Technical Note

Remplissage and Labral Reconstruction Technique Correlated With Dynamic Hip Examination Using the Kite Technique for Restoration of the Suction Seal in Revision Hip Arthroscopy

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Abstract: The hip suction seal plays a key role in distractive stability and maintenance of intra-articular fluid pressure of the hip. Preservation of the suction seal relies on the acetabular labrum and the congruence between the labrum and the femoral head–neck junction. During the treatment of cam-type impingement, iatrogenic over-resection in the femoral head–neck junction or labrum deficiency can cause loss of this suction seal. In this technical note, we describe a remplissage procedure performed in addition to labral reconstruction in a patient with loss of the suction seal due to a dysfunctional labrum and previous over-resection of a cam deformity.

The acetabular labrum plays an integral role in protecting articular cartilage by maintaining intra-articular synovial fluid and pressure.[1-3] The labrum also has been recognized as a major contributor to distractive stability of the hip through the creation of a suction seal effect on the femoral head.[1,4,5] As such, labral reconstruction allows for significant improvement in distractive stability compared with a partial labral resection.[6]

Cam-type femoroacetabular impingement occurs when a peripherally enlarged radius (caused by a bony lesion on the femoral neck) enters the acetabulum throughout range of motion.[7] To alleviate this mechanical impingement, which is most prominent during flexion and internal rotation,[8] and to restore the normal femoral head–neck articulation, bony overgrowth resection (femoroplasty) typically is performed.

Multiple studies have reported that incomplete cam deformity resection is the leading cause of failed hip arthroscopy.[9-11] Conversely, over-resection of the cam deformity may lead to loss of the suction seal normally provided by the congruence between the femoral head and labrum.[12,13] In a recent study, Mansor et al.[14] reported that over-resection leads to worse clinical outcomes compared with under-resection and that the conversion rate to total hip arthroplasty is greater in patients with over-resection. If iatrogenic over-resection of a cam deformity occurs, a remplissage procedure using a soft-tissue graft may be used to restore the suction seal and normal articular anatomy.[13]

In this technical note, we describe a remplissage procedure performed in conjunction with a labral reconstruction in a patient with suction seal loss due to cam deformity over-resection and a dysfunctional labrum.

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Surgical Technique (With Video Illustration)

Preoperative Evaluation and Planning

Clinically, providers may suspect a cam deformity over-resection in patients with unimproved or recurring pain after hip arthroscopy. A lateral hip radiograph, computed tomography (CT), and a 3-dimensional CT reconstruction image are useful in the detection and evaluation of an over-resection (Fig 1). Magnetic resonance imaging and CT are more useful than radiographs in preoperative planning by providing 3-dimensional images. In cases in which there is an indistinguishable continuity in the labrum and previously over-resected anterior femoral head–neck junction (Fig 2), labral reconstruction with semitendinosus allograft and hip remplissage may be performed.

Patient Positioning and Portal Placement

The patient is placed in a supine position using a distractor system table (Smith & Nephew, Andover, MA) after being prepared under general anesthesia. Joint distraction is confirmed with fluoroscopy, and the anterolateral (AL) portal and modified mid-anterior portal (mMAP) are created. An interportal capsulotomy is then created between these portals using an arthroscopic blade (Samurai; Stryker, Kalamazoo, MI). Suspension sutures are passed to apply retraction with the help of a suture passer (Pivot Slingshot; Stryker) via the AL portal and mMAP. Central compartment diagnostic arthroscopy is performed using a 70° arthroscope (Arthrex, Naples, FL), followed by creation of the distal anterolateral accessory (DALA) portal. If labral tissue is preserved, a labral repair may be performed using previously described techniques.[15] However, labral reconstruction is necessary if the labral tissue is deemed inadequate for repair (Fig 2A).

Labral Reconstruction

Following confirmation of significant labral deficiency, labral reconstruction using a semitendinosus allograft is performed (AlloSource, Centennial, CO). The length of the defective area in the labrum is measured with an arthroscopic measurement guide (SCR Guide; Arthrex). The graft should be 5- to 6-mm wide and approximately 30% longer than the measured defect length. Krackow stitches in a longitudinal fashion and nonlocked continuous suture (no. 2-0 VICRYL; Ethicon, Somerville, NJ) are then used to prepare the graft. All knots should be placed on the superior portion of the graft to preserve a smooth interface between soft tissue and bone. Additional sutures should then be placed at both ends of the graft to avoid tearing that may occur during suture passage (Fig 3).

Graft insertion and fixation are performed similarly to the previously described "Kite Technique."[16] Following rim trimming, 2 anchors (1.4-mm Nano-Tack TT; Stryker) are placed. The first anchor is placed as posterior as possible and adjacent to the native labrum while the second anchor is placed as anterior as possible. Depending on the size of the defect, additional anchors may be evenly placed between the most anterior and posterior anchors. While viewing from the mMAP, the anchors are placed through the AL portal at the 11 and 12 o'clock positions. Additional anchors are placed through the DALA portal at the 1- and 2-o'clock positions while viewing from the AL portal. If enough labral tissue is present, one of the suture anchor threads from the chondrolabral junction or labrum remnant is then passed with a suture passer (NanoPass; Stryker) to prepare the area for graft placement (Fig 4).

At this stage, the proximal mid-anterior portal (PMAP) is created as an accessory portal. All suture anchor threads are pulled through the PMAP with the

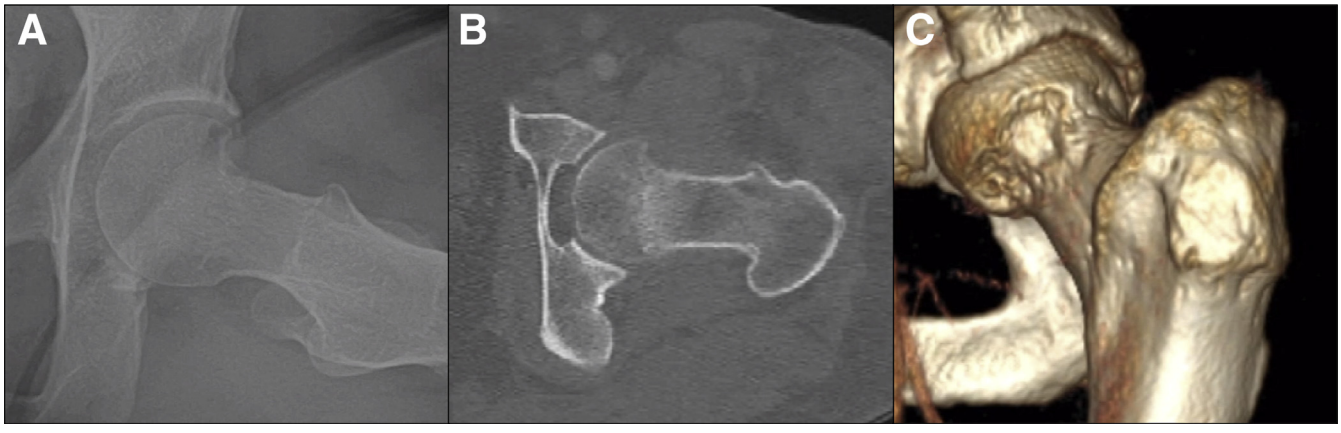

Fig 1. Preoperative imaging of a left hip. Preoperatively obtained (A) lateral hip radiograph, (B) axial computed tomography (CT) slice, and (C) 3-dimensional CT reconstruction image showing over-resection of the anterior femoral head–neck junction in the left hip.

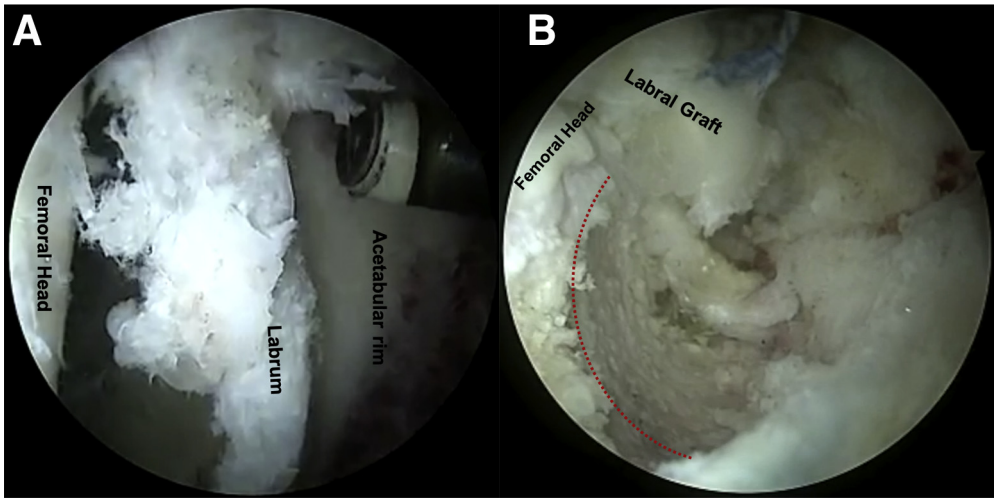

Fig 2. Labrum and femoral head–neck junction view of a left-sided hip through the mid-anterior portal. (A) Irreparable degenerative labral tissue and (B) previously over-resected anterior femoral head–neck junction shown with a curved red line.

exception of the non-post sutures of the most anterior and most posterior anchors passing the labrum remnant. Post sutures from the most anterior and posterior anchors are marked with a marking pen to avoid tangling. Non-post sutures are pulled through the mMAP (Fig 5). A cannula (Pivot TransPort 789 cannula, 110-140 mm, Pivot; Stryker) is then placed in the mMAP to allow for graft passage.

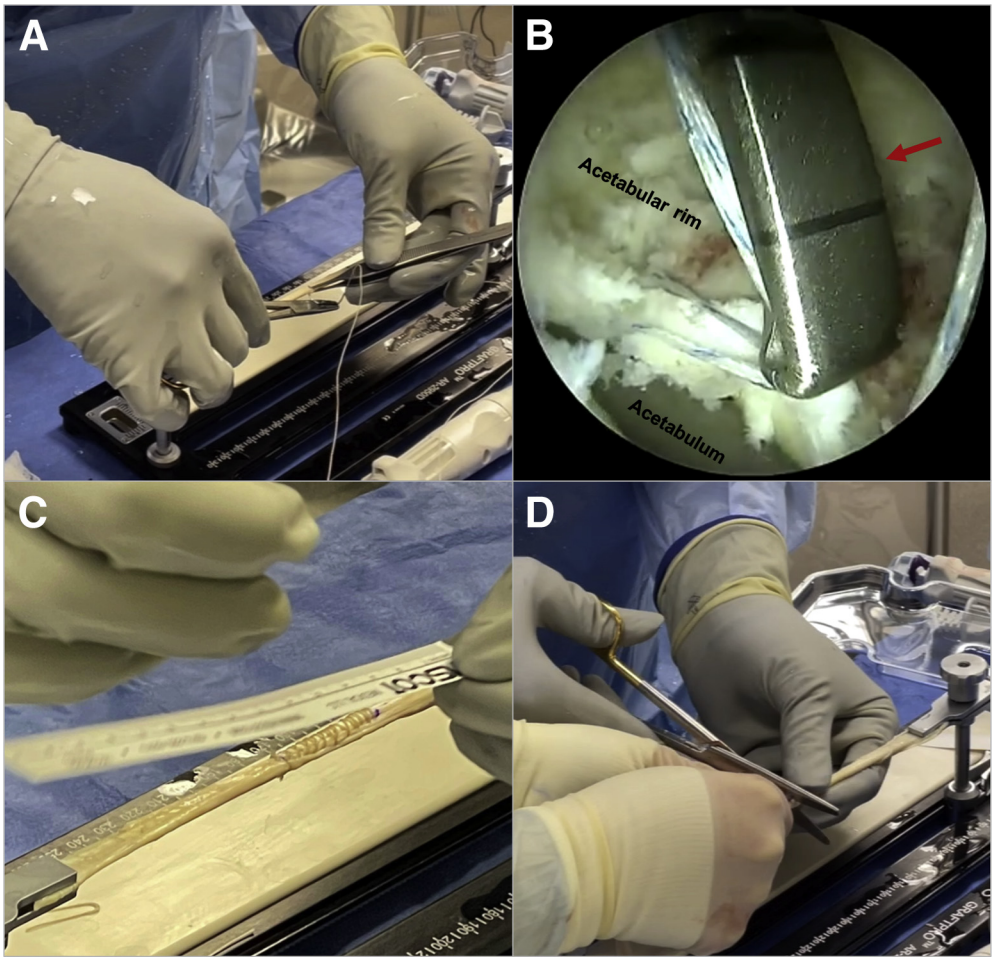

Fig 3. Preparation of the labral graft. (A) Preparation of the graft is accomplished with Krackow stitches in a longitudinal fashion and nonlocked continuous suture. (B) Viewing from the anterolateral portal in a left hip, the length of the defect in the labrum is measured by an arthroscopic measurement guide (SCR Guide; Arthrex, Naples, FL), shown with a red arrow, through modified mid-anterior portal. (C) The graft is marked according to the size of the defect in the labrum and (D) cut with scissors.

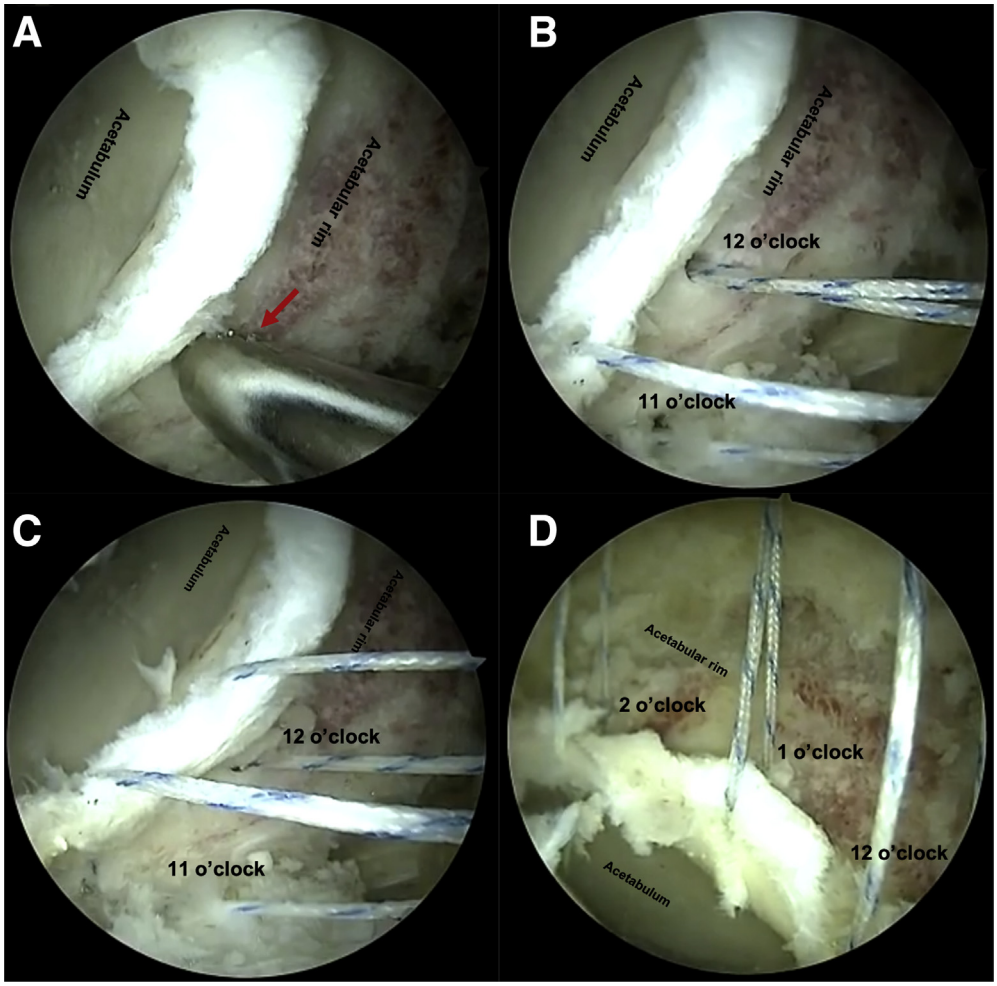

Fig 4. Placement of anchors to the acetabular rim for future graft fixation in a left-sided hip arthroscopy. While viewing from the modified mid-anterior portal (mMAP), (A) drilling with a curved drill guide through the AL portal is shown with a red arrow for anchor placement at 12 o'clock, (B) allowing anchors to be placed at 11 and 12 o'clock. (C) View after passing one of the anchor threads through the labrum remnant. (D) View of the pre-reconstruction preparation from the anterolateral (AL) portal after anchors are placed at 1 and 2 o'clock through the distal anterolateral accessory portal and 11 and 12 o'clock through the AL portal.

Using a free needle, the non-post sutures from the most anterior and posterior anchors are pierced through each end of the graft. Simple half hitches are then used to create a knot at the end of the suture.

The post sutures previously marked through the PMAP are pulled in a controlled manner, and the graft is advanced from the mMAP to the acetabular rim. The post threads belonging to the posterior anchor are pulled, allowing for placement of the posterior part of the graft first. After proper placement of the graft is confirmed arthroscopically, the loop knots that were previously created on the non-post suture in the anterior and posterior portion of the graft are opened sequentially and retied according to standard arthroscopic knot tying principles. The most anterior knot is viewed from the AL portal and tied through a cannula in the mMAP, and the posterior knot is viewed from the mMAP and tied through a cannula in the AL portal (Fig 6). Threads from the mid-body anchors that were previously passed through the labrum remnant are passed through the graft in a simple or horizontal mattress fashion and tied accordingly (Fig 7). For procedures at 11 and 12 o'clock, the AL portal is used as the working portal, whereas the mMAP is used at 1 and 2 o'clock.

Remplissage

After labrum reconstruction, traction is released, and attention is turned to the peripheral compartment. Because the interportal capsulotomy will provide sufficient visibility for the remplissage procedure, a T-capsulotomy is not needed. Dynamic hip examination is then performed, allowing for evaluation of the over-resection and for detection of the point where the suction seal is lost. Remplissage should be performed in the area where the suction seal disappears (Fig 8). The hip is in 20 to 30° flexion throughout the procedure. While using the mMAP for viewing, the cannula is placed in the DALA portal, and 2 anchors (1.4 mm NanoTack TT; Stryker) are placed in the most medial and lateral areas of future graft fixation. The distance between the 2 anchors is measured by the arthroscopic measurement guide (SCR Guide; Arthrex). Using the remainder of the semitendinosus allograft previously used for labral reconstruction, another graft is prepared

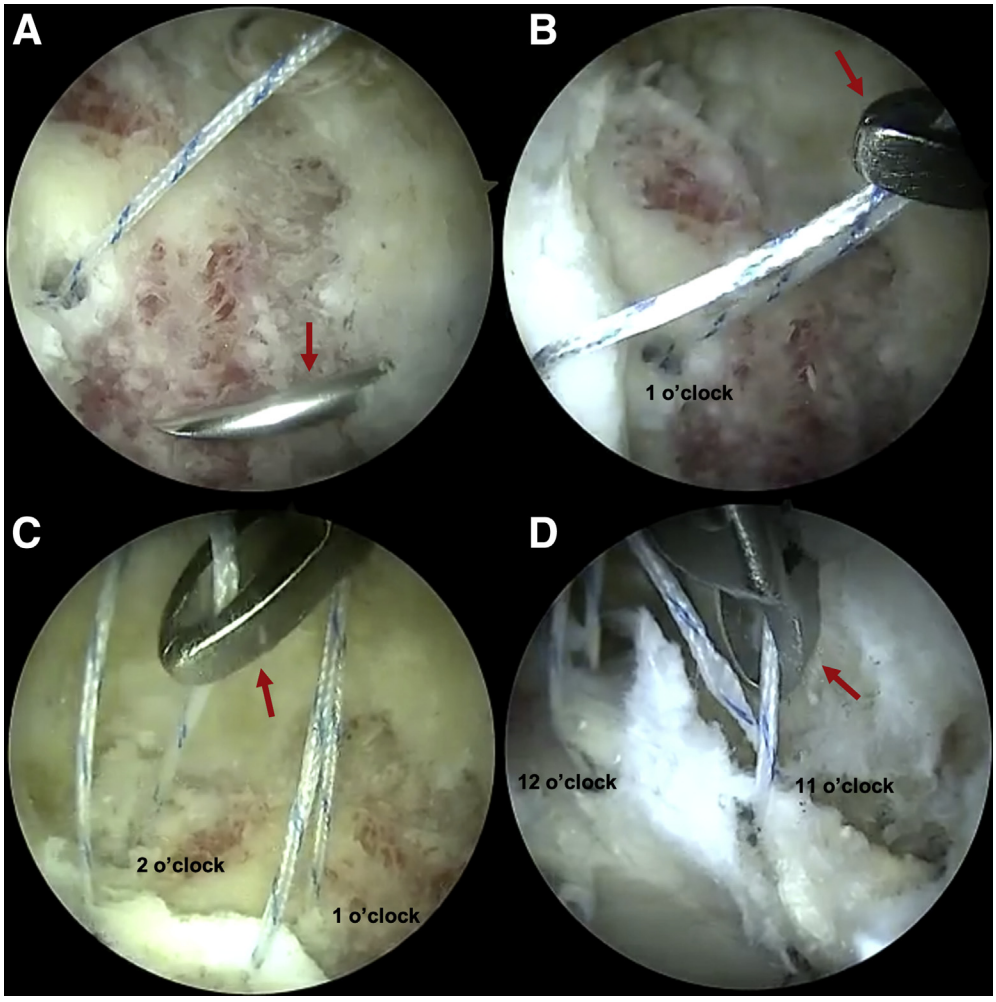

Fig 5. Creating the proximal mid-anterior portal (PMAP). In a left-sided hip arthroscopy, (A) while viewing through the modified mid-anterior portal (mMAP), the PMAP is located and created with the help of an 18-gauge spinal needle indicated with a red arrow. (B) Taking the threads of mid-body anchors at 12 and 1 o'clock to the PMAP with the help of a suture retriever indicated with a red arrow. (C) Taking the "post" sutures not passing through the labrum remnant of the anterior and posterior anchors to the PMAP with the help of a suture retriever, and (D) the "non-post" sutures of the most anterior and most posterior anchors passing through the labrum remnant to the mMAP with the help of a suture retriever indicated by a red arrow.

for the remplissage procedure in the same fashion described above for labral reconstruction. The graft should measure 30% longer than the distance between the medial and lateral anchors. The graft width is determined according to the measured depth of the defect. One thread from each anchor is retrieved from the mMAP, and the other threads are retrieved from the canula in the DALA portal. Using a free needle, the non-post sutures from the most medial and most lateral anchors are pierced through each end of the graft. Simple half hitches are used to create a knot to itself at the end of the suture. The post sutures in the mMAP are then pulled in a controlled manner, and the graft is advanced from the DALA portal to the defect area where remplissage will be performed. After placement of the graft is confirmed, temporary loops in the most medial and most lateral area of the graft are opened and arthroscopically tied through the DALA portal (Fig 8 C and D).

A third anchor (1.8-mm Knotless Hip FiberTak; Arthrex) is placed more proximally (Fig 9) to increase the congruency of the femoral head and acetabulum by elongating the graft from the mid-body. The knotless anchor thread is passed through the graft to form a loop, is tensioned, and subsequently locked.

After remplissage and labral reconstruction, dynamic hip examination is again performed to evaluate graft fixation and position and reestablishment of the suction seal (Fig 10). Interportal capsulotomy is then closed with the help of a suture passer (Pivot Slingshot; Stryker), completing the procedure. The hip arthroscopy technique of a left hip is shown in Video 1.

Rehabilitation

In the initial postoperative period (postoperative day 1), active rehabilitation is focused on the passive and low-force active range of motion with circumduction. Within the first 3 weeks of the postoperative period, the patient is limited to 20 pounds weight-bearing with use of props and should wear a de-rotational boot. At postoperative week 3, the patient

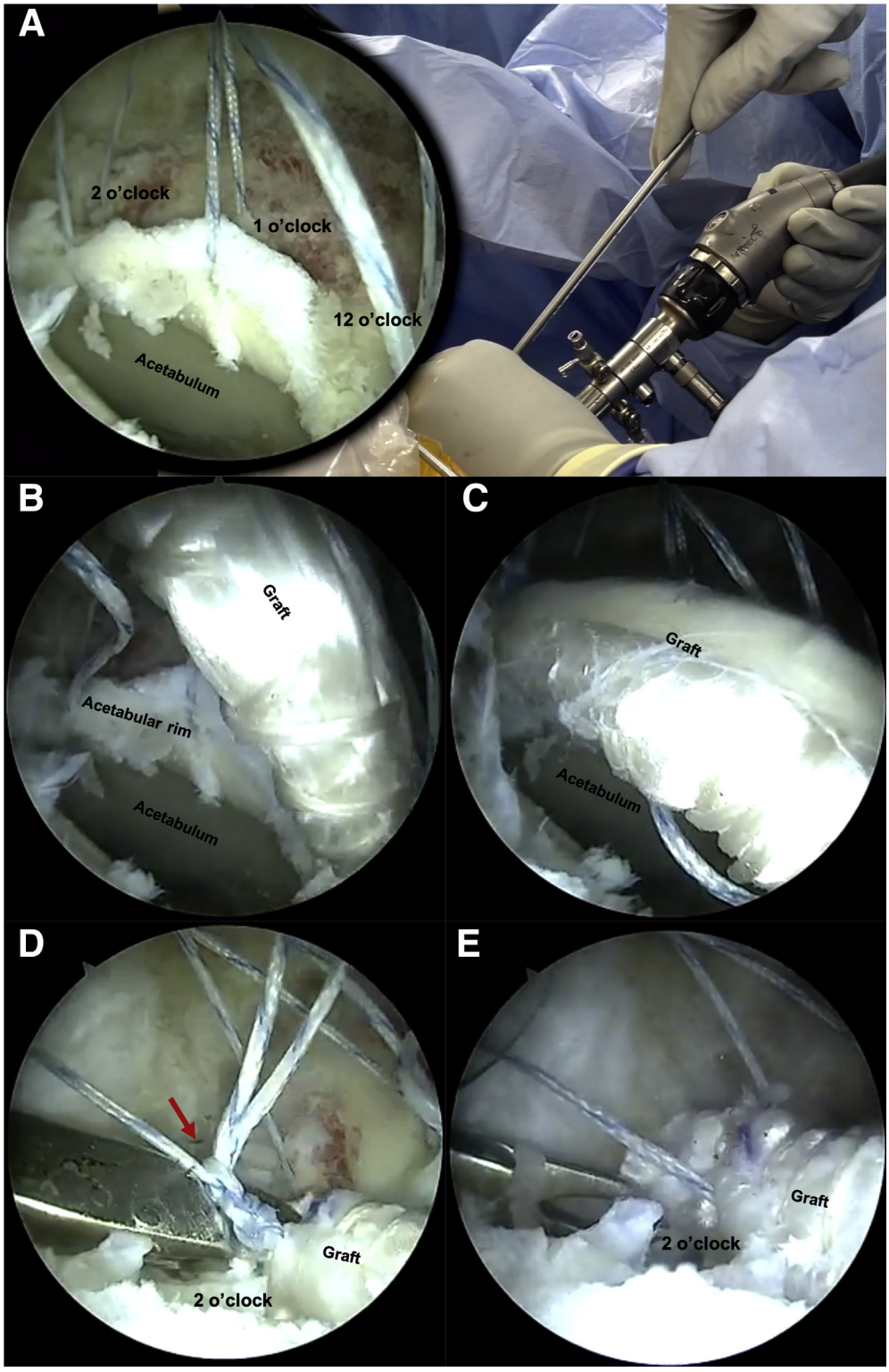

Fig 6. Graft insertion and fixation in a left-sided patient. The post sutures previously marked on the proximal mid-anterior portal are pulled in a controlled manner, and the graft is advanced from the modified mid-anterior portal to the acetabular rim with the help of an arthroscopic grasper while viewing through anterolateral portal. (B) The posterior part of the graft is placed first, (C) followed by the anterior part of the graft. (D) After proper placement of the graft is confirmed, movement of the graft is prevented with an arthroscopic grasper while the temporary knot (red arrow) is pulled out of the joint and opened. (E) Anterior fixation of the graft is achieved arthroscopically by untying the temporary knot and tying again.

should be weaned from crutches and advance weight-bearing. At this time, focus is shifted to re-establishing normal gait during ambulation. At postoperative week 6, open-and-closed chain exercises are started while progressing range of motion. Exercises focusing on return to sport are started after 12 weeks postoperatively. Gradual return to sport may occur 4 to 6 months following surgery.

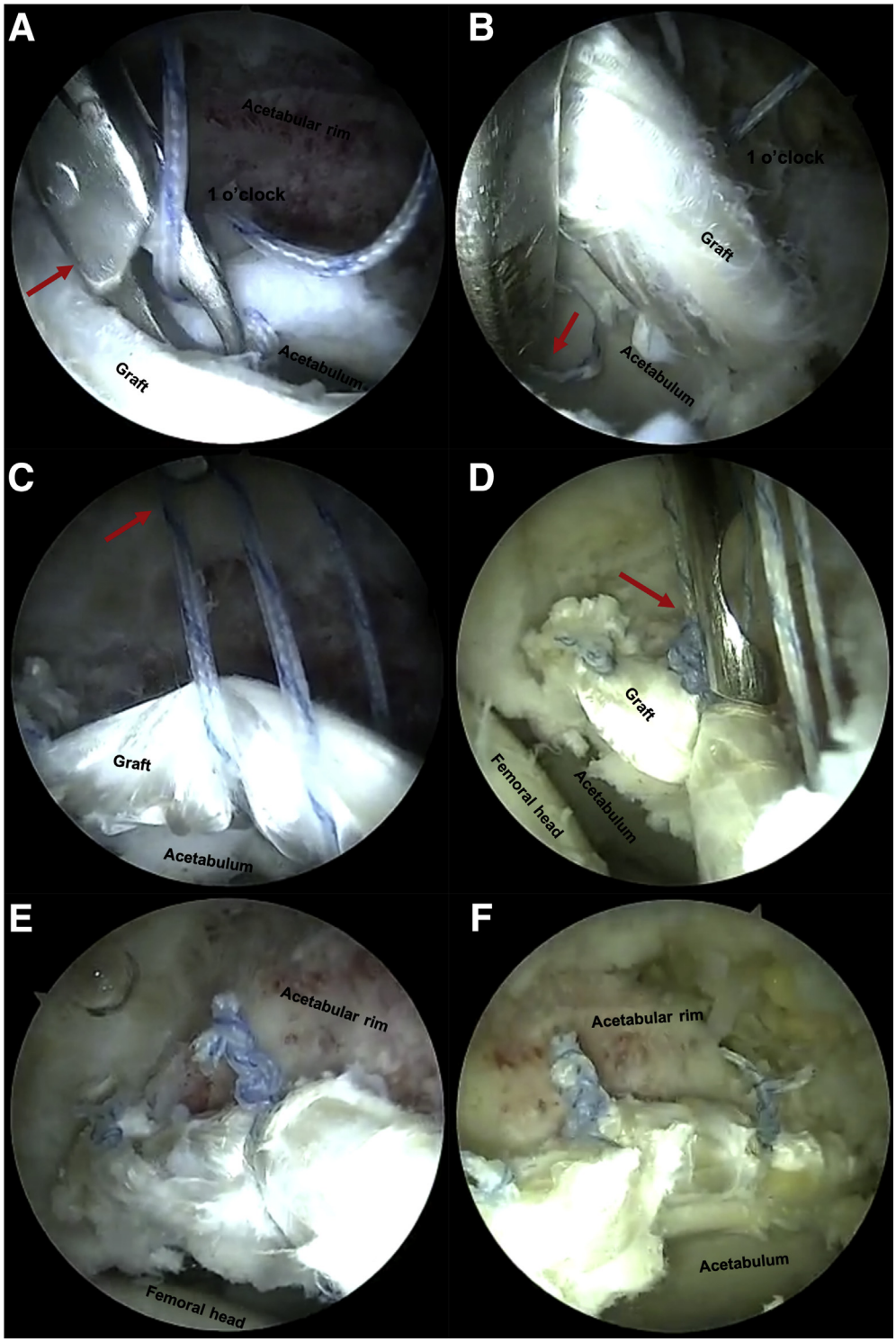

Fig 7. Fixation of the graft to mid-body anchors at 1 and 12 o'clock in a left hip arthroscopy. While viewing from the anterolateral (AL) portal, (A) the thread of the anchor at 1 o'clock that was previously passed through the labrum remnant is passed through the proximal portion of the graft with the help of the suture retriever (red arrow) and (B) grasped from the distal portion of the graft with the help of a suture retriever (red arrow). This anchor thread is then (C) pulled through the modified mid-anterior portal (mMAP). (D) The sutures taken to the mMAP are arthroscopically tied with the help of a knot pusher. After applying the same procedure to the 12 o'clock anchor from the AL portal while viewing through the mMAP, (E) anterior and (F) posterior parts of the labral reconstruction are viewed with a 70° scope from the AL portal.

Discussion

Suction seal loss, which may occur from overresection of a cam deformity or labral damage, can lead to impaired lubrication and nutrition to the articular cartilage in the hip, accelerating cartilage degeneration.[15] As such, loss of the suction seal warrants treatment.[13] Here, we have described a technique to restore the suction seal using a hip "remplissage" technique, in which the area of defect in the femoral head-neck junction is filled with soft tissue. This technique is comparable to the remplissage technique used in the shoulder for the treatment of Hill–Sachs

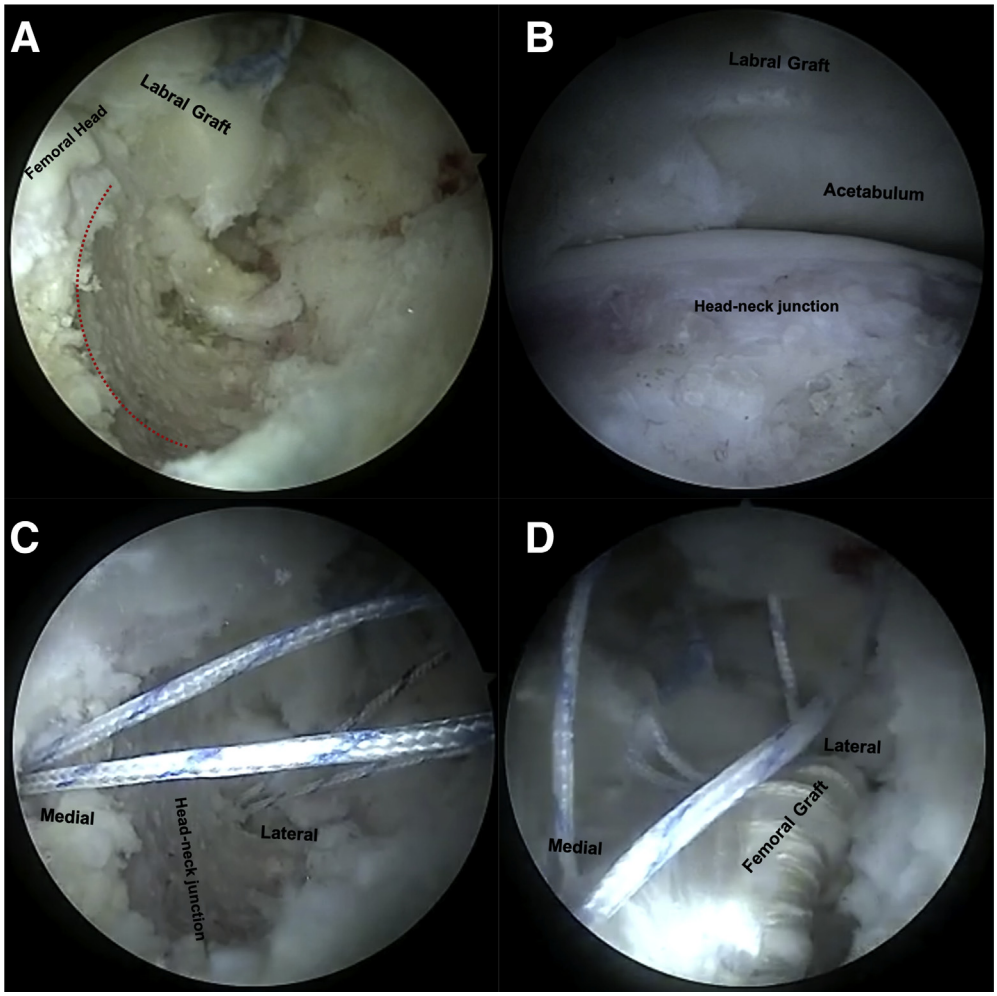

Fig 8. Remplissage procedure in a left-sided hip. (A) The view of the over-resection marked with a red curved line in the anterior femoral head −neck junction through modified mid-anterior portal (mMAP) view. (B) The area where the suction seal disappeared during dynamic hip examination in flexion and internal rotation viewing through the mMAP towards the acetabulum. (C) View after insertion of 2 anchors (1.4 mm NanoTack TT; Stryker, Kalamazoo, MI) from the cannula placed in the distal anterolateral accessory (DALA) portal at the most medial and lateral area where the graft will be placed. (D) View after the graft is passed through the DALA portal and placed in the over-resected area by pulling the "post" sutures in the mMAP according to “kite” technique.

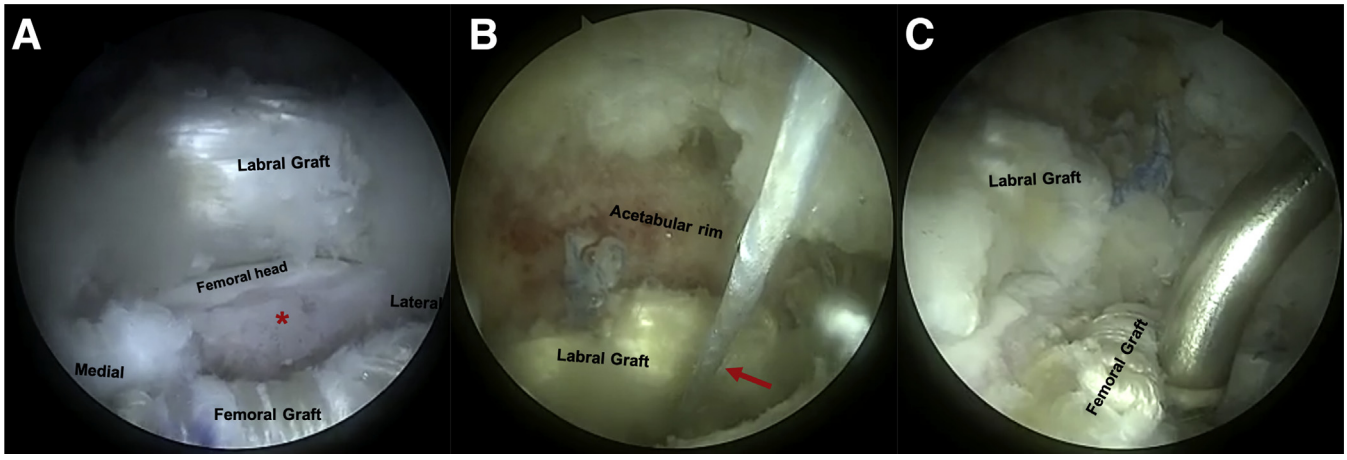

Fig 9. Placement of the mid-body anchor in a left-sided patient. (A) The location of the mid-body anchor, which is planned to be placed in line with the convexity of the femoral head and acetabulum, is shown with a red asterisk. (B) The view from modified mid-anterior portal (mMAP) after placing the third anchor, while the thread belonging to the knotless anchor (1.8 mm Knotless Hip FiberTak; Arthrex, Naples, FL) is indicated with a red arrow. (C) View of the femoral graft after the remplissage procedure through mMAP.

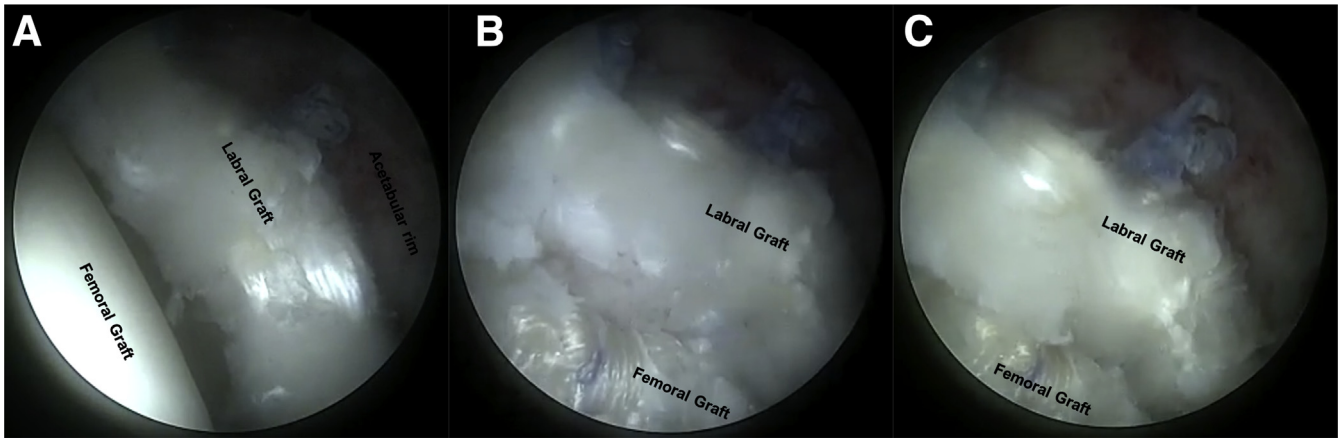

Fig 10. Testing the suction seal in a left-sided hip. While viewing through the modified mid-anterior portal, the reestablishment of the suction seal in different hip positions is evaluated with a dynamic hip examination. Dynamic hip examination at (A) extension with slight traction, (B) 30° flexion and released traction, and (C) 70° flexion and released traction.

defects.[13] In the case described here, the patient presented with irreparable labrum tissue in addition to a previously over-resected cam lesion, requiring labral reconstruction and remplissage application to the over-resection area with a semitendinosus allograft. Dynamic hip examination performed intraoperatively allowed for confirmation of the suction seal restoration using this method (Table 1).

Accurate detection of the previously over-resected portion of the femoral head-neck junction that is contributing to suction seal loss is essential in determining the correct location to perform the remplissage procedure. The strength of this seal differs with the position of the joint, increasing in external rotation and decreasing in flexion with internal rotation.[1] If the graft is placed in the incorrect area of the femoral head-neck junction, cam-type impingement symptoms may occur. When considering this procedure, it is important to keep in mind that some patients may present with an over-resection so severe that a remplissage with soft tissue may not be sufficient to fill the defect (Table 2).

Hip arthroscopy is considered to be a technically demanding procedure with a long learning curve.[17] The application of reconstruction to two different joint regions (the labrum and the femoral head−neck junction) in the same session, and the need for 3-dimensional analysis of target areas with dynamic examination further increases the difficulty of the technique. Surgeons early in their learning curve should pay special attention to the pearls and pitfalls (Table 1) and advantages and limitations (Table 2) when performing this technique to treat patients with an over-resected cam deformity with a degenerative labrum.

Table 1. Pearls and Pitfalls

Pearls
• Opening a proximal mid-anterior portal is useful for preventing suture tangling in labral reconstruction.
• One thread of an anchor is placed in the acetabular rim in labral reconstruction. Passing this thread through the labrum remnant may allow for better incorporation and more appropriate placement of the graft with respect to the chondrolabral junction.
• Intraoperative dynamic hip examination should be performed to determine the area where the suction seal has disappeared.
• During the remplissage procedure, graft application at 20 to 30° hip flexion instead of full flexion allows for the procedure to be performed without touching and damaging the labral graft.
• The use of semitendinosus allograft allows for the completion of 2 separate labral and femoral graft reconstructions with a single allograft.
Pitfalls
• During the remplissage procedure, if the graft placed in the femoral head−neck junction is too thick, it may cause cam-type impingement symptoms.
• Placing the graft in an unsuitable area or insufficient graft thickness without performing hip dynamic examination may prevent reestablishment of the suction seal.
• Improper use of the surgical time under traction may cause risks related to traction.

Table 2. Advantages and Limitations

Advantages
• The suction seal can be reestablished with labral reconstruction and a remplissage procedure performed in correlation with the dynamic hip examination.
• Two procedures can be performed in the same session with the same allograft.
• With the kite technique, the elongation and placement of the graft on the acetabular rim can be arthroscopically confirmed before tying any suture thread.
Limitations
• In hip arthroscopy, which has a long learning curve, the combination of two advanced procedures (labral reconstruction and remplissage) may be surgically difficult to apply in the same session.
• The surgical time may be longer than that of a standard hip arthroscopy, which includes labrum repair and cam resection.
• In cases with an excessive amount of over-resection, remplissage with soft tissue may not be sufficient to fill the defect.

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