showing posterior capsular lesion after releasing its borders. The posterior capsular lesion and its lateral border (LC) and medial border (MC) are being released with a shaver (S) from the infraspinatus muscle (IM) to allow proper identification and facilitate its reduction. (HH, humeral head.)

(Fig 15). The free limbs of the sutures are cut. We check the subscapularis bridge construct for correct filling of the lesion (Fig 16) while taking care not to involve the glenohumeral ligaments (middle or inferior) in the construct. Adequate tension of the subscapularis tendon and normal movement of the long head of the biceps are also evaluated.

Graphical representations of the arthroscopic knotless subscapularis bridge technique for RHSLs with posterior shoulder instability can be seen in Figures 17 and 18.

The limitations and risks of this technique are presented in Table 1, and tips and pitfalls are discussed in Table 2.

Postoperative Care and Radiologic Assessment

Postoperatively, the shoulder is immobilized for a 3-week period with a sling in neutral position with 15° of abduction. Throughout this period, free movement of the elbow and hand is allowed, such as in an isometric strengthening routine for the deltoid and scapular stabilizing muscles. Active internal rotation is not allowed during the first 3 weeks. After this 3-week period, the sling is removed and pendulum plus active-assisted forward flexion exercises are started. Between 4 and 6 weeks postoperatively, progressive stretches in external rotation are performed to achieve a complete range of motion. Muscle-strengthening exercises are started at 6 weeks postoperatively, and a return to sport is allowed at 4 months postoperatively. A postoperative MRI control is performed at 1 month of follow-up to assess the correct subscapularis bridge positioning and, thus, the full coverage of the RHSL (Fig 19).

Discussion

The RHSL is defined as an impression fracture of the anteromedial humeral head as the result of impaction with the posterior rim of the glenoid during a posterior shoulder dislocation. The incidence of RHSLs after acute posterior shoulder dislocation has been found to be between 30%⁴ and 86%.¹² The presence of this lesion is a major risk factor for recurrence of posterior shoulder instability,¹³ especially in patients younger than 40 years and/or with a history of seizures. Historically, the

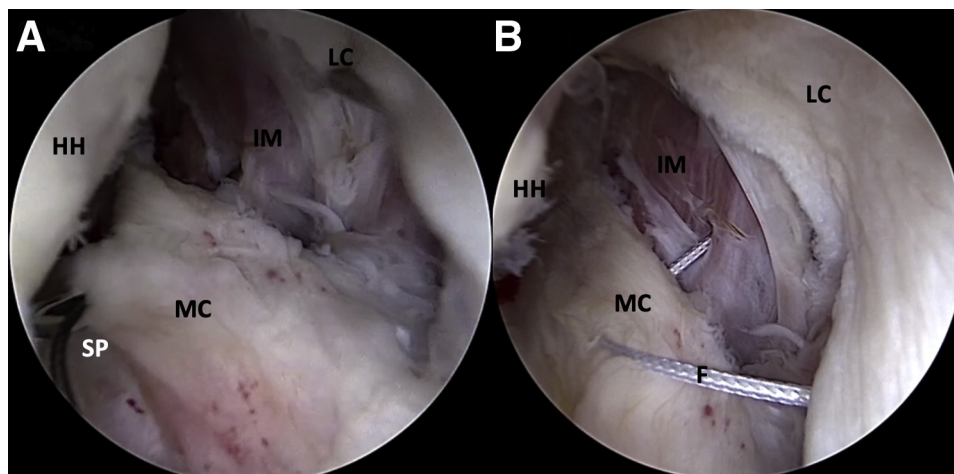


Fig 6. Arthroscopic view of right shoulder with posterior shoulder instability, in lateral oblique position, from superior portal, showing reparation of capsular lesion. (A) A suture passer (SP) loaded with a nitinol wire has been passed through an accessory percutaneous posterolateral portal to the medial border of the posterior capsular lesion. (B) The nitinol wire previously passed through the posterior capsular lesion has been replaced with a FiberWire suture (F). (HH, humeral head; IM, infraspinatus muscle; LC, lateral border of posterior capsule; MC, medial border of posterior capsule.)

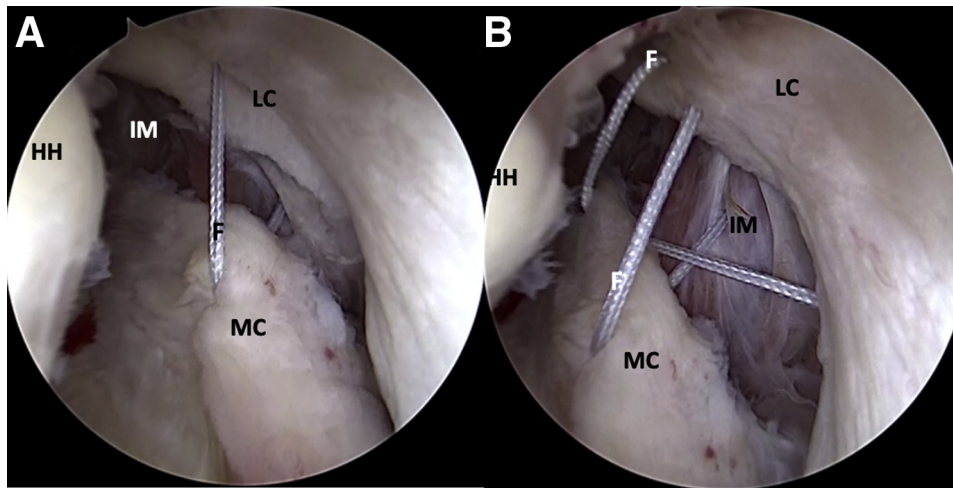


Fig 7. Arthroscopic view of right shoulder with posterior shoulder instability, in lateral oblique position, from superior portal, showing reparation of capsular lesion. (A) The FiberWire suture (F) has been passed through the lateral and medial borders of the posterior capsular lesion. (B) Two parallel FiberWire sutures (F) have been passed through the medial and lateral borders of the posterior capsular lesion. (HH, humeral head; IM, infraspinatus muscle; LC, lateral border of posterior capsule; MC, medial border of posterior capsule.)

treatment recommendations in patients with posterior shoulder instability were based on the humeral head defect size.¹⁴ The humeral head defect was classified by Robinson and Aderinto¹⁵ as small (<25%), medium (25%-50%), or large (>50%). Classically and in general terms, patients with small RHSLs ($\leq 20\%$ of humeral head defect) were treated nonoperatively, as recommended by Cicak¹⁶ and Finkelstein et al.¹⁷ However, in the presence of a significant RHSL (20%-40% of humeral head defect), various surgical approaches have been published. The first author to describe a treatment technique was McLaughlin.⁹ The procedure consisted of transposing the subscapularis into the bed of the defect. The Neer modification of the McLaughlin procedure, using a method of open osteotomy and transposition of the lesser tuberosity into the bone defect, was

subsequently described by Hawkins et al.¹⁰ and Hughes and Neer.¹⁸ Charalambous et al.¹⁹ similarly described a technique using the subscapularis tendon to fill the defect without detaching the tendon. In addition, a surgical procedure involving the disimpaction of the impression fracture and bone grafting with an iliac crest graft or an allograft has been described.²⁰ When one is discussing large humeral head defects, arthroplasty is considered a good option to address the massive RHSL.

In 2013, Moroder et al.²¹ suggested that relying on the defect size for the choice of treatment is unreliable and has no reproducible scientific evidence in general.⁴ This was mainly due to the fact that the previously mentioned publications and other similar articles did not specify the measurement method used to determine the defect size. Because of this, Moroder et al. published a standardized

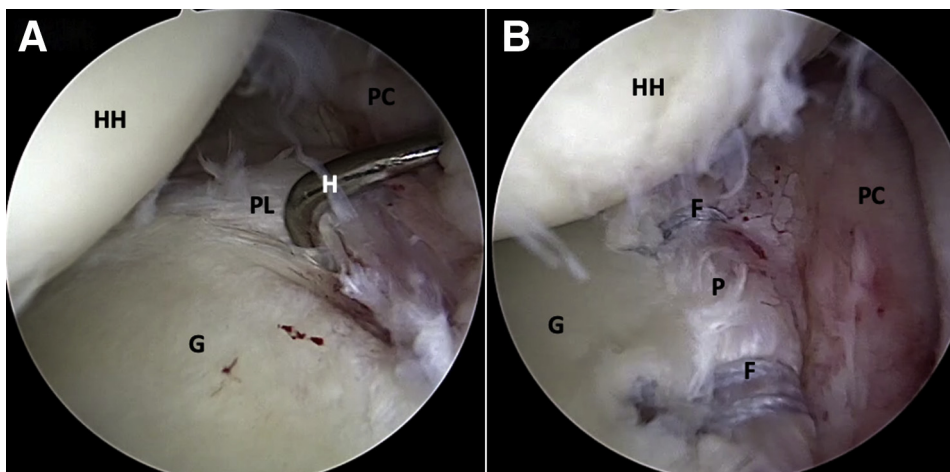


Fig 8. Arthroscopic view of right shoulder with posterior shoulder instability, in lateral oblique position, from superior portal. (A) Posterior labral lesion (PL) being tested with a hook (H). (B) Final view of repaired posterior capsular lesion and posterior capsulolabral complex with two 2.9-mm Bio-PushLock knotless anchors after being debrided with curette and shaver. (F, FiberWire suture; G, glenoid; HH, humeral head; P, repaired labral lesion; PC, posterior capsule.)

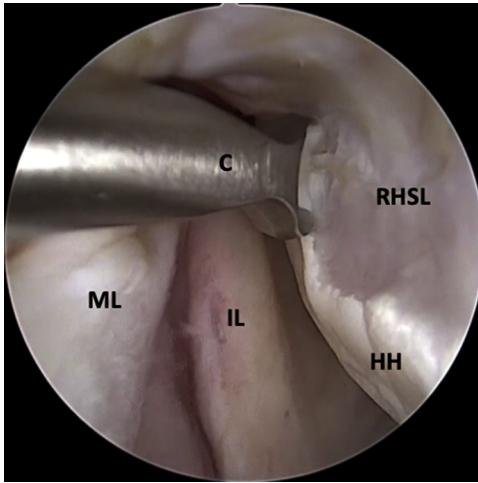


Fig 9. Arthroscopic view of right shoulder with posterior shoulder instability, in lateral oblique position, from superior portal. The reverse Hill-Sachs lesion (RHSL) is debrided using a curette (C) introduced from the standard anterior portal. (HH, humeral head; IL, inferior glenohumeral ligament; ML, medial glenohumeral ligament.)

method for quantifying the location and size of RHSLs based on a best-fit circle technique and a simple angle, dubbed the “gamma angle.” The gamma angle defines the position of the posterior edge of the RHSL with reference to the bicipital groove (Fig 20). Moroder et al. defined the critical gamma angle to be approximately 90° . Therefore, RHSLs with small gamma angles may not engage in internal rotation, whereas those with large gamma angles may engage. Moreover, Moroder et al.²² established that the risk of engagement will also depend on the interindividual capacity of internal rotation in adduction of the humeral head and not only on RHSL depth, location, and

orientation. The number of degrees by which the humeral head can internally rotate until engagement is defined as the “delta angle.” This angle is measured between a line from the center of the best-fit circle to the posterior defect edge and another line drawn from the center of the circle to the posterior glenoid rim (Fig 21). In patients with anterior shoulder instability, evidence has shown that early detection and restoration of the osseous injury to the glenoid bone are critical in effective management. Critical bone loss of the anterior glenoid has proved to be essential in choosing the best treatment for preventing recurrence.^{23,24} Unfortunately, on the other hand, there are few published data on posterior glenoid bone defects. Bryce et al.²⁵ found a correlation between posterior bone loss and posterior humeral head translation. Moroder et al.²² established a highly significant correlation with a decrease in the delta angle of approximately 2° per each increased millimeter of glenoid defect size (i.e., an increase of 2° in the gamma angle per millimeter of the glenoid defect). According to these data, a posterior glenoid bone defect can turn a non-engaging RHSL into an engaging RHSL.²⁶ This change in gamma angle measurement as a function of glenoid bone loss was defined as the “gamma angle concept”²² (Fig 22). It emphasizes the importance of the treatment choice in patients with posterior shoulder instability based on the preoperative determination of bipolar bone lesions, just as it has been defined in patients with anterior shoulder instability with the “glenoid track concept.”²⁷

Nacca et al.,²⁸ using a methodology similar to anterior instability models, established that posterior glenoid bone loss greater than 20% leads to increased posterior humeral head translation, thus resulting in persistent shoulder instability after isolated soft-tissue repair.

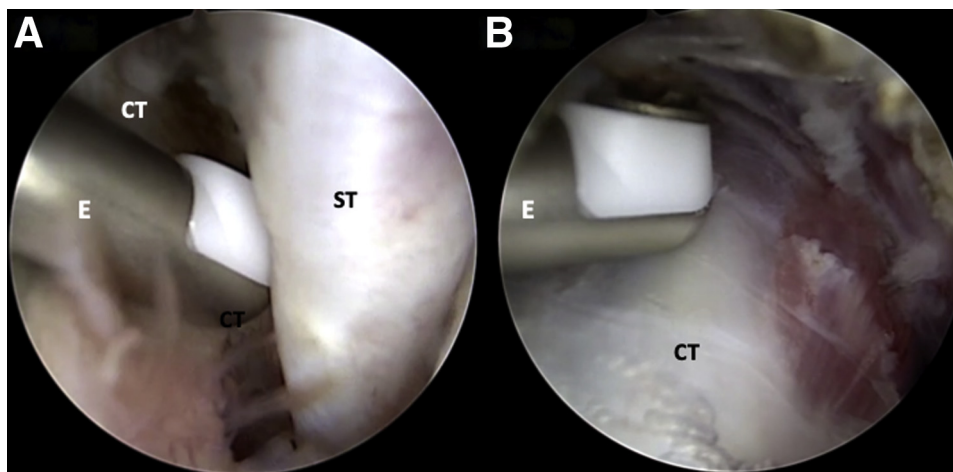


Fig 10. (A, B) Arthroscopic view of right shoulder with posterior shoulder instability, in lateral oblique position, from superior portal. With removal of the cannula from the standard anterior portal using an electrocoagulation device (E), the pre-subscapularis working space is developed between the anterior side of the upper third of the subscapularis muscle and the lateral side of the conjoint tendon. This is the space where the first and inferior trans-subscapularis screw will be passed. (CT, conjoint tendon and clavipectoral fascia; ST, subscapularis tendon.)

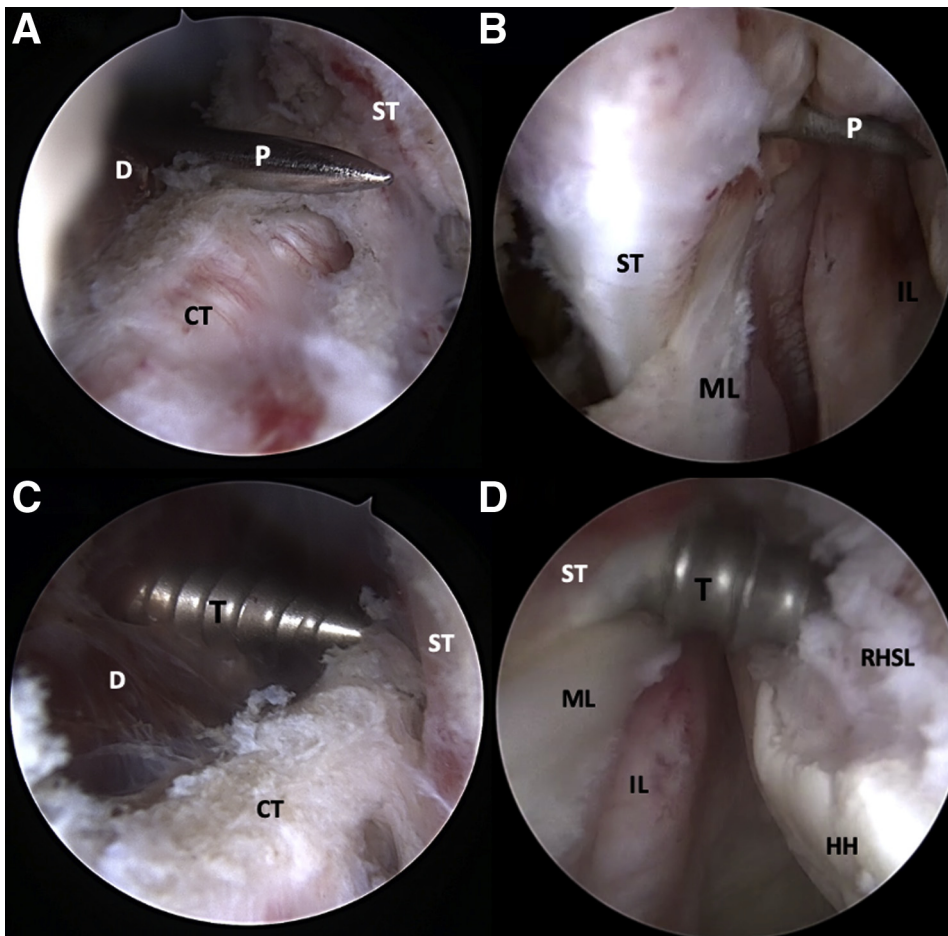


Fig 11. Arthroscopic view of right shoulder with posterior shoulder instability, in lateral oblique position, from superior portal. (A) Previously prepared pre-subscapularis working space. The puncher (P) is introduced through the percutaneous accessory portal, lateral to the conjoint tendon and anterior to the subscapularis tendon. (B) The puncher (P) is introduced through the subscapularis tendon in the reverse Hill-Sachs lesion (RHSL) to prepare the inferior anchor hole bed. (C) Tapper (T) through anterior working space, after removal of puncher. (D) The tapper (T) is introduced through the subscapularis tendon in the RHSL to prepare the inferior anchor hole. (CT, conjoint tendon; D, deltoid; HH, humeral head; IL, inferior glenohumeral ligament; ML, medial glenohumeral ligament; ST, subscapularis tendon.)

Therefore, the cutoff value of 20% of posterior glenoid bone loss generally warrants posterior bone block stabilization.²⁶

After the increase in the number of studies concerning posterior shoulder instability, Moroder and Scheibel²⁹ published the “ABC Classification of Posterior

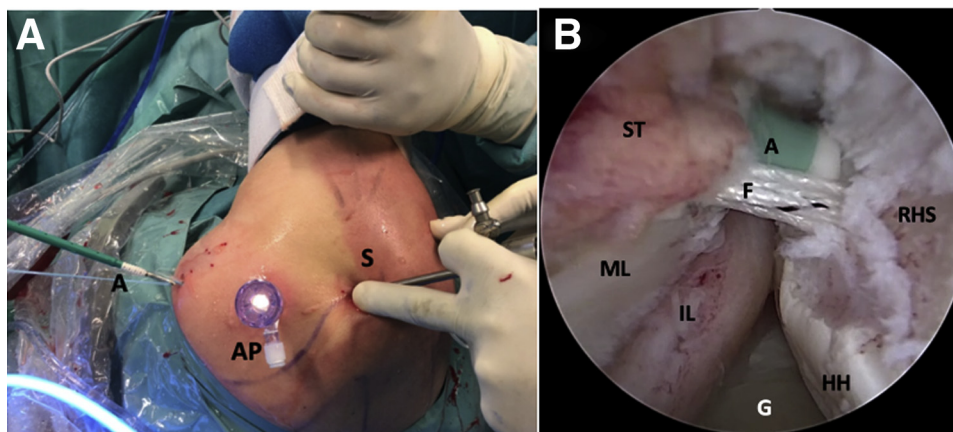


Fig 12. (A) A Bio-SwiveLock anchor loaded with FiberTape suture is introduced into the inferior percutaneous portal, crossing the pre-subscapularis working space, to continue through the subscapularis tendon. (B) Arthroscopic view of right shoulder with posterior shoulder instability, in lateral oblique position, from superior portal. The anchor is introduced into the inferior anchor hole previously made in the reverse Hill-Sachs lesion (RHS), going across the subscapularis. (A, Bio-SwiveLock anchor; AP, anterior portal with cannula; F, FiberTape suture; G, glenoid; HH, humeral head; IL, inferior glenohumeral ligament; ML, medial glenohumeral ligament; S, superior portal with camera; ST, subscapularis tendon.)

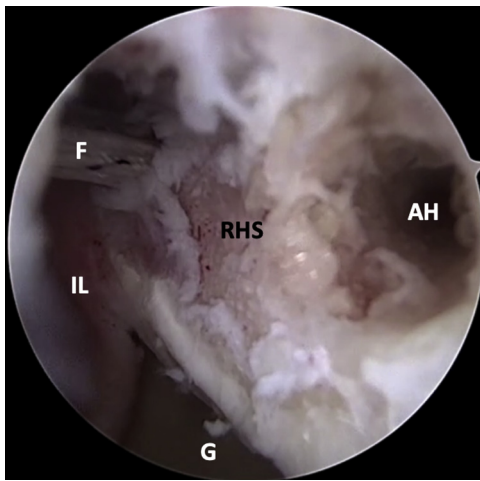
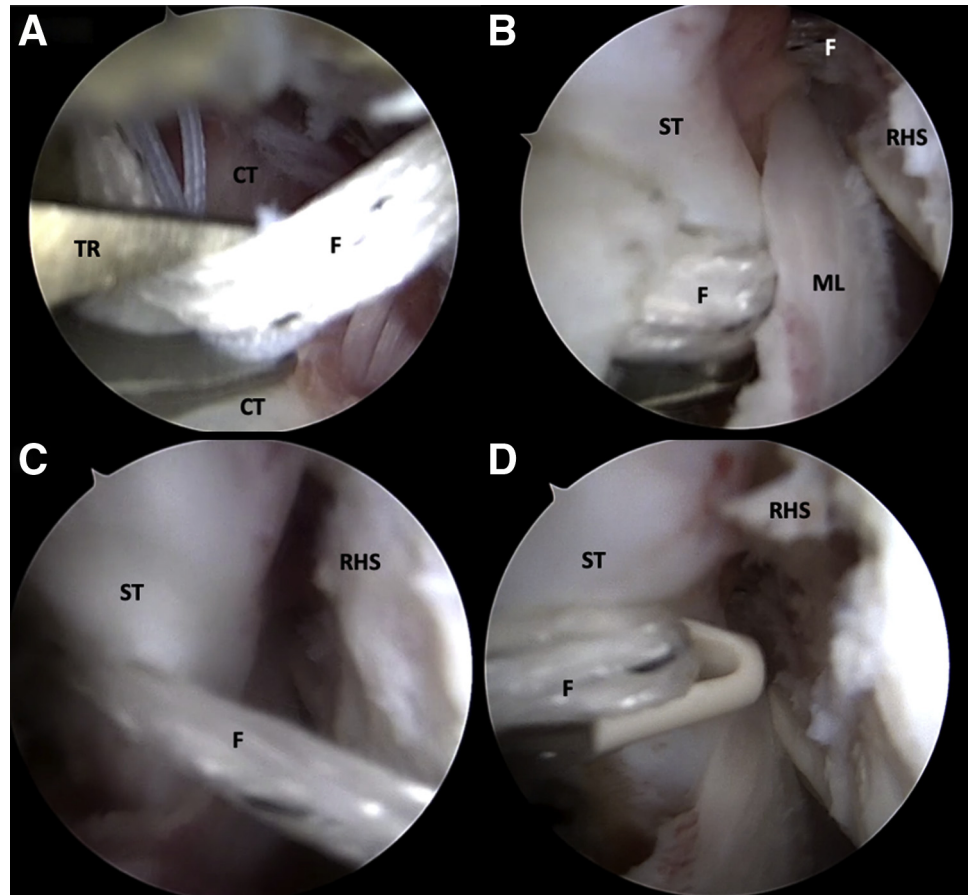


Fig 13. Arthroscopic view of right shoulder with posterior shoulder instability, in lateral oblique position, from superior portal. By use of the tapper, a second anchor hole (AH) is made through the cannula in the anterior portal and superiorly to the first hole in the upper side of the reverse Hill-Sachs lesion (RHS). The inferior anchor with the FiberTape suture (F) is noted. (G, glenoid; IL, inferior glenohumeral ligament.)

Shoulder Instability” in 2017, in an attempt to offer a simple and comprehensive tool with clear distinction criteria and therapeutic relevance, representing a guideline for the generally recommended type of treatment. Nowadays, many arthroscopic procedures have been developed for the treatment of posterior shoulder instability.³⁰⁻³³ Arthroscopic techniques decrease the morbidity associated with open procedures. Since 2006, most of these arthroscopic techniques were used to repair posterior Bankart and capsule lesions. Nonetheless, in the case of concomitant glenoid bony defects, it is supposed that these defects also may be restored to achieve a competent glenohumeral joint in terms of stability.^{2,13} In light of this, Krackhardt et al.¹¹ published the first all-arthroscopic technique for the treatment of large RHSLs in 2006. The discussed technique is performed by fixing the subscapularis tendon in the humeral impression fracture using 2 suture anchors placed medially and laterally in the humeral bony defect. The wires are crossed through the subscapularis tendon and then knotted. Krackhardt et al. concluded that this

Fig 14. Arthroscopic view of right shoulder with posterior shoulder instability, in lateral oblique position, from superior portal. (A) From the pre-subscapularis working space, the FiberTape suture (F)—from the anchor placed in the inferior edge of the reverse Hill-Sachs lesion (RHS) through the anteroinferior portal—is retrieved from the anterior portal through the cannula. (B) The FiberTape suture (F) is introduced into the joint by pushing the retriever. (C) The FiberTape suture (F) is recovered with the retriever from the posterior portal and pulled to assess the proper coverage of the anterior bone defect (RHS) with the subscapularis tendon before anchoring. (D) The FiberTape suture (F) is loaded in the eyelet core screw. (CT, conjoint tendon; ML, medial glenohumeral ligament; ST, subscapularis tendon; TR, tape retriever.)



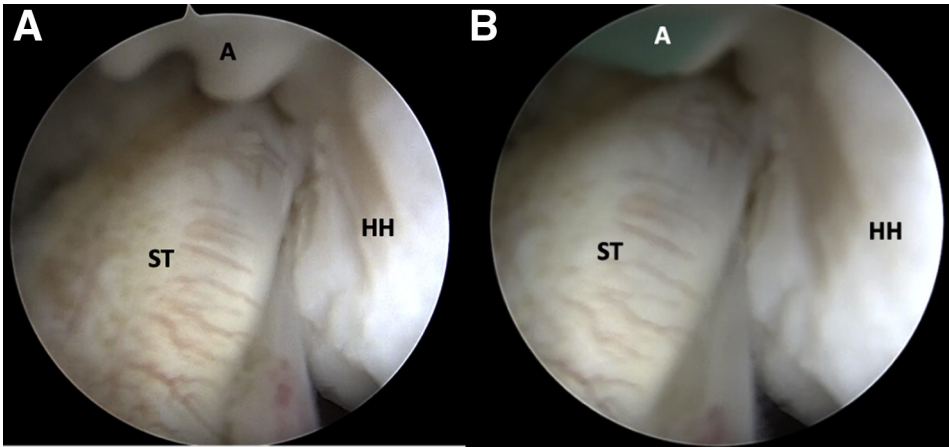


Fig 15. Arthroscopic view of right shoulder with posterior shoulder instability, in lateral oblique position, from superior portal. (A) The Bio-SwiveLock screw is inserted in the second hole of the reverse Hill-Sachs lesion (RHSL), superiorly and without piercing the subscapularis tendon (ST). (B) With the screw almost fully inserted, the subscapularis tendon (ST) filling the defect can be noted. (A, Bio-SwiveLock anchor; HH, humeral head.)

Fig 16. Arthroscopic view of right shoulder with posterior shoulder instability, in lateral oblique position, from superior portal. (A) Final FiberTape suture bridge construct. The FiberTape suture, before the tape is cut, wraps the subscapularis tendon and covers the reverse Hill-Sachs lesion. (B) Final suture bridge construct covering reverse Hill-Sachs lesion. (F, FiberTape sutures; G, glenoid; HH, humeral head; ST, subscapularis tendon.)

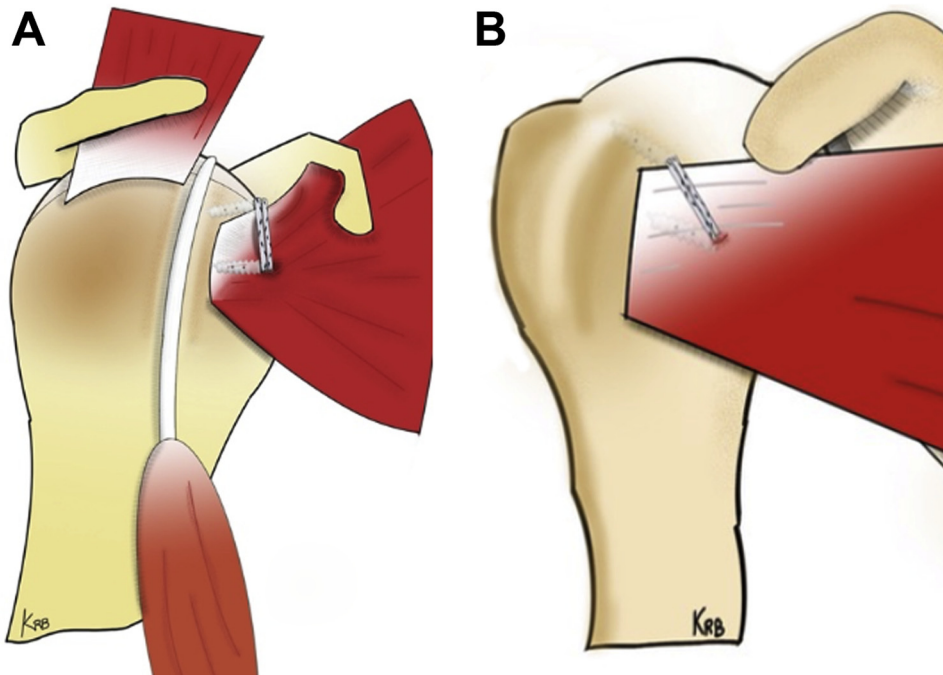
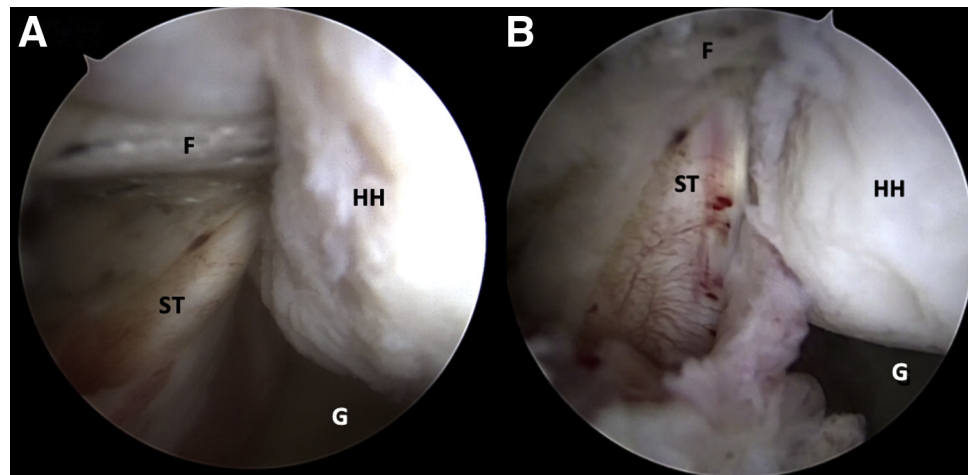


Fig 17. Graphical representation of final subscapularis bridge construct for reverse Hill-Sachs lesion (RHSL) treatment with posterior shoulder instability: sagittal plane (A) and coronal plane (B). The FiberTape sutures preloaded in the inferior anchor cross the subscapularis tendon to reach the inferior part of the RHSL. The superior knotless anchor is loaded with the FiberTapes coming from the inferior anchor, bypassing the subscapularis tendon. This leaves the whole RHSL covered by the subscapularis tendon bridge.



Fig 18. Graphical representation of final subscapularis bridge construct for reverse Hill-Sachs lesion treatment with posterior shoulder instability: axial plane. The superior knotless anchor is loaded with the FiberTape coming from the inferior anchor, wrapping the subscapularis tendon and covering the reverse Hill-Sachs lesion.

technique appears to be as safe as the open procedure and asserted that the limited internal rotation of the arm fixed in this manner can be reversed later. In 2013, Martetschläger et al.³⁴ published a modified arthroscopic McLaughlin procedure performed with 2 suture anchors introduced through the subscapularis tendon into the bony reverse Hill-Sachs defect and knotted by a mattress configuration. This technique differs from that of Krackhardt et al. in that one suture anchor is placed

in a superior position and one is placed in an inferior position into the defect, increasing the area of contact and improving the healing environment. Martetschläger et al. concluded that by using the mattress suture configuration, they avoid subscapularis suture strangulation, which could be a potential pitfall similar to what happens in the remplissage technique in cases of anterior shoulder instability.³⁵ Also in 2013, Duey and Burkhart³⁶ published an arthroscopic technique based on fixation of the medial glenohumeral ligament into the RHSL using suture anchors placed into the defect. They contended that this technique is superior to others because they believe that using the medial glenohumeral ligament instead of the subscapularis tendon avoids significant loss of internal rotation strength owing to subscapularis dysfunction resulting from altering its force vector. During the past few years, a number of articles have been published that describe knotted reverse remplissage techniques that resort to using 1 or 2 screws.^{37,38} More recently, Bernholt et al.³⁹ published an arthroscopic knotless subscapularis remplissage procedure with a unique anchor and concluded that the knotless anchors allow for a more efficient surgical procedure and may offer a biomechanically sounder construct.

This article is a surgical Technical Note with no comment on clinical and functional outcomes. Nevertheless, we recommend the use of the described technique because we believe it could possess advantages over

Table 2. Tips and Pitfalls of Technique

Tips

- Posterior capsulolabral and other concomitant lesions should be addressed prior to RHSL treatment.
- The integrity of the subscapularis tendon should be assessed before attempting this technique.
- The rotator interval should be opened generously to achieve better exposure of the lateral coracoid process and conjoint tendon space to keep this technique an all-in-the-box technique.
- A wide space should be developed between the anterior and lateral parts of the subscapularis tendon and the lateral border of the conjoint tendon.
- A curette should be used for full debridement of the RHSL footprint.
- The surgeon should localize the point of anterior-distal accessory portal placement with the aid of a needle under direct arthroscopic vision while staying lateral to the conjoint tendon.
- The inferior anchor should always be placed first.
- The surgeon should retrieve the suture tape from the first anchor through the anterior portal and make sure there is no soft-tissue interposition.
- The surgeon should check that no damage to the conjoint tendon has been made and assess for proper defect coverage by pulling the FiberTape suture strands from the posterior portal.
- Adequate tension of the tapes should be verified before completion of the bridge with the superior anchor.
- After the final construct is completed, the surgeon should assess the stability of the long head of the biceps and the proper tensioning of the subscapularis.

Pitfalls

- Treatment of the posterior capsulolabral defects must be performed first; otherwise, there will be great difficulty in correcting these lesions after RHSL filling is performed.
- If the pre-subscapularis working space is not well developed, it will be impossible to perform this technique properly.
- The percutaneous needle must be introduced distal to the anterior portal and lateral to the conjoint tendon to place the first anchor in the lowest part of the RHSL.
- The anchors must be placed at the center of the defect—far from the cartilage—to avoid excessive loss of external rotation.
- To obtain a strong subscapularis bridge construct, proper tensioning of the subscapularis tendon and adequate coverage of the defect must be checked before the second implant is placed.

RHSL, reverse Hill-Sachs lesion.

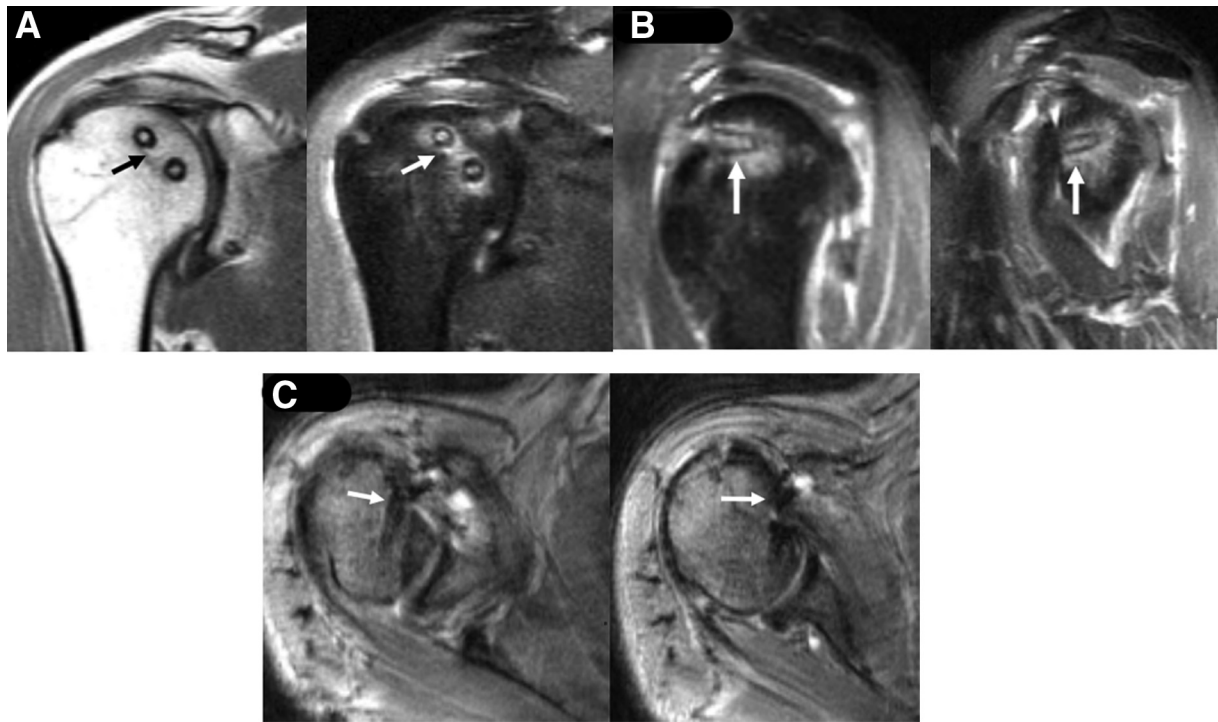


Fig 19. Postoperative magnetic resonance imaging control of subscapularis bridge construct for reverse Hill-Sachs lesion (RHSL) treatment with posterior shoulder instability. (A) On the coronal view, 2 Bio-Composite knotless screws (Arthrex), used to fix the subscapularis in the anterior humeral defect (RHSL), can be noted (black and white arrows). (B) On the sagittal view, the superior knotless screw can be seen wrapping the subscapularis tendon (left) and the inferior knotless screw can be seen crossing the subscapularis tendon (right) (white arrows). (C) The axial view at the coracoid process level (left) and under the coracoid process (right) shows the RHSL filled with the subscapularis tendon (white arrows).

previously published techniques. The subscapularis knotless bridge technique is an all-inside-the-box technique using an open rotator interval to obtain access to the

pre-subscapularis working space from the anterosuperior portal; therefore, it does not require a subacromial approach. This procedure achieves full coverage of the

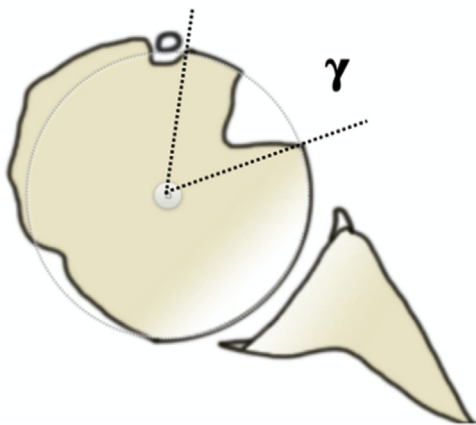


Fig 20. Graphical representation of gamma angle (γ) in axial view of shoulder for reverse Hill-Sachs lesion (RHSL) with posterior shoulder instability. The gamma angle is measured between the posterior aspect of the bicipital groove and the most posterior edge of the RHSL. This angle defines the location and size of the RHSL. Best-fit circle indicates circle performed across the articular cartilage and dashed line indicates a gamma angle.

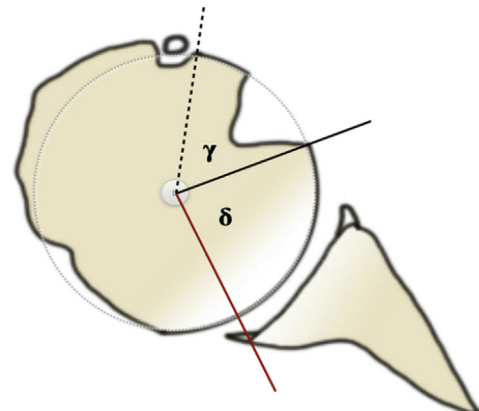


Fig 21. Graphical representation of delta angle (δ) in axial view of shoulder for reverse Hill-Sachs lesion with posterior shoulder instability. The delta angle is measured between a line drawn from the center of the best-fit circle to the posterior reverse Hill-Sachs defect edge and another line drawn from the center of the circle to the posterior glenoid rim. This angle determines the number of degrees by which the humeral head can internally rotate until engagement. Best-fit circle indicates circle performed across the articular cartilage and black and red line indicates delta angle. (γ , gamma angle.)

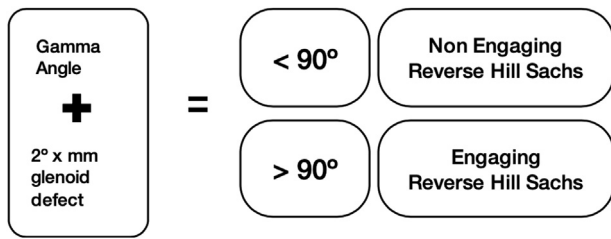


Fig 22. Graphical representation of gamma angle concept for reverse Hill-Sachs lesion with posterior shoulder instability.

RHSL by placing 2 anchors—one superiorly and one inferiorly—into the humeral head bony defect. In this method, the defect becomes completely extra-articular, avoiding engagement with the posterior glenoid rim. Additionally, in this technique, isolated partial articular subscapularis tears can be restored simultaneously by medializing the subscapular insertion. The knotless subscapularis bridge technique may also decrease damage to the tendon because only 1 end of the bridge crosses through it. Furthermore, the bridge acts as a low-profile repair, thus avoiding knot impingement; it may also eliminate knots being a pitfall point in the construct. Another possible advantage, as in all knotless techniques, is that the knotless subscapularis bridge may decrease the operative time, resulting in a more efficient surgical procedure. Finally, we consider this technique, when performed by experienced shoulder surgeons, to be reproducible and effective. Hence, in conclusion, we believe that our arthroscopic knotless subscapularis bridge technique provides a potentially superior alternative for the treatment of RHSLs with posterior shoulder instability.

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