

A Modified “Shuttle” Method Technique for Arthroscopic Hip Capsular Reconstruction in Capsular Deficiency



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Abstract: The hip capsule has been recognized as a vital structure in the stability and proper function of the hip. Preserving its integrity during arthroscopic surgery is one of the utmost important principles in hip preservation surgery. When capsular deficiency is present, capsular reconstruction may be indicated to restore stability and proper hip mechanics. In this technical note, we introduce a simple and reproducible shuttle method technique for hip capsular reconstruction using a dermal allograft.

Introduction

Proper capsular management is integral to arthroscopic hip surgery. Maintaining its integrity is an important tenant of hip preservation surgeons. It is now recognized that the iliofemoral ligament plays an important role in hip biomechanics, as it provides stability, limits joint, distraction, translation, and rotation within the normal range of hip motion.¹⁻³ In addition, studies have shown that capsule repair after hip arthroscopy returns hip biomechanics to their native ranges and improves postoperative patient-related outcomes.³⁻⁵ In patients with capsular deficiency, usually from iatrogenic excessive debridement of the

proximal capsular flap, failure to close the capsule, or in the setting of revision surgery with failed capsular closure; capsular reconstruction using allograft is an option to resolve instability and discomfort.^{6,7} In this technical note, we illustrate a simple and reproducible “shuttle method” for arthroscopic hip capsular reconstruction (Video 1).

Surgical Technique

Anesthesia and Patient Positioning

General anesthesia with complete muscle relaxation is induced followed by endotracheal intubation. Then, the patient is placed supine on postless distraction table (Pivot Guardian; Stryker Endoscopy, Kalamazoo, MI). The operative extremity is elevated 20° and internally rotated (Fig 1).

Portal Placement

This technique employs four portals (Fig 2). X-ray fluoroscopy is then used to perform an air arthrogram to break the suction seal. The operative extremity is then placed under traction, and the standard anterolateral portal (ALP) is used to enter the hip joint. Then 6 cm distal and at a 45° angle the mid-anterior portal (MAP) is made under direct visualization using a spinal needle, and a Stryker Transport Cannula is placed (Stryker Endoscopy, Kalamazoo, MI). At this point, diagnostic arthroscopy is performed, as well as any labral or central compartment work. Then, using a spinal needle the

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Fig 1. Intraoperative patient positioning. The patient is placed in the supine position. The left operative extremity elevated 20° and internally rotated. A post-less distraction pad is placed under the patient. The white asterisk indicates the caudal positioning of patient. The white arrow indicates the cranial portion of patient positioning.

distal anterolateral portal (DALA) and proximal mid-anterior portal (PMAP) are made, and two more transport cannulas are placed.

Preparation/Anchor Placement/Defect Measurement

Then using an arthroscopic shaver, burr, and ablator the subspinous and supra-acetabular rim is exposed and prepared to a bleeding cancellous bed. Then a 45° curved Stryker NanoTack (Stryker Endoscopy, Kalamazoo, MI) guide is used to place 3 anchors (1.4-mm NanoTack anchor; Stryker) under fluoroscopic assistance on the prepared supra-acetabular rim in: one on the medial aspect, one midpoint, and one on the lateral aspect of the defect (Fig 3). These three anchors will provide the proximal fixation for the graft. Next, through the MAP portal, the medial proximal-to-distal and anterior-to-posterior distance is measured using an arthroscopic knot pusher and hemostats by sliding the knot pusher from the most anterior anchor sutures along the acetabular rim and across length of the defect (Fig 4). The same maneuver is performed for the most posterior anchor for the lateral proximal to distal measurement. Of note, the defect measurement is done with the hip in full extension, so as not to undersize the graft, which would require higher

degrees of hip flexion for repair and, thus, over-constrain the hip.

Graft and Suture Preparation

After defect measurement, one limb from each suture anchor is brought out of the PMAP and one limb out of the DALA portal (Fig 3). The sutures tails are made short out of the PMAP, since these will be used to shuttle the graft down to its position. The acellular human dermal matrix graft (GraftJacket NOW, Stryker Orthopaedics, Mahwah, NJ) is then prepared on the back table. The graft is 2-3 cm thick and prepared to the dimensions previously measured arthroscopically, with the addition of 5 mm to each side. The additional length in the proximal-to-distal dimension allows suture placement 5 mm from the rim of the graft, which ensures adequate suture fixation.

The graft is then brought to the field in the correct orientation, making sure the deep surface of dermal matrix facing downward. This will allow healing of the graft to the prepared bony surface on the supra-acetabular rim. Then, a free needle is used to pass suture and secure the limbs to the graft (Fig 5). A simple knot is tied at the end of these suture limbs to easily identify them for arthroscopic knot tying. In addition, it is important to ensure that the suture limbs are not twisted before securing the limbs to the graft, since this

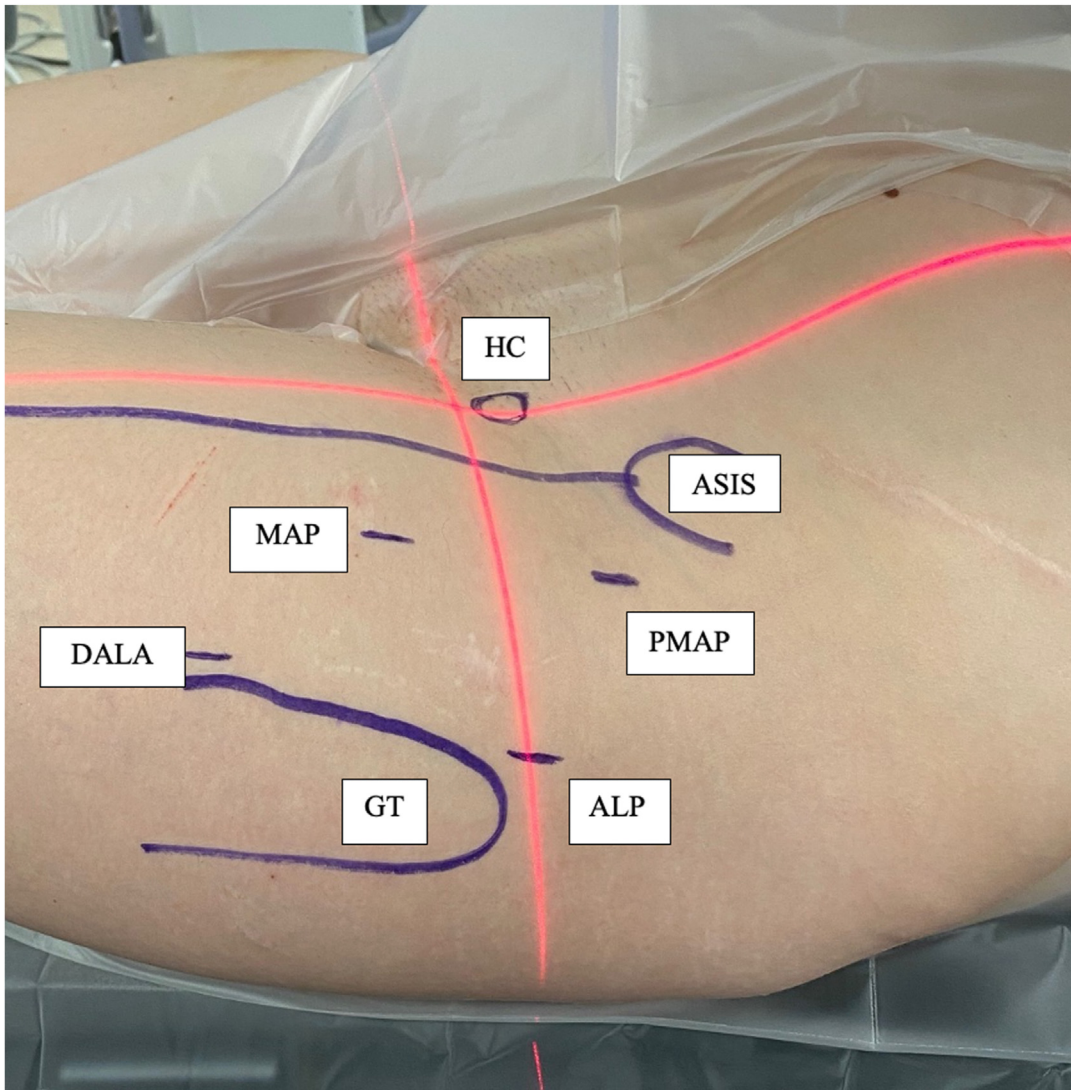


Fig 2. Intraoperative photograph of a left hip in the supine position, demonstrating the 4 portal locations. ALP, anterolateral portal; ASIS, anterior superior iliac spine; DALA, distal anterolateral accessory portal; GT, greater trochanter; HC, hip center; MAP, mid-anterior portal; PMAP, proximal mid-anterior portal. The red laser crosshairs indicate C-arm position on the patient.

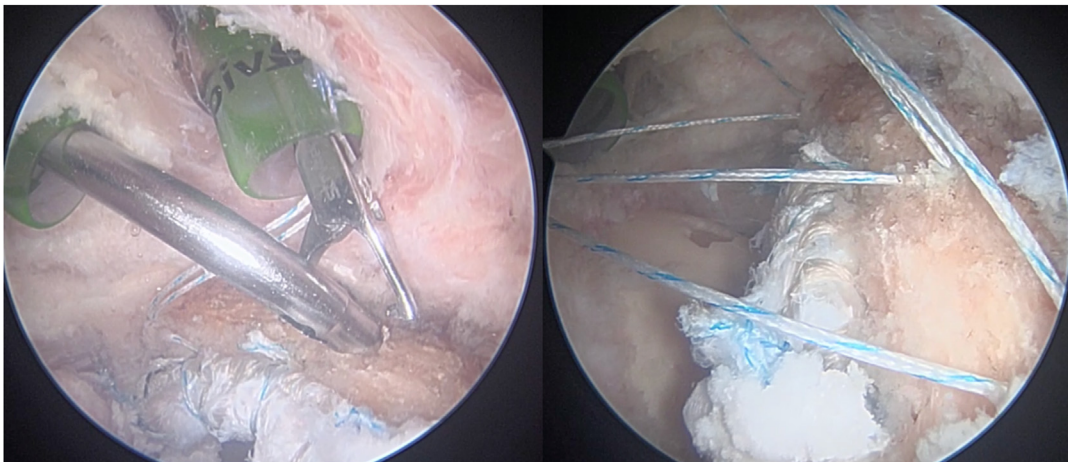


Fig 3. Intraoperative arthroscopic imaging in a left hip of a patient in the supine position. The arthroscope is viewing from the anterolateral portal. Anchor placement (1.4-mm NanoTack anchor; Stryker) is done on the prepared supra-acetabular rim using 45° curved Stryker NanoTack guide (Stryker Endoscopy, Kalamazoo, MI) inserted from the MAP portal through a TransPort Cannula (Stryker Endoscopy, Kalamazoo, MI). One end of the suture limbs from each anchor is brought out the proximal mid-anterior portal and distal anterolateral portal.

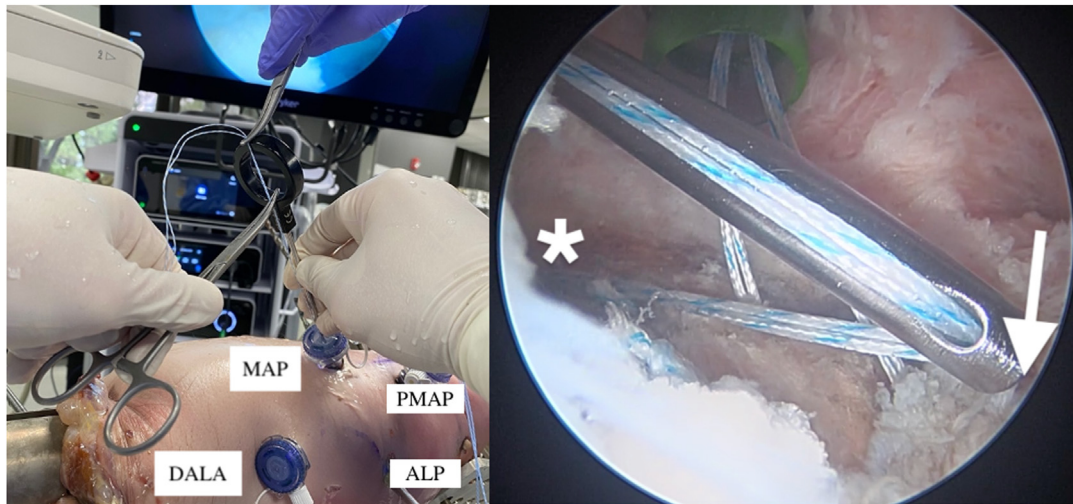


Fig 4. Defect measurement using suture anchor limbs, two hemostats, and arthroscopic knot pusher and viewing from the ALP. The knot pusher is placed through the MAP portal to the most medial anchor denoted by a white asterisk. A hemostat is placed outside the hip at the top of the knot pusher ring. Then the knot pusher is advanced to the most lateral anchor indicated by the white arrow. Another hemostat is placed at the top of the knot pusher ring. The distance between the hemostats is measured and used for graft preparation. ALP, anterolateral portal; DALA, distal anterolateral accessory portal; MAP, mid-anterior portal; PMAP, proximal mid-anterior portal.

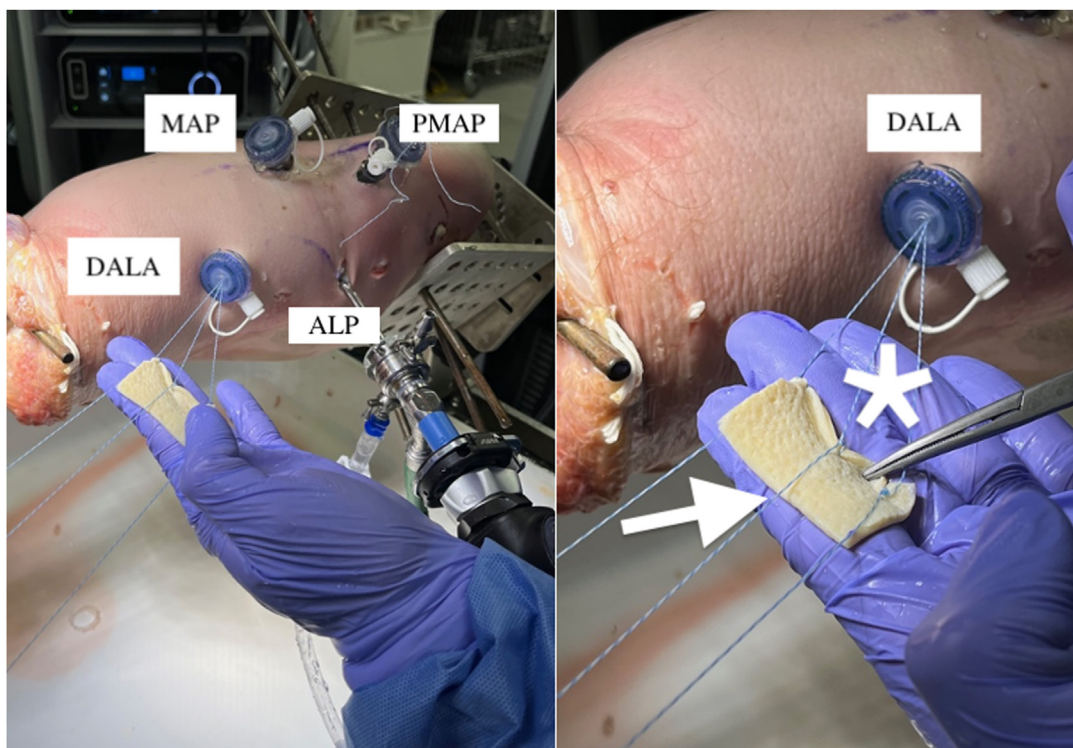


Fig 5. Allograft for capsule reconstruction. Pictured is a left hip cadaveric specimen in the supine position. The sutures are passed with free needle in proximal limb of graft for subsequent shuttling. Sutures are brought out DALA and PMAP for graft passage. Images show correct graft orientation and that sutures are not twisted. The white asterisk indicates the proximal end of graft, and the white arrow denotes distal end of graft. ALP, anterolateral portal; DALA, distal anterolateral accessory portal; MAP, mid-anterior portal; PMAP, proximal mid-anterior portal.

Fig 6. Graft passage. Pictured is a left hip cadaveric specimen in the supine position. The dermal allograft is tightly rolled and inserted with the help of an arthroscopic grasper into the DALA portal canula. The shortened suture tails in the PMAP portal are sequentially pulled to shuttle graft to its position on the supracetabular rim. The white asterisk indicates the proximal end of graft, and the white arrow denotes distal end of graft.

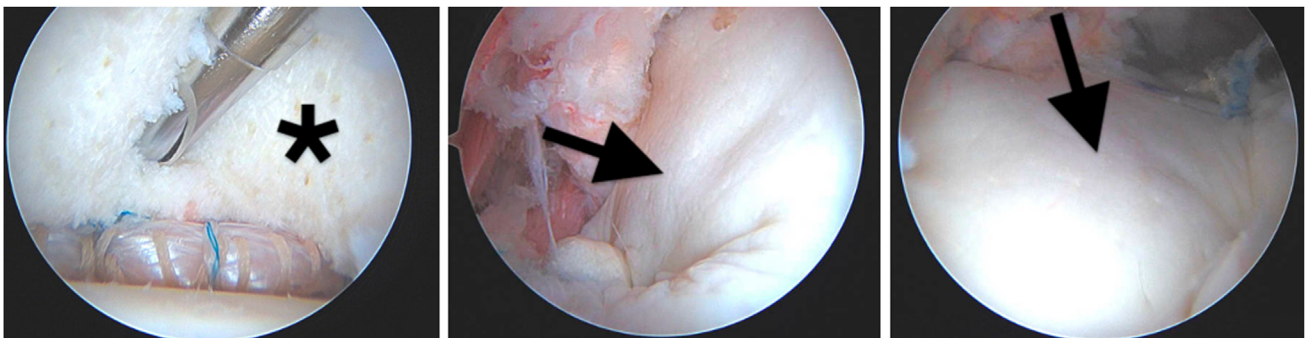
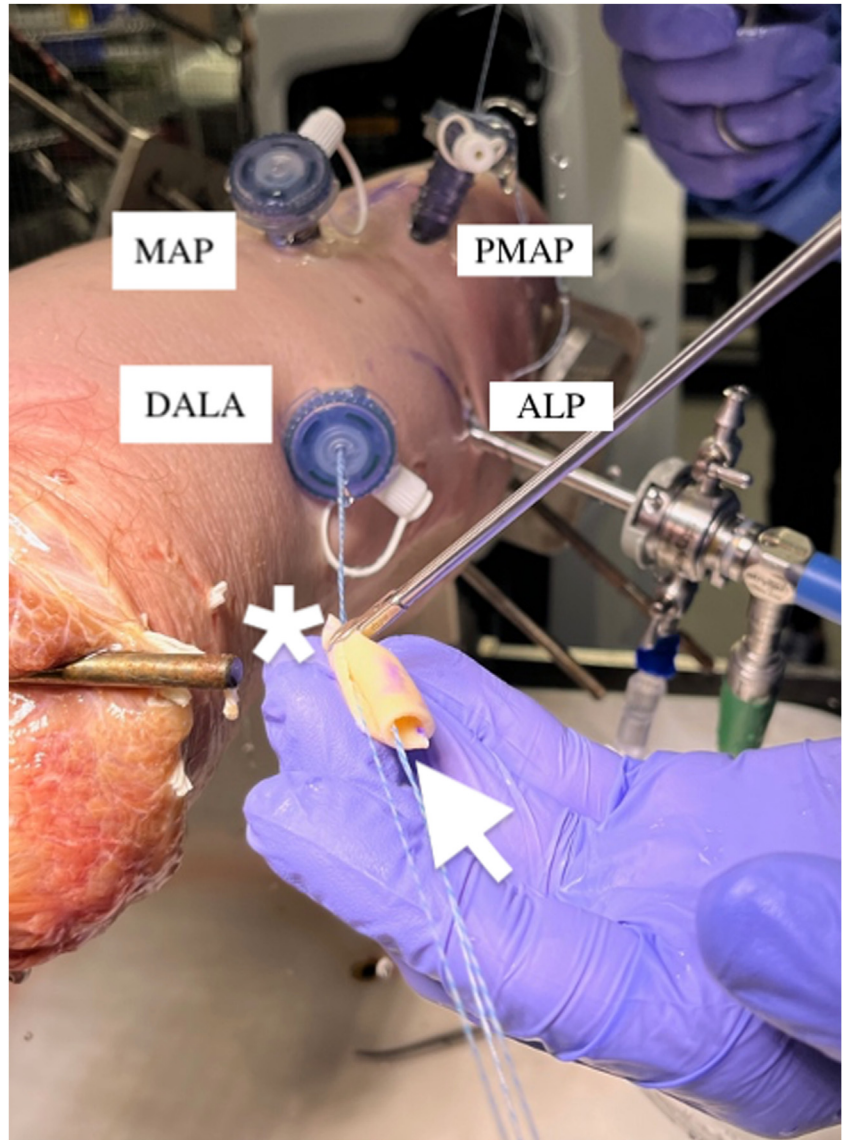


Fig 7. Final arthroscopic intraoperative photos of the hip capsular reconstruction viewed from the ALP, anterolateral portal. The black asterisk indicates the interarticular sides of the graft, and the black arrow indicates the extraarticular side of the graft.

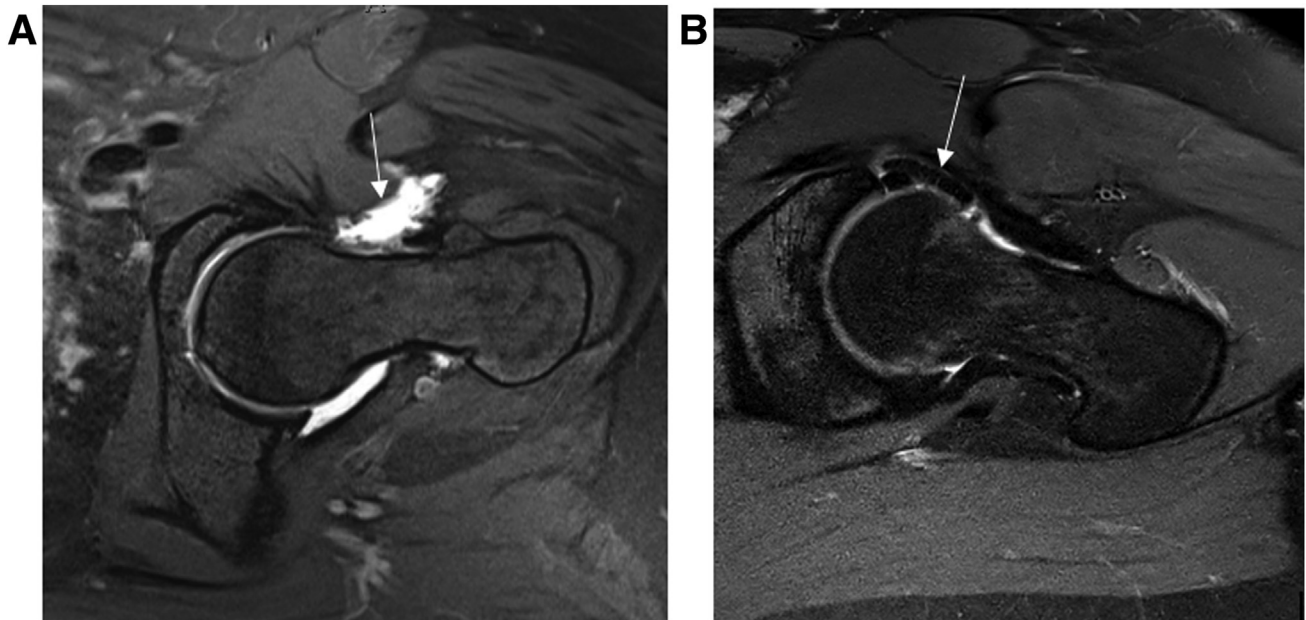


Fig 8. (A) Supine presurgical axial T2 MRI of the left hip, illustrating capsular defect with synovial fluid extravasation into the pericapsular tissues. (B) Supine postsurgical axial T2 MRI of the left hip after capsular reconstruction now showing well delineated capsule without a defect and no synovial fluid extravasation. In A, the white arrow denotes capsular defect with fluid extravasation, and in B, the white arrow denotes allograft portion of capsular reconstruction with intraarticular fluid containment.

will ensure that the graft limbs will not entangle the graft with passage.

Graft Passage and Fixation

After the graft is secured, it is tightly rolled and inserted with the help of an arthroscopic grasper into the DALA portal canula (Fig 6). Next the 3 limbs of suture from the PMAP are sequentially pulled to shuttle the graft down to the acetabular limb. The two limbs from each anchor are sequentially brought out of the MAP portal and tied with an arthroscopic knot pusher, taking note that knotted suture limb will be

the non-post. When three anchors are used, one limb from the most medial and most lateral proximal anchor knot stack may be paired with the corresponding limbs of the middle anchor for reinforced proximal graft fixation using a horizontal mattress suture configuration.

Capsular Closure

After secure fixation of the graft, capsular closure is performed with the use of the Stryker Injector II (Stryker Endoscopy, Kalamazoo, MI) to pass the suture through the distal capsular flap and the graft. The

Table 1. Technical Pearls

- Preparation and Defect Measurement
 - Ensure the footprint for capsular reconstruction is appropriately visualized to place anchors in the appropriate position.
 - Use of an arthroscopic probe can help to prevent bowstringing of the suture on the supra-acetabular rim, which will aid in accurate sizing of the defect in the anterior to posterior direction.
 - Add additional 5 mm of length to proximal-distal dimension of the graft to allow suture fixation.
 - The operative limb should be placed in extension when measuring proximal-distal extent of defect to not undersize the allograft.
- Suture Management and Graft Passage
 - The suture tails brought out of the DALA and PMAP need to be of adequate length and not entangled to allow smooth graft passage.
 - Take note to bring the allograft to the field in the correct orientation, so that the suture limbs are passed with a free needle in the correct position on the graft.
 - The dermal allograft should have the deep surface facing downward, and the epidermal surface facing upward. If the epidermal surface faces downward, it will be the side that is fixed to the bony bed and will not allow the graft to heal and scar to the supracetabular rim.
- Allograft Fixation and Capsular Closure
 - When securing the allograft to its proximal position, make sure it is reduced and the knotted suture through the allograft is NOT used as the post for arthroscopic knot tying. This will ensure no laxity and snug reduction of the allograft to supra-acetabular rim.
 - The operative extremity is placed in extension and off traction for capsular closure. This will ensure that the capsular reconstruction in appropriately tensioned during the closure.

DALA, distal anterolateral accessory portal; PMAP, proximal mid-anterior portal.

operative limb is placed in full extension and off traction. Arthroscopic knots are tied to close the newly reconstructed capsule. Then, the one limb from the most posterior and anterior anchor is paired with the most anterior and posterior knot stack from the capsule closure. These paired suture limbs are then tied to their corresponding knot stack for reinforced fixation. A final dynamic examination is performed to ensure that the graft fixation is adequate and the graft is appropriately tensioned (Fig 7).

Postoperative Management/Rehabilitation

Postoperatively, the patient will follow the normal postoperative recovery for hip arthroscopy. The patient will be 50% weight bearing for 3 weeks and then will wean from crutches after that. In addition, no extension, or prone exercises for 6 weeks with the brace set 30-70° for ROM to protect the reconstruction. After 6 weeks, the brace is unlocked to allow progression to full PROM and full weight bearing. Progressive strengthening and rehabilitation are carried out with formal physical therapy.

Discussion

The described “shuttle” technique provides an effective and reproducible means for arthroscopic hip capsular reconstruction for capsular deficiency. Pre-surgical and postsurgical magnetic resonance imaging confirms that this technique closes the capsular defect and provides tissue integrity for capsular healing (Fig 8). Like previously published reconstructions techniques, it provides a technique to secure the graft outside the patient and then use sliding sutures to reduce graft to supracetabular rim.^{8,9} However, the present technique offers a few modifications and advantages. First, it makes use of a fourth portal, the PMAP, which makes suture management easier and prevents entanglement. Second, it allows the graft to be secured outside the body, inserted into the DALA portal, and then sequentially brought down to the supracetabular rim. Third, after securing the proximal portion of the graft, one of the suture limbs from the

anchor can be tied to one of the limbs from corresponding capsular closure limbs for reinforced fixation of the reconstruction. Technical pearls are listed in Table 1.

References

1. Myers CA, Register BC, Lertwanich P, et al. Role of the acetabular labrum and the iliofemoral ligament in hip stability: An in vitro biplane fluoroscopy study. *Am J Sports Med* 2011;39:(Suppl):85S-91S.
2. Nepple JJ, Smith MV. Biomechanics of the hip capsule and capsule management strategies in hip arthroscopy. *Sports Med Arthrosc Rev* 2015;23:164-168.
3. Abrams GD, Hart MA, Takami K, et al. Biomechanical evaluation of capsulotomy, capsulectomy, and capsular repair on hip rotation. *Arthrosc J Arthrosc Relat Surg* 2015;31:1511-1517.
4. Owens JS, Jimenez AE, Shapira J, et al. Capsular repair may improve outcomes in patients undergoing hip arthroscopy for femoroacetabular impingement: A systematic review of comparative outcome studies. *Arthrosc J Arthrosc Relat Surg* 2021;37:2975-2990.
5. Beck EC, Suppauksorn S, Nho SJ. The role of comprehensive capsular management in hip arthroscopy for the treatment of femoroacetabular impingement syndrome. *Arthrosc J Arthrosc Relat Surg* 2020;36:9-11.
6. Ruzbarsky JJ, Seiter MN, Comfort SM, Soares RW, Briggs KK, Philippon MJ. Arthroscopic hip capsular reconstruction using iliotibial band allograft as a salvage option for unrepairable capsular defects demonstrates good survivorship and improved patient-reported outcomes. *Arthrosc J Arthrosc Relat Surg* 2022;38:2219-2226.
7. Fagotti L, Kemler BR, Utsunomiya H, et al. Effects of capsular reconstruction with an iliotibial band allograft on distractible stability of the hip joint: A biomechanical study. *Am J Sports Med* 2018;46:3429-3436.
8. Scheidt M, Bhatia S, Fenoglio Z, Ellman MB. Capsular reconstruction of the hip using modified kite technique: A technical guide for efficient graft management and fixation. *Arthrosc Tech* 2021;10:e209-e216.
9. Bhatia S, Chahla J, Dean CS, Ellman MB. Hip labral reconstruction: The “kite technique” for improved efficiency and graft control. *Arthrosc Tech* 2016;5:e337-e342.