Technical Note

Hill-Sachs Remplissage Procedure Based on Posterosuperior Capsulomuscular Anatomy

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Abstract: The remplissage technique is a procedure designed to fill a posterosuperior humeral head defect with the infraspinatus tendon and posterior-superior capsule in patients with engaging Hill-Sachs lesions. We describe a remplissage technique using 2 posterior working portals that respects the anatomy of the posterior-superior area of the glenohumeral joint without compromising the vascularization.

Remplissage (a French term meaning "to fill in") involves a posterior capsulodesis and infraspinatus tenodesis performed arthroscopically in patients with anterior shoulder instability and engaging Hill-Sachs lesions. The aim of the remplissage procedure is to transform the intra-articular Hill-Sachs lesion into an extra-articular lesion, as well as to prevent the humeral head from engaging with the anterior glenoid rim during abduction and external rotation of the arm.

This arthroscopic technique was first described by Wolf and Pollack[1] in 2004. Koo et al.[2] in 2009 modified the technique by placing the sutures more laterally through the infraspinatus tendon, using a double-pulley suture technique with 2 anchors.

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In the literature, various other techniques have been described, each with a focus on achieving strong fixation with a less invasive procedure. The results of surgical treatment using a remplissage procedure in combination with anterior capsulolabral reconstruction are promising compared with anterior reconstruction alone, but complications nevertheless exist. The recurrence rate after anterior capsulolabral reconstruction in combination with the remplissage procedure varies from 0% to 10%, and the combined recurrent dislocation and subluxation rate varies from 0% to 15%.[3,4] This variation in postoperative recurrence rates highlights the need for increased knowledge about the anatomy of the involved structures.

On the basis of anatomic studies of the posterosuperior capsulomuscular structures of the glenohumeral joint, the most important capsular structure in this area is the rotator cable (semicircular ligament). The posterior insertional area of the rotator cable is where the teres minor, infraspinatus, and supraspinatus tendons merge[5] and is an important factor for anterior-inferior stability.[6]

In previous studies, descriptions of the anatomy of the involved structures have been scarce. An improved appreciation of the involved anatomy may lead to a better understanding of the procedure, thereby improving clinical results, as well as decreasing the risk of vascular complications. This study presents a remplissage procedure, taking anatomic aspects into account, and illustrates the procedure with an anatomic specimen.

Surgical Technique

Patient Selection

In this study, the indication for using the remplissage technique is an engaging Hill-Sachs lesion with or

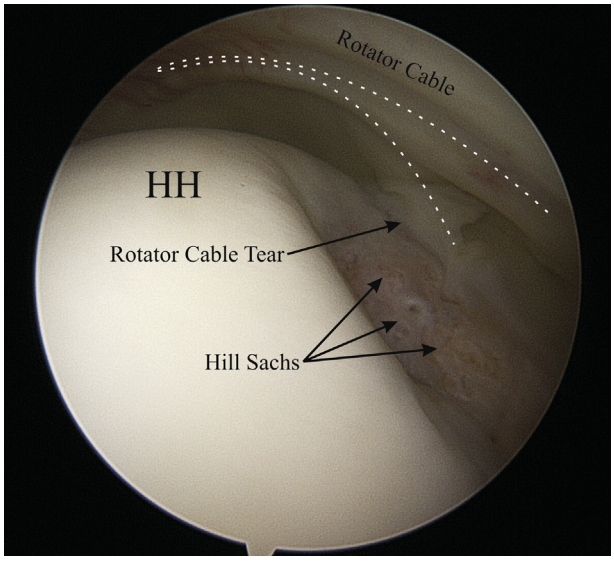

Fig 1. Arthroscopic view of the right shoulder through the posterior portal showing a Hill-Sachs lesion and a rotator cable injury of the posterior part. (HH, humeral head.)

without anterior glenoid loss of less than 25% or a non-engaging lesion with a concomitant rotator cable tear of the posterior part (Fig 1).

Patient Positioning

The patient is placed in the beach-chair position, using a Maquet operation table (Rastatt, Germany) without a shoulder pad, in a sitting position between 70° and 80°, with neutral rotation of the shoulder, and with the elbow flexed between 80° and 90°. No arm holder or additional traction is used.

Portal Placement

The posterior portal is placed in the soft spot 2 to 3 cm inferior and 2 to 3 cm medial to the posterolateral corner of the acromion. The anterior portal is placed using the inside-out technique with a spinal needle under direct visualization.

Evaluation of Glenohumeral Joint

The right glenohumeral joint is visualized from the posterior portal using a 30° arthroscope. The glenohumeral joint structures are probed through the anterior portal. The Hill-Sachs lesion is visualized with the arthroscope in the posterior portal. The shoulder is abducted and externally rotated to check the position, size, and depth of the Hill-Sachs lesion and its engagement with the anterior glenoid rim (Video 1).

Preparation of Additional Posterolateral Portal

With the shoulder in 20° of abduction and 30° of external rotation, directed by a spinal needle, an additional posterior portal is made about 2 to 3 cm lateral to the first posterior portal and at the same horizontal level, perpendicular to the medial border of the Hill-Sachs lesion (Video 1). The portal is created with a knife and sharp dissection, parallel to the infraspinatus tendon fibers to reach the Hill-Sachs lesion, after the subacromial space has been released blindly using a trocar. No cannula is used because it can limit the working space posteriorly.

Preparation of Hill-Sachs Lesion

Debridement of the defect is performed with a shaver. A 5.5-mm Corkscrew titanium anchor (Arthrex, Naples, FL) with 2 or 3 cords is inserted close to the medial border of the humeral head defect, approximately 1 cm inferior to the superior border and in line with the rotator cable insertion area (Fig 2, Video 1).

The sutures are positioned in the horizontal plane, parallel to the infraspinatus fibers. Initially, the

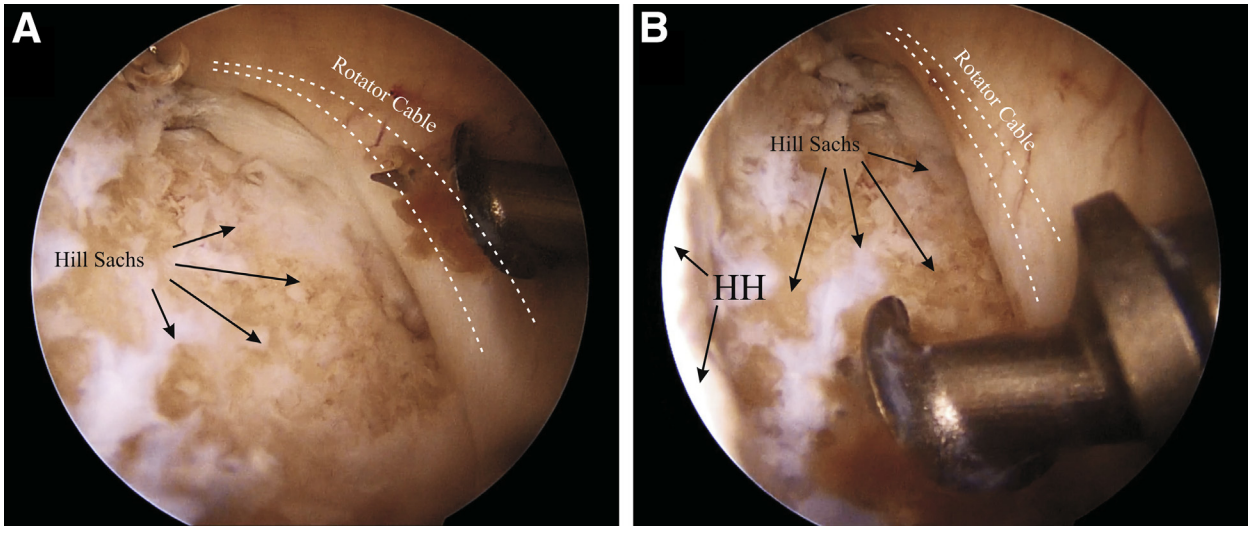

Fig 2. (A, B) Arthroscopic view of the right shoulder through the posterior portal showing a Hill-Sachs lesion and insertion of a titanium anchor through the additional posterolateral portal. (HH, humeral head.)

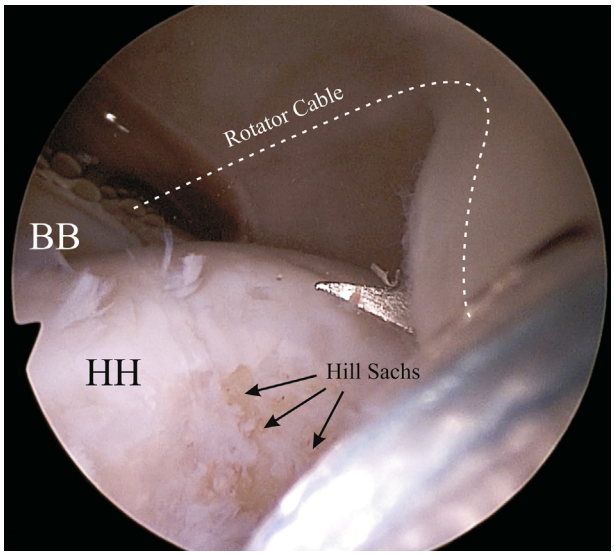

Fig 3. Arthroscopic view of the right shoulder through the posterior portal showing the use of the BirdBeak instrument to attach the posterior part of the rotator cable to create a superior suture through the additional posterolateral portal. (BB, long head of biceps tendon; HH, humeral head.)

superior suture is placed over the posterior part of the rotator cable, using a sharp BirdBeak penetrator (Arthrex) (Fig 3). Subsequently, a second suture is placed in the same way, just inferior to the first suture (Figs 4 and 5).

The direction of the sutures must be from lateral to medial to preserve the vascularization of the infraspinatus tendon and the capsule (Fig 6). The knots are tied blindly (ie, subcutaneously) after the subacromial space has been released again (using a trocar) and the range of motion (ROM) has been checked. If ROM is limited, the subacromial space is examined to confirm that the knots are not stuck to the deltoid muscle or subcutaneous tissue.

Preparation of the anterior capsulolabral lesion and the anterior reconstruction are subsequently performed using suture anchors in the standard manner. The remplissage technique also allows for rotator cable refixation to restore the posterosuperior capsular integrity. This is especially important in cases in which the insertional area of the rotator cable has been damaged and, in addition, a Hill-Sachs lesion is present.

In cases in which the Hill-Sachs lesion is large, the use of 2 anchors is recommended; however, care must then be taken not to include the teres minor tendon in the remplissage. Pearls and pitfalls of the described technique are reported in Table 1, and advantages and disadvantages are listed in Table 2.

Cadaveric Illustration

One fresh cadaveric shoulder specimen from a female donor, aged 76 years, is used to illustrate the technique. Prior to the anatomic dissection, the specimen is injected with 200 mL of latex, diluted in a 10% aqueous solution stabilized with ammonia (0.7% concentration), via the subclavian and brachial arteries simultaneously. After the injection, the specimen is fixed in an alcohol-formalin-glycerol solution and meticulously dissected. This technique has previously been described in detail by Põldoja et al.[7] Ethical permission for the dissection was obtained (Gesetz über das Leichen, Bestattungs- und Friedhofwesen des Landes Schleswig-Holstein vom 04.02.2005, Abschnitt II, §9 [Leichenöffnung, anatomisch]).

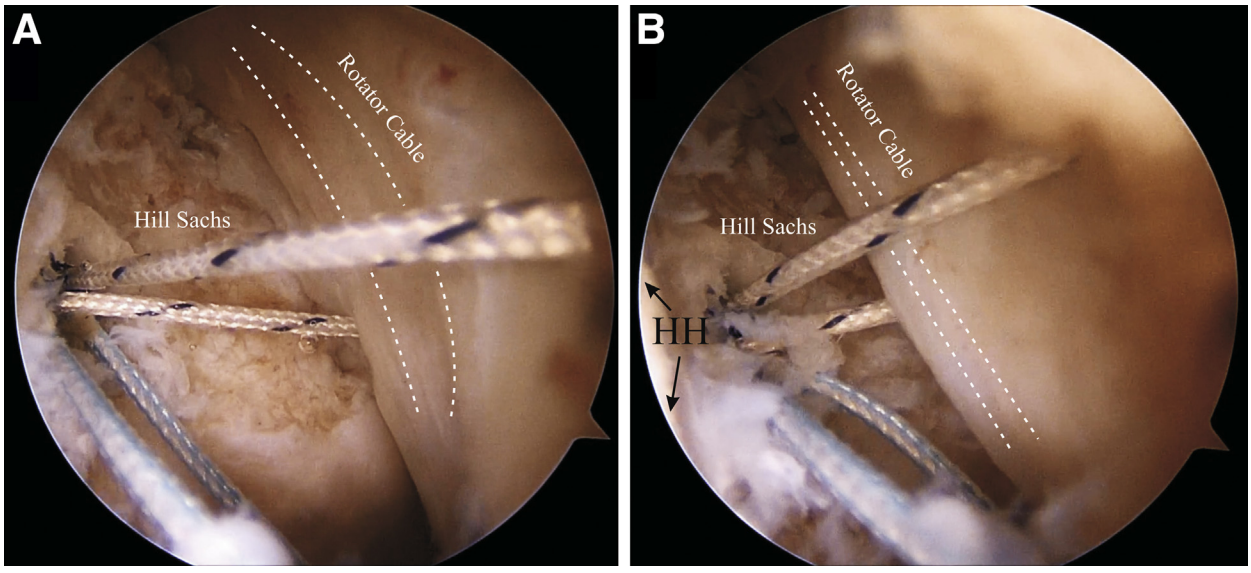

Fig 4. (A, B) Arthroscopic view of the right shoulder through the posterior portal showing suture positions after attaching the rotator cable during the remplissage procedure. (HH, humeral head.)

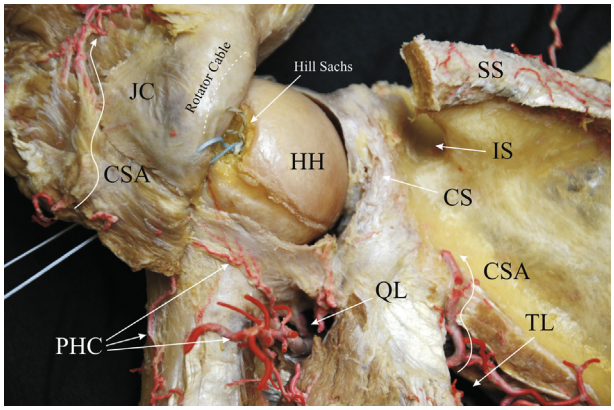

Fig 5. Cadaveric illustration of a left shoulder showing the position of the remplissage sutures inside the joint. The superior suture is white with a black stripe, and the inferior suture is blue. (CS, collum scapulae; CSA, circumflex scapular artery; HH, humeral head; IS, incisura scapulae; JC, joint capsule; PHC, posterior humeral circumflex artery; QL, quadrilateral space; SS, spina scapulae; TL, trilateral space.)

Table 1. Pearls and Pitfalls

Pearls
The use of the beach-chair position allows the surgeon to check the ROM easily after the remplissage procedure and to check if the subacromial sutures are stuck.
No cannula is used to avoid difficulties with working through 2 posterior portals, as well as to avoid damage to the rotator cable caused by the cannula.
It is recommended not to perform the anterior-inferior capsulolabral preparation before the remplissage procedure to avoid bleeding and poor visualization.
The anterior-inferior capsulolabral structures are subsequently easy to restore because the humeral head moves posteriorly after the remplissage procedure.
Pitfalls
The surgeon should always check the ROM after the remplissage procedure to verify that the subacromial space is free after the blind suturing.
The use of a 30° arthroscope sometimes limits visualization when working through 2 posterior portals.

ROM, range of motion.

Discussion

This study describes a remplissage technique using 2 posterior working portals, which respects the anatomy of the posterior-superior area of the glenohumeral joint without compromising the vascularization. If damage to the posterior area of the rotator cable is found in the absence of an engaging Hill-Sachs lesion, the remplissage technique may also be used.

The importance of the posterior part of the rotator cable to the stability of the glenohumeral joint was noted by Pinkowsky et al.[6] in a biomechanical cadaveric study. They reported a significant increase in anterior, inferior, and total translation, at 30° and 120° of external rotation, when the posterior insertional area of the rotator cable was violated.

Our technique is based on the use of a proximal anchor to perform the remplissage, attaching the capsule and the posterior part of the rotator cable together into the Hill-Sachs defect. This allows for stronger fixation in the horizontal plane. A further advantage is that horizontal sutures avoid disturbance of the vascularization of the infraspinatus tendon and posterior capsule. A standard suturing technique with knots tied over the anchor is used. This approach is in line with the report of Tan et al.,[8] who found, in a biomechanical navigated robotic study, that all tested techniques using knots tied over an anchor and over double-pulley or knotless anchors with suture tape re-stabilized the

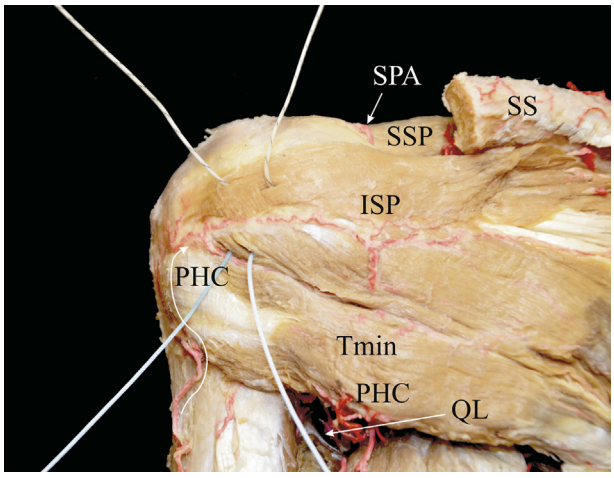

Fig 6. Cadaveric illustration of a left shoulder showing the position of the remplissage sutures in the subacromial space after the removal of the acromion. The superior suture is white with a black stripe, and the inferior suture is blue. (ISP, infraspinatus muscle; PHC, posterior humeral circumflex artery; QL, quadrilateral space; SPA, suprascapular artery; SS, spina scapulae; SSP, supraspinatus muscle; Tmin, teres minor muscle.)

Table 2. Advantages and Disadvantages

Advantages
Performing the remplissage first allows the following:
Easier control of ROM without possible damage to previously reconstructed anterior-inferior capsulolabral structures
Better visualization and easier reconstruction of the anterior-inferior capsulolabral structures because the humeral head moves more posteriorly
Inserting the sutures from lateral to medial attaching the rotator cable, as well suturing in the horizontal plane, allows stronger fixation and avoids damage to the blood supply of the posterior capsule and infraspinatus tendon.
Disadvantages
Blind suturing during the remplissage procedure sometimes requires the surgeon to check the subacromial space.
In cases with a concomitant supraspinatus rupture, orientation and determination of the rotator cable structure can be difficult.

ROM, range of motion.

glenohumeral joint and prevented engagement of the Hill-Sachs defect sufficiently.

Contrary to most previously described techniques,[1,2,9,10] in our study a full remplissage procedure is initially performed using posterior portals with the patient in the beach-chair position. This enables the surgeon to easily review the ROM and movement of the humeral head, as well as to assess for the presence of engagement of the Hill-Sachs defect after the remplissage procedure.

Another important aspect of this technique is that the knots are tied blindly; if ROM is unrestricted, the subacromial space is then not routinely checked. After the remplissage procedure, the position of the humeral head becomes more posterior, thereby enabling a complete anterior-inferior capsulolabral reconstruction without any limitation on working space.

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