Technical Note

Arthroscopic Hip Labral Reconstruction With Fresh Meniscal Allograft

Steven F. DeFroda, M.D., M.Eng., Brett Crist, M.D., and James L. Cook, D.V.M., Ph.D.

Abstract: The acetabular labrum is essential to maintaining the functional health of the hip joint through contributions to joint congruity, stability, and the negative pressure suction seal. Injury, overuse, long-standing developmental disorders, or failed primary labral repair can eventually lead to functional labral insufficiency requiring management via labral reconstruction. While numerous graft options exist for hip labral reconstruction, there is no current gold standard. The optimal graft should best mimic the native labrum with regard to geometry, structure, mechanical properties, and durability. This has led to the development of an arthroscopic technique for labral reconstruction with fresh meniscal allograft tissue.

Introduction

Symptomatic acetabular labral pathology resulting from developmental disorders or traumatic or repetitive injuries of the hip is becoming more frequently diagnosed, especially in young, active individuals.[1-4] Labrum insufficiency results in abnormal joint biology and biomechanics, which can cause hip pain, mechanical symptoms, instability, and dysfunction. As such, effective methods for restoring labral integrity are paramount for preserving hip joint health and function. Labral reconstruction emphasizes recapitulation of labrum structure and function in order to reestablish joint health.[5]

Labral reconstruction is performed through either an open or arthroscopic approach using autografts or allografts.[1,6-9] In the United States, allografts have become the most popular choice for acetabular labrum reconstruction based on reported advantages when compared to autografts.[6,10-15] Fresh-frozen tendon allografts are currently used most frequently and are associated with consistently good short-term outcomes.[16-19] However, tendon allograft reconstructions do not consistently restore the articular contact areas, suction seal function, or material properties of the native labrum, and are associated with treatment failure rates, ranging from 0% to 24.3%.[10,16-21] Meniscus allografts have been recently implemented for open labral reconstruction based on their similarities in size, shape, and geometry; tissue composition and architecture; synthetic and metabolic profiles; and material properties when compared to acetabular labrum tissue.[5,22-27] In an effort to avoid the morbidity associated with open hip surgery and replicate the advantages noted for outpatient surgery with use of tendon allografts, we have developed an arthroscopic

From the Department of Orthopaedic Surgery, University of Missouri, Columbia, Missouri, U.S.A. (S.F.D., B.C., J.L.C.); and Thompson Laboratory for Regenerative Orthopaedics, University of Missouri, Columbia, Missouri, U.S.A. (S.F.D., B.C., J.L.C.).

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Address correspondence to Steven F. DeFroda, M.D., M.Eng., Department of Orthopaedic Surgery, Missouri Orthopaedic Institute, Thompson Laboratory for Regenerative Orthopaedics, University of Missouri, 1100 Virginia Ave., Columbia, MO, 65212, U.S.A. E-mail: defrodas@health.missouri.edu

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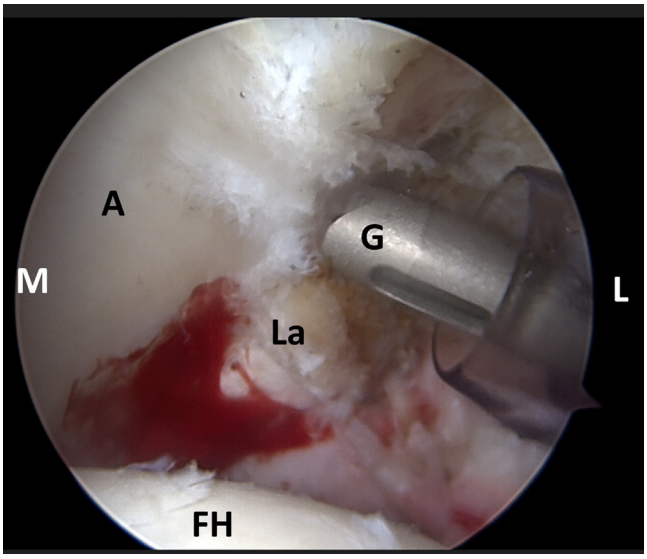

Fig 1. Arthroscopic drill guide (G) is placed at the posterior extent of the prepared acetabulum (A). Note the remnant posterior labrum (La). Medial (M), lateral (L). Left hip viewed with 70° arthroscope from modified mid anterior portal.

technique for hip labral reconstruction using fresh meniscal allograft.

Surgical Technique

Patient Positioning and Portal Placement

Full demonstration of our technique is seen in Video 1. Patients are positioned supine on a postless hip arthroscopy table (Pivot Guardian, Stryker, Kalamazoo, MI).[28] The patient is secured in traction boots, and their arms are placed across their chest. Care is taken to ensure that the patients' skin is in contact with the pad. Slight Trendelenburg is applied to aid in distraction of the operative hip. Balanced suspension is applied to the operative leg to achieve adequate joint distraction which is confirmed via fluoroscopy. A standard anterolateral portal (ALP) is established with fluoroscopic assistance, with care taken to enter the joint parallel to the acetabular sourcil. The 70° arthroscope is inserted into the joint and the modified mid-anterior portal (MMAP) is created under direct visualization. The camera is then moved to the MMAP to verify the placement of the ALP with respect to the femoral head and labrum. Diagnostic arthroscopy is performed to evaluate the labrum, acetabular and femoral cartilage, the state of the capsular tissue, and the ligamentum teres. If labral deficiency, or an irreparable labral tear is present, the decision is made to perform labral reconstruction.

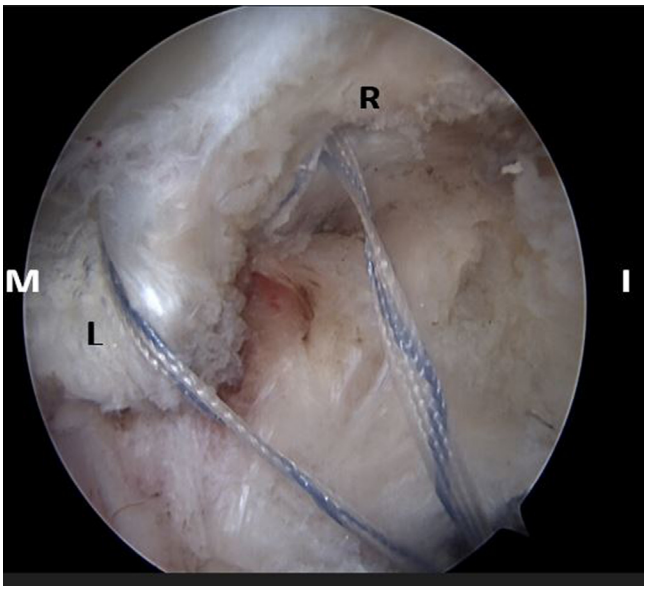

Fig 2. The "junctional repair stitch" is passed through the remnant posterior labrum (L). Note the prepared acetabular rim (R) for allograft fixation. Medial (M), lateral (L). Left hip viewed with 70° arthroscope from modified mid anterior portal.

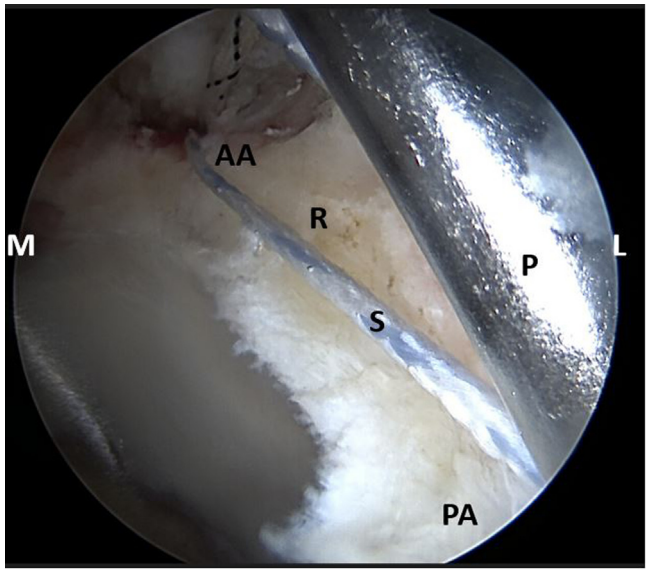

Fig 3. The suture (S) from the anterior-most anchor (AA) is manipulated across the prepared acetabular rim (R), to the posterior-most anchor (PA), with a knot pusher to measure the defect. Medial (M), lateral (L). Left hip viewed with 70° arthroscope from anterolateral portal.

Capsulotomy and Identification of Pathology

Once the ALP has been optimized, the Samuri blade (Stryker, Kalamazoo, MI) is introduced via the ALP and the horizontal capsulotomy is started. The camera is moved back to the ALP, and the blade is then brought into the MMAP, completing the horizontal capsulotomy for ease of instrumentation and graft passage during the procedure. A tagging stitch is then used via the MMAP to apply traction to the acetabular

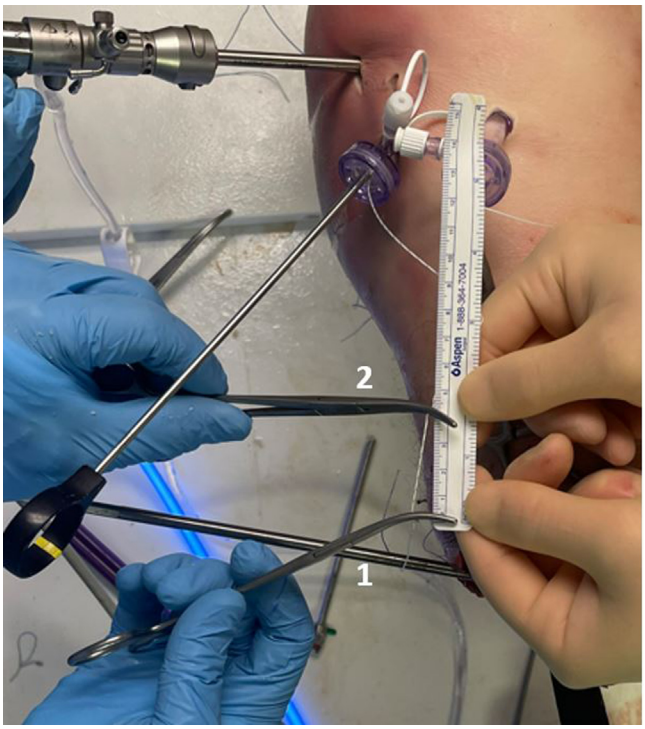

Fig 4. Two hemostat clamps are used to determine the length of the suture that traverses the acetabular rim as shown in Fig 3. The first hemostat (1) is placed with the knot pusher flush against the suture at the anterior anchor, while the second that is placed on the knot pusher brings the suture to the posterior anchor (2). Distance is then obtained, and 7 mm is added. Right hip is used here for demonstration purposes, and the camera is in anterolateral portal in this image. Sutures are out of the distal anterolateral portal.

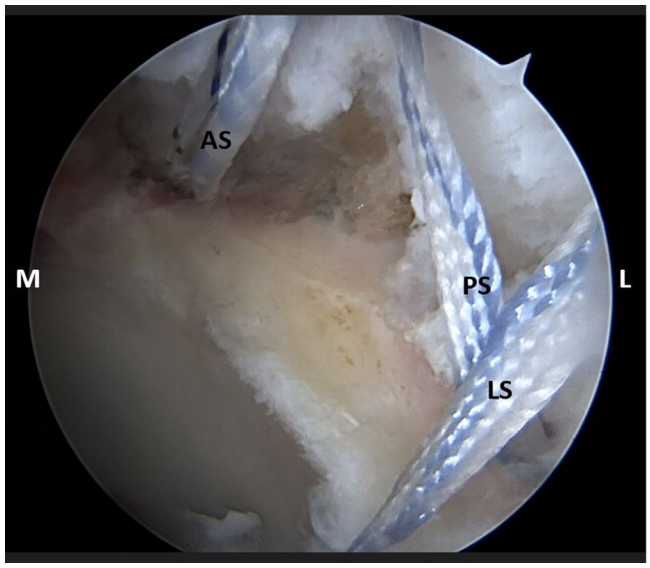

Fig 5. A suture limb from the anterior most anchor (AS), and posterior most anchor (PS), are retrieved via the distal anterolateral portal to shuttle the graft into the joint. Care needs to be taken to ensure the PS limb is anterior to the already passed suture limb in the native labrum (LS). Medial (M), lateral (L). Left hip viewed with 70° arthroscope from anterolateral portal.

recess of the capsulotomy, allowing for improved identification and access to the acetabular rim during joint preparation. At this point, the labrum is investigated, and the extent of labral deficiency can be determined. A 4.0-mm full radius arthroscopic shaver (Arthrex, Naples, FL) is then used to reflect and demarcate the acetabular capsular leaflet from the acetabular rim and remnant labrum, followed by an arthroscopic radio frequency ablation device (Stryker, Kalamazoo, MI). The labrum is noted to be either deficient, or densely calcified, and deemed irreparable. Often extensive capsular adhesions are present, as this is typically a revision arthroscopy setting. A 4.0-mm arthroscopic burr (Arthrex) is then introduced via the MMAP and any osteophytes, calcified labrum, or pincer lesions can be resected, allowing for a well-contoured bleeding bed of bone for graft placement. The acetabular rim and remnant labrum are further exposed by moving the camera to the MMAP once more and repeating the aforementioned exposure steps to evaluate the posterior extent of the labral deficiency. An additional capsular tagging stitch is placed via the ALP, followed by dissection with the shaver and radiofrequency ablation device, and subsequent usage of the burr to complete the acetabuloplasty component of the procedure. During this portion of the procedure, care should be taken to define the anterior- and posterior-most limits of the labral deficiency to allow for the most accurate sizing for graft placement.

Initial Anchor Placement and Graft Sizing

With the acetabulum now prepared and the camera already in the MMAP, a 3.0-mm biocomposite SutureTak single-loaded suture anchor (Arthrex) is placed at the posterior extent of the prepared acetabular rim (Fig 1; anchor #5 in Fig 7 illustration). A hip length 8.25 mm × 9 cm cannula (Arthrex) is inserted into the ALP over a switching stick to prevent soft tissue bridge during anchor insertion. The anchor is placed with care taken not to violate the acetabular cartilage. A single limb of suture from the anchor is then shuttled through the posterior remnant labrum using the NanoPass (Stryker) suture retrieval device. This will serve as the "junctional repair stitch" at the transition point between the meniscal allograft and the native labrum (Fig 2). The camera is moved back to the ALP, and a hip length 8.25 mm × 9 cm cannula (Arthrex) is placed in the MMAP. Both limbs of the suture from the posterior anchor, which was just placed, are temporarily pulled out of the ALP. A distal anterolateral portal (DALA) is created under direct visualization with care taken to ensure that it occurs within the pre-existing horizontal

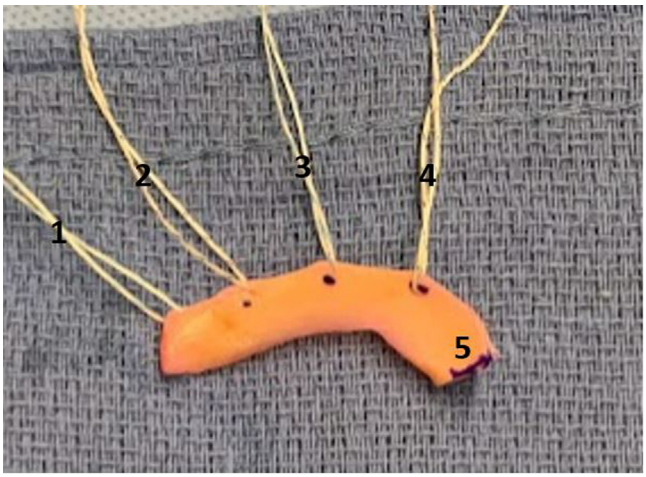

Fig 6. Using the arthroscopic measurement for length, the surgeon marks the meniscus allograft for sharp trimming to final size and shape by mapping the required dimensions on its femoral surface, such that the peripheral curvature is minimized, and the thickness and width match the native labrum. FiberLink passing sutures of alternating colors are placed in the graft from the anterior-most aspect of the graft (1) to the posterior most (4) with (5) corresponding to the site for the junctional suture. Numbered hemostats are applied for suture management purposes.

capsulotomy. This portal will be essential for further anchor placement and graft passage. A hip length 8.25 mm × 9 cm cannula (Arthrex) is placed in the DALA portal. The central dam of the cannula is removed prior to insertion to aid in graft passage through the cannula. A drill guide for the anterior-most anchor is then introduced via the DALA and a 3.0-mm knotless, single-loaded biocomposite anchor (Arthrex) is placed at the anterior extent of the prepared acetabular rim (anchor #1 in Fig 7 illustration).

The repair suture limb from this anchor is then retrieved from the MMAP and will be used to size the defect. A knot pusher is introduced over this limb of suture, and a hemostat is placed on the stitch at the external end of the knot pusher. The knot pusher is then used intra-articularly to manipulate the suture to approximate the contour of the acetabular rim back to the posterior anchor (Fig 3). A second hemostat is placed on the repair suture again at the external end of the knot pusher. The distance between the two clamps is then measured (Fig 4). To account for anchor positioning within the recipient bed, 7 mm is added to the measurement to determine final graft length.

The repair suture limb from the anterior-most anchor is then retrieved once more out the DALA in preparation for graft passage. A looped retriever is then used to bring the nonrepair suture limb from the posterior-most knotted anchor out the DALA. When retrieving the stitch from the posterior anchor, care should be taken to ensure that it is anterior to the already-passed suture limb in the native labrum to avoid tangling during passage (Fig 5). The previously passed stitch from the posterior anchor is left in the ALP.

Graft Preparation

On the graft preparation table, a fresh meniscus allograft (medial or lateral meniscus allograft, Missouri Osteochondral Preservation System (MOPS), MTF Biologics) is prepared. The entire meniscus is removed from the tibial plateau by sharp dissection at the roots and capsular rim. Using the arthroscopic measurement for length, the meniscus allograft is marked for sharp trimming to final size and shape by mapping the required dimensions on its femoral surface, such that the peripheral curvature is minimized, and thickness and width match the native labrum (Fig 6). The femoral surface of the allograft is used as the articular surface of the transplant, which determines anterior and posterior ends of the graft. FiberLink passing sutures (Arthrex) of alternating colors are placed in the allograft as follows:

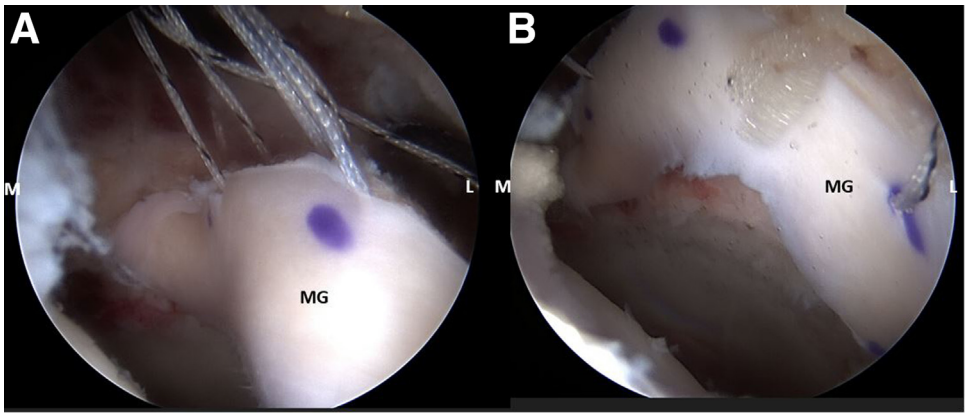

Fig 7. (A) Meniscal allograft (MG) labral reconstruction in place along the acetabular rim prior to final tensioning. (B) After final tensioning. Medial (M), lateral (L). Left hip viewed with 70° arthroscope.

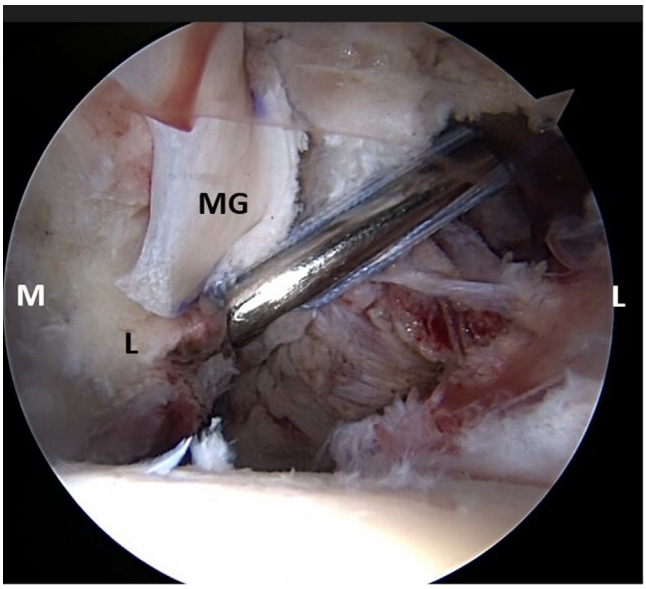

Fig 8. Junctional stitch (#5) being tied to connect the meniscal labral allograft (MG) with the remnant native labrum (L). Medial (M), lateral (L). Left hip viewed with 70° arthroscope from anterolateral portal.

- Anterior (#1) − 4 mm from the anterior end of the graft, the suture is placed from the superior margin of the cut rim to exit on the femoral surface 2 mm from the cut rim.
- Intermediate (#2 to 4-6, depending on graft length) − starting 1 cm from the anterior suture, sutures are placed at 1-cm intervals until ~1 cm from the posterior end of the graft. Each of these sutures is placed from the inferior margin to the superior margin of the cut rim.

Numbered hemostats are placed on each of the passing sutures (Fig 7).

Graft Delivery and Fixation

The graft is brought onto the surgical field, and the free limb from the posterior anchor is passed through the posterior end of the graft from the cut end to exit 3 to 4 mm anteriorly on the nonarticular surface, and a mulberry knot is tied and pulled flush against the graft (#5 in Fig 7 and Fig 10 illustration). The #5 suture limb, which is still out of the ALP, is pulled to begin shuttling the posterior end of the graft into the joint. Once the graft begins to engage the cannula, the anterior-most FiberLink passing suture (#1) is used to complete both steps of anchor suture preparation for knotless fixation at the anterior anchor (anchor #1). The fixation suture from the anterior anchor (#1) and the suture limb of the posterior anchor (#5), passed in the graft with mulberry knot, are then used to pass the graft into the joint using the "kite-technique".[29] Tension is pulled on the posterior suture limb (#5) in the ALP to bring the posterior end of the graft firmly onto the recipient acetabular rim over the posterior anchor (#5). An assistant can use a tissue grasper to aid in passing the graft through the cannula, maintaining its proper orientation. Once the posterior aspect of the graft is seated, the anterior fixation suture (#1) is tensioned to seat the anterior end of graft firmly into the recipient acetabular rim over the anterior anchor (#1). The anterior fixation suture (#1) is retrieved via the MMAP so that it can undergo final tensioning at the conclusion of the procedure.

A proximal accessory portal (PAP) is created anterior to the MMAP to retrieve the intermediate passing sutures (#2-4 in Fig 7 and Fig 10 illustration) to aid in suture management, as well as orientation of the graft along the acetabular rim. Additional anchors are inserted from anterior to posterior. The guide for each knotless suture anchor (SutureTak, Arthrex Inc.) is introduced via the DALA portal and placed 1 cm posterior to anchor #1 to directly oppose passing suture #2 for placement of knotless suture anchor #2. The fixation suture from anchor #2 and the posterior most limb of the FiberLink passing suture in the graft are retrieved together with a looped retriever and taken out the DALA portal. The fixation suture is loaded into the link and shuttled into the graft. The fixation suture and shuttle suture from anchor #2 are then grabbed together via the DALA portal to eliminate any tangles, and the fixation suture is loaded and passed into the anchor. Anchor #2 is provisionally tensioned, further reducing the allograft into the recipient bed. This fixation suture is similarly retrieved via the MMAP and

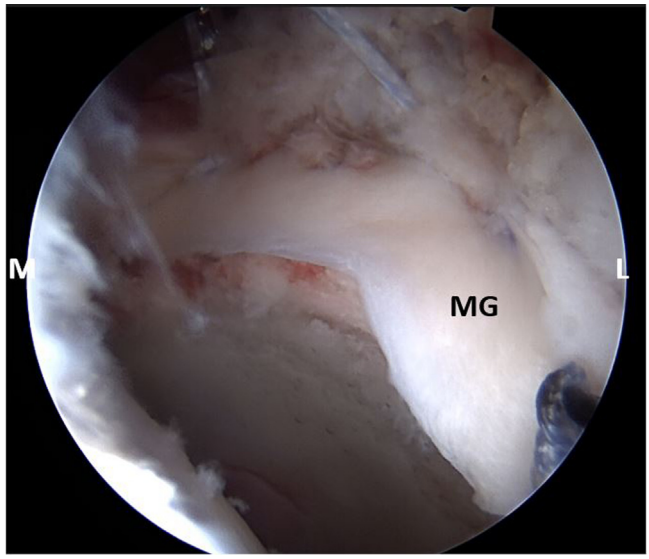

Fig 9. Final meniscal allograft (MG) labral reconstruction after final tensioning and placement of junctional stitch. Medial (M), lateral (L). Left hip viewed with 70° arthroscope from anterolateral portal.

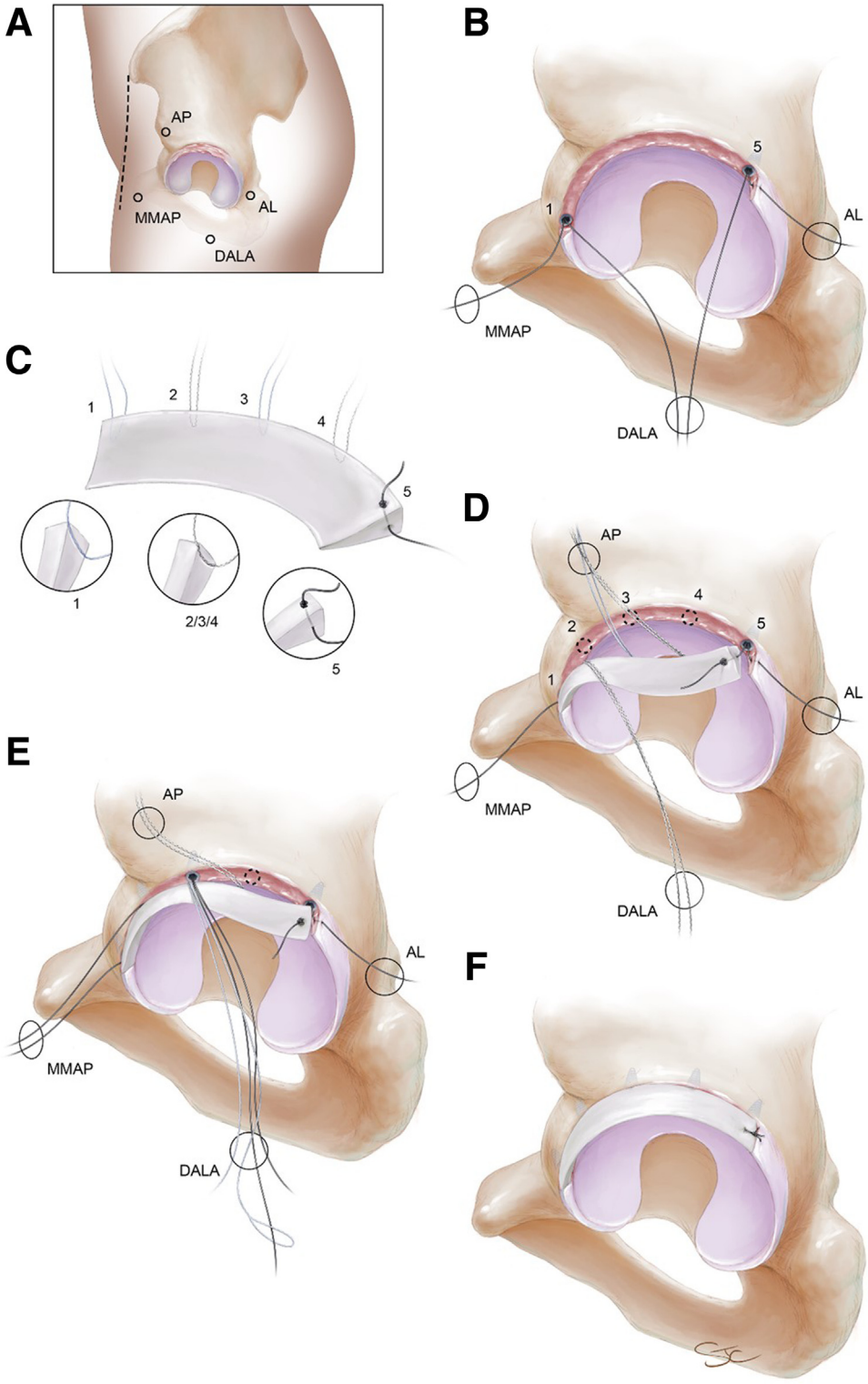

Fig 10. Summary of our surgical technique. (A) The portals used for arthroscopic labral reconstruction include the anterior lateral (AL), modified midanterior portal (MMAP), proximal accessory portal (AP), and distal anterolateral accessory portal (DALA). (B) The graft is shuttled via the DALA portal via a suture limb from the anterior-most (#1) and posterior-most (#5) anchor. (C) The graft is prepared for corresponding anchor placement. Passing sutures are placed (#1-4), and the passing limb from the posterior anchor #5, is passed with a free needle, and a mulberry knot is tied for suture shuttling. (D) Graft is seated, and sequential passing of the subsequent anchors occurs. Passing stitch #2 is retrieved via the DALA. (E) Sequential fixation occurs, here the passing stitch #3 is in the DALA portal, as well as the repair stitch from anchor #3. Note that the previously passed repair stitch from anchors #1 and #2 is in the MMAP, and the passing suture #4 is in the AP. (F) Final construct after sequential tightening.

Table 1. Pearls and Pitfalls of Surgical Technique

Pearls	Pitfalls
Place the anterior and posterior most anchor at the extent of the labral deficiency.	Anchor placement can be a challenge depending on the extent of the defect, and portals should be optimized based on patient anatomy.
Shuttle the graft posterior first via the mulberry knot while tightening the anterior passing stitch in the knotless anchor.	Ensure that the two passing sutures are not tangled in the cannula and use a grasper to help the graft enter the joint to avoid tangling.
A probe through the accessory portal can keep the graft from flipping and properly orient it during passage.	Failure to orient and separate the middle passing stitches can lead to tangling.
The accessory portal will allow for aid in suture management and helps orient the graft when the passing sutures from the mid-body of the meniscal graft are retrieved.	Increased risk of suture management issues without an accessory portal
Don't fully tighten the knotless anchors until the end, as this allows for some extra mobility of the graft for ease of anchor placement.	Overtightening the graft may make it difficult to visualize the acetabular rim for subsequent anchor placement after the graft has been shuttled.
When retrieving the link stitch to shuttle the repair stitch, grab the posterior-most stitch with the repair stitch at the same time to avoid tangling or suture bridging.	Numerous sutures and inability to detangle can result in a complicated suture bridge.
Placing a dot on the meniscal graft allows for ease of anchor spacing during implantation and drilling.	Inappropriate spacing of the anchors can lead to uneven tensioning of the graft during final fixation.

tagged with a numbered hemostat for subsequent final tensioning. The anchors are not fully tensioned until all anchors have been inserted to make visualization of the acetabular rim easier to perform. These steps are repeated every 1 cm for remaining intermediate knotless suture anchors (#3 and #4 in Fig 7 and Fig 10 illustration). Once all the knotless anchors have been placed and passed, they are sequentially tensioned, fixating the graft firmly into the recipient bed, extending from the acetabular rim to recreate the labral suction seal. The repair stitches are cut flush. Lastly, the camera is moved back to the MMAP. A hip-length cannula is replaced in the ALP and the mulberry knot that is through the graft is retrieved. The knot is cut off, and the reciprocal limb which is passed through native labrum is retrieved. These sutures are then tied, both anchoring the graft posteriorly, and performing a junctional repair between the native labrum and the meniscal allograft (Fig 8). The final fixation is investigated both from the MMAP, and by switching the camera back to the ALP. Traction is released, and the suction seal of the reconstruction can be assessed (Fig 9). The procedure is summarized in Fig 10.

Peripheral Compartment Arthroscopy and Capsular Management

The peripheral compartment can then be entered, and any cam deformity can be treated in the standard fashion with a balance resection to restore the normal head-neck offset at the femoral head neck junction. A T-capsulotomy can be performed, as needed, for adequate visualization of any cam deformity, and a balanced cam resection should be performed with the aid of fluoroscopy. Once adequate resection has taken place, a dynamic evaluation can be performed to confirm no residual deformity is present. Capsular closure should then be performed as has been previously described to avoid any potential microinstability.[30]

Rehabilitation

Rehabilitation for labral reconstruction is like our protocol after surgical intervention for FAIS and labral repair.[31] Briefly, the patient is instructed to remain foot-flat weight bearing for a minimum of 2 weeks. This is followed by a full week of 50% weight bearing with crutches, followed by a full week of 100% weight

Table 2. Advantages and Disadvantages of Surgical Technique

Advantages	Disadvantages
Meniscus allograft may better imitate native labral tissue in shape, function, and biology.	Fresh meniscal allograft may be difficult to obtain at certain surgery centers/institutions.
Knotless repair allows for tensionable fixation of the graft.	Knotless fixation may be technically demanding and lead to possible suture tangling.
Meniscal graft can be tailored to the radius of curvature and size of the defect.	Meniscal allograft is not as long as other allografts, so its utility may be limited based on defect size.
Meniscal tissue is more rigid than tendon allografts.	This may make graft passage challenging.

bearing with crutches, prior to progression to full weight bearing. Weight bearing can progress to 100% without crutches at ~5 to 6 weeks postoperatively. Strengthening occurs at ~12 weeks, with running beginning around 20 weeks. Return-to-sport specific activity occurs at 6 months postoperatively.

Discussion

Here, we present our technique for arthroscopic labral reconstruction utilizing fresh meniscal allograft. This is a technically challenging technique with many pitfalls (Table 1). Meniscal allograft has been used for labral reconstruction via open techniques, but to our knowledge, arthroscopic techniques have not been described. Chen et al.[25] described a technique for labral reconstruction using meniscal allograft via an open surgical dislocation approach. A fresh-frozen, nonirradiated medial meniscal allograft was used, beveling the peripheral rim to allow the graft to lie flush with the femoral head to ensure sealing. The authors analyzed 7 hips with an average follow-up of 17.4 months. There were no significant postoperative complications. The Merle d'Aubigné-Postel score increased by a mean of 3.6 ($P < .03$), and there was a significant increase in hip flexion and nonsignificant increase in abduction. No long-term outcomes were reported. At our institution, meniscal allograft has also been used for open labral reconstruction. Rucinski et al.[26] reported on the outcomes of 22 patients who underwent open labral reconstruction with meniscal allograft with at least 1-year clinical follow-up (mean 26.8 months). This cohort had a 90.1% survivorship rate, with only 2 patients requiring conversion to THA, with both patients also having undergone a concomitant open osteochondral femoral head allograft transplantation. Both failures were related to the osteochondral grafts, not the labral allograft. Short-term clinical results indicate that this is a successful option for hip preservation and labral reconstruction.

A potential advantage of this graft is that the meniscus mimics the gross morphology of the labrum and can be contoured to fit the acetabular rim (Table 2). Although there is some evidence in support of effective revascularization, integration, and remodeling of the meniscus allograft after implantation at the acetabular rim,[26,27] more research is needed to determine whether the biomechanical and histological properties of the meniscus provide benefits for patient outcomes after meniscal allograft transplant for acetabular labral reconstruction.

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