



Anterior Shoulder Stabilization Using Single Needle-Assisted Outside-In Remplissage Technique and Bankart Repair

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Abstract: Arthroscopic repair of Bankart injury is the first choice for the treatment of anterior shoulder instability. How to avoid recurring shoulder joint dislocation is a challenge, especially when combined with Hill–Sachs lesions. The arthroscopy technology allows for broader vision and less surgical trauma but is limited by a smaller operating space. At present, extensive descriptions about the surgical procedure of arthroscopic Bankart repair have been published. In this Technical Note, we describe the use of remplissage filling with Hill–Sachs lesion combined with Bankart repair to further improve the surgical accuracy and clinical efficacy. In particular, the application of single needle-assisted outside-in remplissage technique and Bankart repair is introduced in detail.

In young people or athletes, the shoulder is the joint with the greatest incidence of total body dislocation as the result of its great flexibility.^{1,2} Hill–Sachs lesion is a compression fracture of the posterolateral humeral head after anterior dislocation of the shoulder.³ In addition, anterior dislocation is usually accompanied by humeral avulsion of the glenohumeral ligament, glenolabral articular disruption, anterior labroligamentous periosteal sleeve avulsion, rotator cuff injury, axillary nerve injury, as well as other fractures.^{1–4}

The original Bankart repair procedure is composed of a coracoid osteotomy and a subscapularis tenotomy.⁵

With the development of shoulder arthroscopy, surgical instruments, and implants, research on shoulder instability progressed, and the optimal indications, contraindications, and efficacy of many subtle technical variations need to be further clarified.⁶ Off-track Hill–Sachs lesion is a significant and important risk factor for the recurrence of instability, and revision surgery often is required after arthroscopic Bankart repair.⁷ In Bankart injury with combined Hill–Sachs lesion, concurrent treatment of the Hill–Sachs lesion is necessary. This technique is safe and reliable and can effectively reduce the recurrence rate of anterior dislocation of the shoulder.^{8–10}

Among surgical techniques that have been reported, the single needle-assisted outside-in remplissage technique has not yet been applied in clinical practice, and the application of suture passer for Bankart repair is also rare. In this Technical Note, we aimed to describe the detailed technical steps of anterior shoulder stabilization using the single needle-assisted outside-in remplissage technique and suture passer for Bankart repair (Table 1, Video 1).

Patient Evaluation and Indications for Surgery

Hill–Sachs lesion is a grooved bony defect in the posterior superior aspect of the humeral head due to sliding of the humeral head into the anterior inferior aspect of the scapular glenoid, where the anterior rim of the articular glenoid extrudes and impinges against the

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Table 1. Tips and Main Surgical Procedure

Surgical Step	Tips and Pearls	Pitfalls
Remplissage technique	Clean the surface of the posterior and joint capsule and the surface of Hill–Sachs lesion. A spinal needle is used to assist in locating the Hill–Sachs lesion, and an anchor is inserted. Thread the PDS to assist in threading the suture on the anchor into the tendon and the joint capsule.	The extent of the infraspinatus tendon suture that is sutured to fill the Hill–Sachs lesion is adjusted by controlling the skin entry point and the exit point within the joint of the spinal needle, which otherwise tends to result in insufficient filling of the Hill–Sachs lesion or the need to increase the number of anchors. There is a definite learning curve for novice surgeons to learn this technique, and high-volume shoulder surgeons are much more comfortable with it.
Bankart repair	Clear the scar tissue and thoroughly release the inferior capsulolabral complex. Place the drill guide at the 5:30-o'clock position to drill a hole for the purpose of implanting a double-suture anchor. Introduce the suture passer through the anterior inferior approach into the joint space. Implant a second anchor in the 5:00- to 6:00-o'clock direction in the same manner.	The use of a radiofrequency electrocautery device will inhibit labral healing to the glenoid rim. The glenoid labrum should be adequately relieved before placement of the anchor nail or reset will be difficult. Requires devices from a particular supplier to complete the procedure.

PDS, polydioxanone.

posterior superior aspect of the humeral head.³ Radiographs, computed tomography, and magnetic resonance imaging are frequently used tools for the evaluation of shoulder dislocations and the associated Hill–Sachs lesions. Among these auxiliary examinations, computed tomography arthrography has been reported with the greatest accuracy.¹¹ The surgical technique known as "remplissage" involves converting a bony intra-articular defect into an extra-articular one while providing soft-tissue coverage. The remplissage technique aims at preventing engagement and is typically performed on patients with moderate-to-large Hill–Sachs lesions that are associated with glenoid defects ranging from <20% to 25%.³

Surgical Technique (With Video Illustration)

Anesthesia and Patient Positioning

Before he or she enters the operating room, the patient is anesthetized with an interscalene nerve catheter on the operative side to mitigate postoperative pain. Before positioning, general anesthesia and tracheal intubation are usually performed. Then, the patient is placed in the lateral position on the healthy side, with the body leaned back approximately 30°. The shoulder joint is placed in the 30° outward and 15° forward flexion position. A force of 10 kg is exerted to pull the arm at the far end.

Diagnostic Arthroscopy

The arthroscope is entered into the glenoid humeral joint through a posterior approach, that is, from the side of the humeral head protrusion, in order to center the Hill–Sachs lesion. Then, diagnostic examinations, including Bankart injury and type, glenoid defect and

size, Hill–Sachs lesion and size, SLAP injury, etc., are performed under arthroscopy.

Subsequently, an anterior inferior approach is established on the rotator cuff gap, and an 8.25-mm diameter corkscrew cannula (Smith & Nephew, Andover, MA) is inserted through this approach as the main working pathway for anterior labial reconstruction. Further, an anterior superior approach is established at the anterior edge of the acromion, and a 7.0-mm diameter corkscrew cannula (Smith & Nephew) is inserted. This approach can directly enter the posterior part of the biceps tendon. The arthroscope is then transferred from the posterior approach to the anterior superior approach, and a 7.0-mm diameter corkscrew cannula is placed into the posterior approach to further observe the Hill–Sachs lesion and Bankart injury (Fig 1).

Remplissage Technique

First, the surface of the posterior and lower joint capsule and the injured surface of Hill–Sachs are cleaned with a shaver to freshen the wound while ensuring that the least bone on the surface is removed. A spinal needle is used to assist in locating the injury of Hill–Sachs lesion, and a BIORAPTOR 2.9 Suture anchor (Smith & Nephew) is inserted. Then, the 0-polydioxanone (PDS) thread is used to assist in threading a suture on the anchor into the tendon and the joint capsule behind. Another spinal needle is inserted 0.5 cm away from the first opening, and the PDS is threaded to assist in threading the remaining suture on the anchor into the tendon and the posterior joint capsule (Fig 2). The suture is tightened properly to confirm the reasonability of the suture layout and whether it can cover the Hill–Sachs lesion well. If the sutures are not evenly distributed, they can be possibly

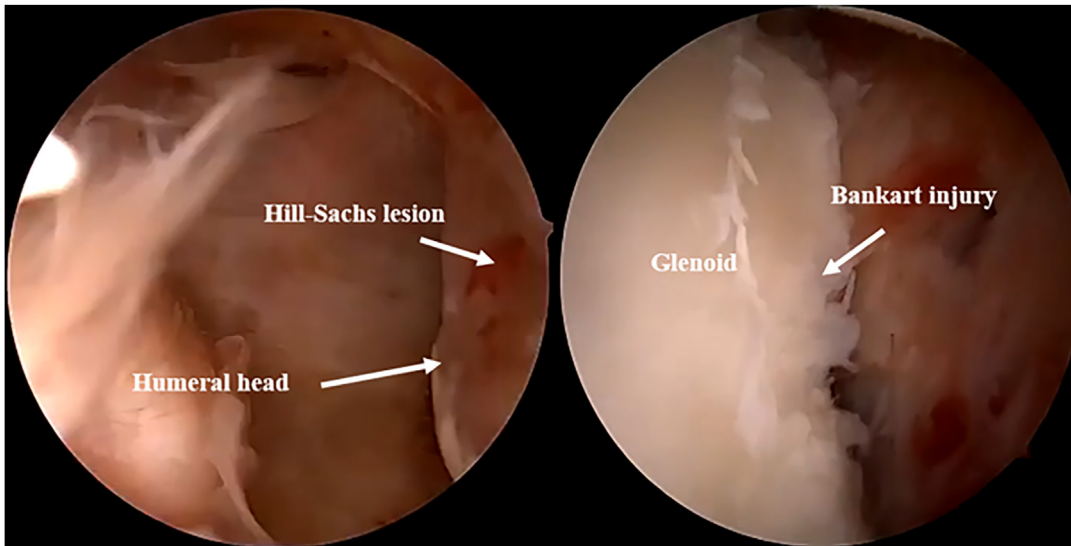


Fig 1. The patient is placed in the lateral position on their healthy side. The Hill–Sachs lesion and Bankart injury of the left shoulder can be seen from the anterior superior approach.

adjusted with a spinal needle, or a second anchor may be implanted. Lastly, after the Bankart injury is repaired, the sutures are tied securely with the posterior joint capsule and some soft tissues of the infraspinatus in the subacromial space.

Bankart Repair

The scar tissue in the anterior inferior approach is cleaned using a soft-tissue scraper (Arthrex, Naples, FL). The inferior capsulolabral complex is then thoroughly released using a Bankart rasp or radiofrequency electric knife by starting from the upper edge of the glenoid cavity and moving downwards. Continue releasing the edge until the infraspinatus fibers are visible and

downwards until the 6:00-o'clock position, ensuring complete hemostasis. A 2-mm thick layer of cartilage is removed from the anterior inferior labrum edge using a cartilage scraper for anchor insertion. Then, the bony cortex of the labrum edge is gently grinded using a burr until the bone surface bleeds slightly for the purpose of promoting soft-tissue healing. After placing the drill guide at the 5:30-o'clock position, a hole is drilled to implant a BIORAPTOR 2.9 Suture anchor. The suture tails of the anchor are retrieved through the corkscrew cannula and are loaded into a suture passer (FIRSTPASS MINI Suture Passer; Smith & Nephew). The suture passer is introduced through the anterior inferior approach into the joint space (Fig 3). The soft tissue is entered from the

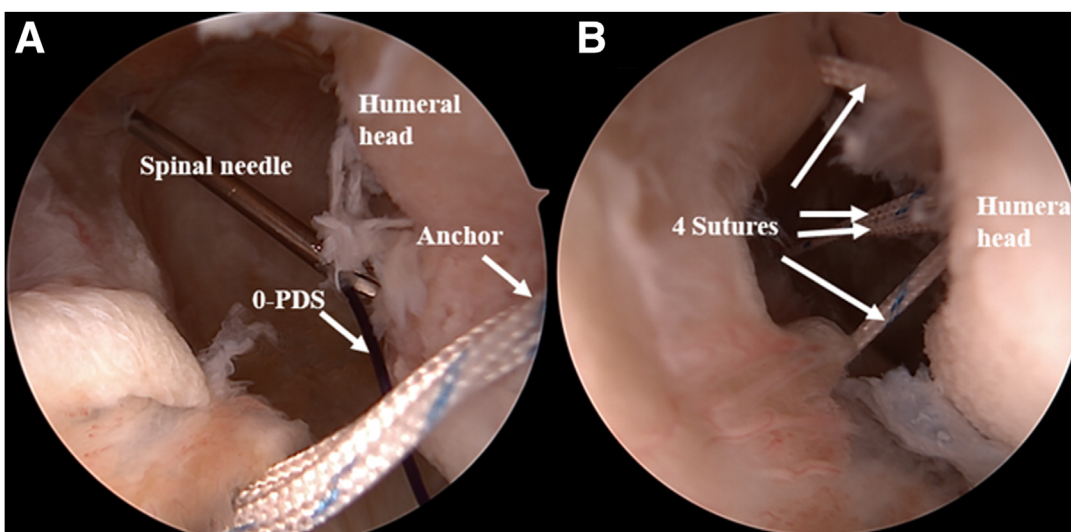


Fig 2. (A) A spinal needle is used for positioning the left shoulder, and the polydioxanone (PDS) thread is used to assist in threading a suture on the anchor into the tendon and the joint capsule behind. (B) Another spinal needle is inserted 0.5 cm away from the first opening. Thread the PDS to assist in threading the remaining suture on the anchor into the tendon and the posterior joint capsule. (The healthy side, lateral position, and the anterior superior approach are shown.)

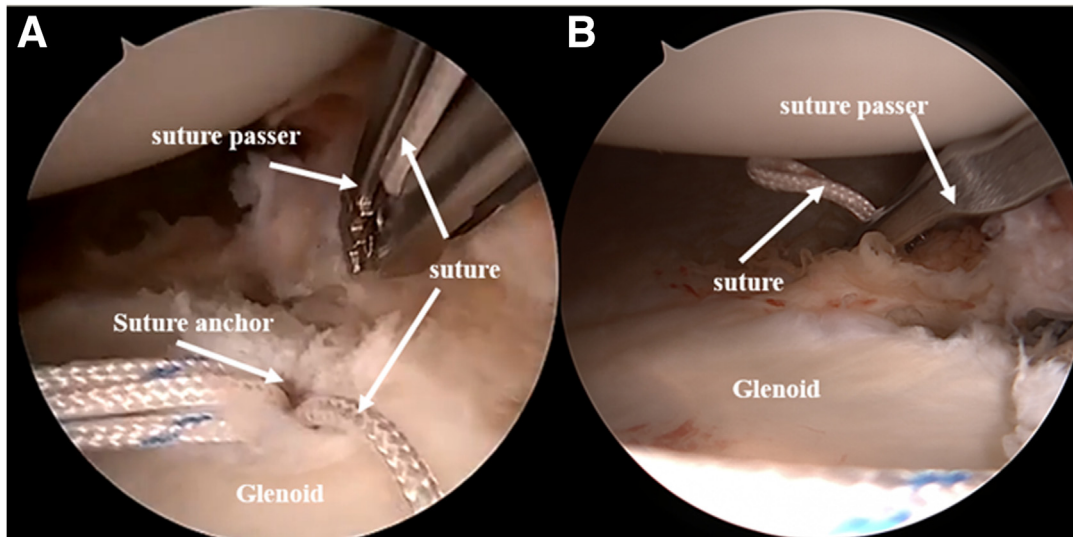


Fig 3. (A) The suture tails of the anchor are retrieved through the corkscrew cannula and are loaded into a FIRSTPASS MINI suture passer. The suture passer is introduced through the anterior inferior approach into the joint space. (B) The capsulolabral complex is sutured with the suture passer in the 6:00-o'clock direction. (The healthy side, lateral position, and the anterior superior approach of left shoulder are shown.)

inferior aspect of the labrum in order to grab the tissue as close to the 7:00-o'clock position as possible. Once the depth (approximately 10 mm) is confirmed, the scorpion needle is shot and passed through the capsulolabral complex to remove the suture passer. Subsequently, the suture passer is passed between the 5:00- and 6:00-o'clock position (as close to the 6:00-o'clock position as possible) using the same method while maintaining a distance about 2 to 4 mm between the sutures to ensure a more reasonable distribution of the threads. The 2 sutures of the same color are pulled out from the joint and tied together securely. The capsulolabral complex is

pulled and tensioned upwards and outwards, ensuring close contact with the glenoid rim. Next, the additional suture anchors are implanted continuously based on the extent of the Bankart. If the tear extends to the 2:00-o'clock position, a single-suture anchor is implanted at the 4:30-o'clock, 3:30-o'clock, and 2:30-o'clock positions, and an over-the-top suture repair is performed on the capsulolabral complex at these positions using a suture shuttle with a PDS, with a suture depth of approximately 10 mm. The suture anchor sutures are further introduced into the capsulolabral complex using the PDS, and edge-to-edge tensioning and knot tying are

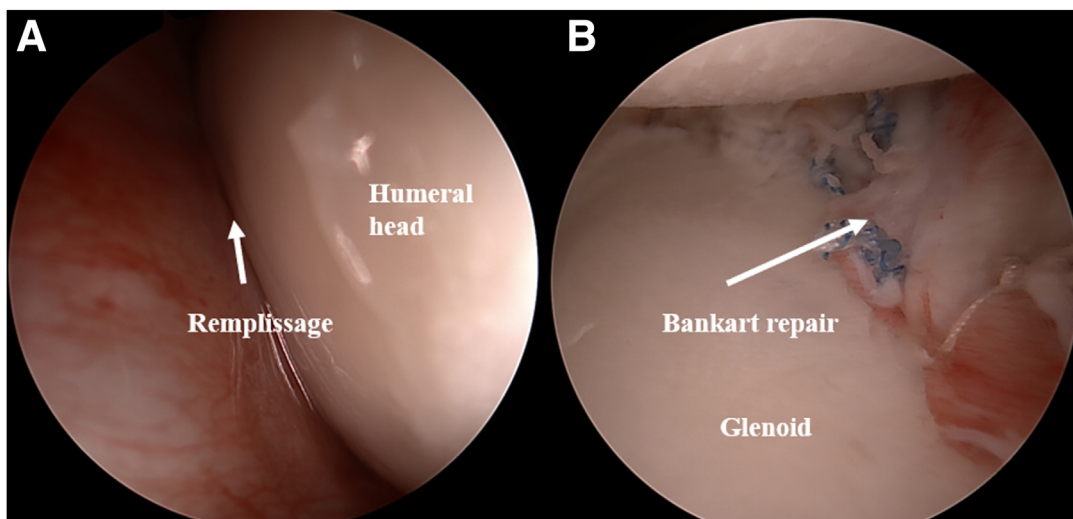


Fig 4. (A) The suture is tied with the posterior joint capsule and some soft tissues of the infraspinatus in the subacromial space of the left shoulder. (B) A labial eminence is formed at the anterior inferior glenoid rim after Bankart repair. (The healthy side, lateral position, and the anterior superior approach of left shoulder are shown.)

Table 2. Advantages and Disadvantages

	Advantages	Disadvantages
Spinal needle	Less-invasive surgery Easy to adjust risky layout Fewer anchors used Shorter surgery time	High technical requirements for surgical operation
Suture passer	Suitable for narrow shoulders with anterior and inferior sutures Easier to suture the glenoid labrum capsule tissue at the 5:00- 6:30-o'clock position (left shoulder) and 7:00- to 5:30-o'clock position (right shoulder) High quality of Bankart repair Easy to suture in both left and right shoulders	Able to prevent breakage of the needle

performed at each site. Once the repair is completed, a "labial eminence" (a capsule, when sutured to the glenoid labrum, creates a bulge that prevents the shoulder from dislocating again) should be formed at the anterior inferior glenoid rim (Fig 4).

Rehabilitation

The protocol of postoperative care and local immobilization should be personalized, usually requiring immobilization for 6 weeks. While the patient is performing daily activities under control, the bracing device can be temporarily removed but must not exceed 1 to 2 days. When removing the bracing device, caution is needed to make sure not to extend or rotate the arms beyond the midline of the body. Starting from 6 weeks, active and resistance movements are allowed, whereas physical activity or sports can only be carried out after 6 months.

Discussion

With the development of surgical techniques and arthroscopic instruments, the surgical approach for anterior dislocation of the shoulder has been updated and advanced. The single needle-assisted technique can reduce the number of surgical approaches and facilitate postoperative healing. In contrast, a suture passer can be used for rapid threading so as to reduce the number of shuttling steps and facilitate suture management (Table 2).

For anterior dislocation of the shoulder, the current surgical approaches can be categorized into bony and soft-tissue surgeries. The glenoid bone loss and type of bone loss (on-track/off-track) are important factors

when recommending treatment strategy. Bone grafting for glenoid bone loss using autograft or allograft, such as distal tibial allograft, is recommended in patients with a failed Latarjet procedure or those with significant bone loss.² Plath et al.¹² demonstrated that the Latarjet procedure provides an effective treatment for off-track engaging Hill–Sachs lesions, despite an evident glenoid remodeling process. Werner et al.¹³ proved that the medial posterior capsular plication surgery similar to remplissage was able to effectively increase the stability of the shoulder without limiting its range of motion. Moreover, it has been proven in previous research that remplissage can significantly reduce the recurrence and reoperation rates compared with surgical alternatives such as Bankart repair alone or the Latarjet procedure.¹⁴

In patients with recurrent anterior shoulder instability, the combination of remplissage along with Bankart repair is reported to significantly reduce the recurrent shoulder dislocation and reoperation rates.¹⁴⁻¹⁸ MacDonald et al.¹⁵ concluded that the remplissage procedure had significantly lower rates of redislocation in high-risk patients with Hill–Sachs lesions ≥ 20 mm and/or $\geq 15\%$ in size. The low risk of recurrence is associated with an objective limitation on active external rotation, which, however, does not seem to influence the patient's daily or sports activities.¹⁷ In addition to remplissage, the use of bone grafting in combination with Bankart repair for large Hill–Sachs lesions also allows for a lower risk of anterior shoulder dislocation recurrence.¹⁹

Nonetheless, complex surgical steps can elevate the operative difficulty of the procedure and increase the length of time needed. Kim et al.²⁰ proposed a double-pulley remplissage procedure using only 2 portals and knotless sutures, which minimized the number of portals necessary for the operation and reduced the operative time and technical difficulty. When the anchor for remplissage was medially placed or 2 anchors were used concurrently, it was found that the stability of the glenohumeral joint would increase but with a loss in the range of motion.¹⁶ In addition, in a bipolar bone loss model with off-track Hill-Sachs lesions, the remplissage exhibited better capabilities to make the restoring translation and stiffness closer to the intact state.²¹ Further, Callegari et al.²² described 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 was effectively improved. In future research, it is still worth exploring about how to simplify the steps of the procedure, as well as creating more convenient tools to facilitate the surgical process.

Disclosures

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