Technical Note

Arthroscopic Triple Reconstruction in the Hip Joint: Restoration of Soft-Tissue Stabilizers in Revision Surgery for Gross Instability

Hari K. Ankem, M.D., Samantha C. Diulus, B.S., Mitchell B. Meghpara, M.D., Philip J. Rosinsky, M.D., Jacob Shapira, M.D., David R. Maldonado, M.D., Ajay C. Lall, M.D., M.S., and Benjamin G. Domb, M.D.

Abstract: Gross hip instability in an active adult with previous normal hip anatomy is usually due to disruption of the static stabilizers of the hip joint. Although such a disruption can result from a high-grade injury, it can be iatrogenic after previous hip arthroscopy. The patient may present with a painful limp and recurrent subluxation sensation in the affected hip joint. Revision hip arthroscopy in this scenario is generally complicated, and it is not uncommon for all the soft-tissue stabilizers to be compromised. The labrum, ligamentum teres (LT), and capsule of the hip joint are often so damaged that reparation is not an option. Reconstruction of the torn LT is an established method to add secondary stability while addressing the labral pathology in the hip joint with microinstability. Concomitant reconstruction of all the static restraints has yet to be described addressing triple instability. This Technical Note presents a stepwise approach, including tips and pearls, for arthroscopic triple reconstruction of the labrum, LT, and capsule. We believe this method is a safe and reproducible way to effectively treat gross hip instability in young patients.

From American Hip Institute Research Foundation, Chicago, Illinois, U.S.A. (H.K.A., S.C.D., M.B.M., P.J.R., J.S., D.R.M., A.C.L., B.G.D.); AMITA Health St. Alexius Medical Center, Hoffman Estates, Illinois, U.S.A. (M.B.M., A.C.L., B.G.D.); and American Hip Institute, Chicago, Illinois, U.S.A. (A.C.L., B.G.D.).

The authors report the following potential conflicts of interest or sources of funding: M.B.M. receives nonfinancial support for educational support, food/beverage, and travel/lodging from Smith & Nephew, Stryker, and Arthrex, outside the submitted work. P.J.R. receives nonfinancial support for food/beverage from Arthrex, Stryker, Smith & Nephew, and Ossur and for travel/lodging from Arthrex, Stryker, and Smith & Nephew, outside the submitted work. J.S. receives nonfinancial support for food/beverage from Arthrex, Stryker, Smith & Nephew, and Ossur and for travel/lodging from Arthrex, Stryker, and Smith & Nephew, outside the submitted work. D.R.M. receives nonfinancial support for food/beverage from Arthrex, Stryker, Smith & Nephew, and Ossur and for travel/lodging from Arthrex, Stryker, and Smith & Nephew, outside the submitted work. In addition, D.R.M. is an editorial board member of Arthroscopy. *A.C.L. receives food and beverage support from Arthrex, Iroko, Smith & Nephew, Stryker, Vericel, and Zimmer Biomet; receives grant support from Arthrex and Stryker; receives travel and lodging support from Arthrex and Stryker; receives consulting fees from Arthrex and Graymont Medical; and receives education support from Medwest and Smith & Nephew, outside the submitted work. In addition, A.C.L. is Medical Director of Hip Preservation at St. Alexius Medical Center and a clinical instructor at the University of Illinois College of Medicine. B.G.D. reports that the American Orthopedic Foundation provides grant support that pays staff and expenses related to all research. In addition, B.G.D. receives consulting fees from Adventist Hinsdale Hospital, Amplitude, Arthrex, Medacta, Pacira Pharmaceuticals, Stryker, and Mako Surgical; receives research support from Arthrex, Kaufman Foundation, Medacta, Pacira Pharmaceuticals, Stryker, Mako Surgical, and ATI Physical Therapy; receives educational support from Arthrex, Medacta, Stryker, Breg, Medwest Associates, St. Alexius Medical Center, and Ossur; receives royalties from Arthrex, DJO Global, Medacta, Stryker, Orthomerica, Mako Surgical, and Amplitude; receives speaking fees from Arthrex and Pacira Pharmaceuticals; receives travel and lodging support from Arthrex, Medacta, and Stryker; receives food and beverage payments from Arthrex, DJO Global, Medacta, Pacira Pharmaceuticals, Stryker, and Mako Surgical; receives honoraria from Medacta; receives nonconsulting payments or fees from Pacira Pharmaceuticals and Stryker; and has a medical directorship with St. Alexius Medical Center, outside the submitted work. Moreover, B.G.D. has patents issued and receives royalties for the following: method and instrumentation for acetabular labrum reconstruction (8920497), licensed by Arthrex; adjustable multi-component hip orthosis (8708941), licensed by Orthomerica and DJO Global; and knotless suture anchors and methods of suture repair (9737292), licensed by Arthrex. Finally, B.G.D. is Medical Director of Hip Preservation of St. Alexius Medical Center; is a clinical instructor at the University of Illinois College of Medicine; is a board member of the American Hip Institute Research Foundation, Arthroscopy Association of North America Learning Center Committee,* Journal of Hip Preservation Surgery, *and* Arthroscopy*; and has had ownership interests in the American Hip Institute, Hinsdale Orthopedic Associates, Hinsdale Orthopedic Imaging, S.C.D.#3, North Shore Surgical Suites, and Munster Specialty Surgery Center. Full ICMJE author disclosure forms are available for this article online, as supplementary material.*

Received November 23, 2020; accepted January 11, 2021.

Address correspondence to Benjamin G. Domb, M.D., American Hip Institute, 999 E Touhy Ave, Ste 450, Des Plaines, IL 60018, U.S.A. E-mail: DrDomb@americanhipinstitute.org

2212-6287/201897

https://doi.org/10.1016/j.eats.2021.01.018

Gross hip instability in an active adult with previous normal hip anatomy is usually due to disruption of the primary and secondary stabilizers of the hip joint.[1-3] Although such a disruption can result from a high-grade injury, it can be iatrogenic after previous hip arthroscopy.[4-11] The patient usually presents with a painful limp and recurrent subluxation of the affected hip that may result in frequent falls. Furthermore, the patient may give a history of spontaneous dislocation of the hip during sleep, requiring emergency reduction. Repetitive injury from either the patient's recreational activities or prior arthroscopic exploration of the hip joint is sometimes forthcoming in the narrative.[4-11] Alternatively, the patient might sustain a secondary traumatic incident that could then trigger the train of events that followed primary hip arthroscopy.

Recent advances in arthroscopic hip preservation have led us to better understand the roles of various static stabilizers in maintaining the hip's suction seal.[12-14] A diagnostic workup with advanced imaging studies delineates the extent of soft-tissue injury and helps plan definitive surgical management. Soft-tissue deficiencies such as segmental labral defects, torn nonfunctional labra,[15,16] complete ligamentum teres (LT) tears,[17-19] and capsular defects after previous arthroscopic interventions[20-23] are often noticed, in addition to secondary avulsion injuries. Generalized ligamentous laxity further increases the instability risk in these individuals.[11,24,25]

Revision hip arthroscopy in this scenario is generally complicated, and it is not uncommon for all the soft-tissue stabilizers to be compromised.[4-11] The labrum, LT, and capsule of the hip joint are often so damaged that reparation is not an option. Reconstruction of the torn LT has recently gained traction to add secondary stability while addressing the capsulolabral defects in the grossly unstable hip joint.[17-19] Concomitant reconstruction of all the static restraints in the setting of complex instability (i.e., triple reconstruction) has yet to be described. This Technical Note presents a stepwise approach, including tips and pearls, for arthroscopic triple reconstruction of the labrum, LT, and capsule. We believe this method is a safe and reproducible way to effectively treat gross hip instability in young patients.

Indications, Patient Evaluation, and Imaging

The patient history could include prior hip arthroscopy after which a trivial trauma causes instability symptoms with repetitive subluxations and sometimes even an anterior hip dislocation. There could be significant hip pain limiting the patient's activities of daily living that will be unresponsive to conservative management. Clinical examination findings are positive for hip impingement and anterior apprehension, suggesting hip instability. Radiographically, there may be a large cam morphology with a loose bony fragment representing capsular avulsion (Fig 1 A-C). Magnetic resonance arthrogram of the affected hip will show a labral tear with a capsular defect anterosuperiorly and a tear of the LT (Fig 1 D-G).

Surgical Technique

Patient Preparation and Positioning

After induction of general anesthesia, the patient is placed in the modified supine position on the traction extension table with a well-padded peroneal post, the genitalia protected, and the feet well secured.[26] The operative hip and the contralateral iliac crest are prepared and draped in usual sterile fashion. Traction is applied to the hip under fluoroscopy.

Fluoroscopic Technique

The C-arm is positioned on the nonoperative side and draped in sterile fashion. A true anteroposterior radiograph of the pelvis is obtained by tilting the C-arm to compensate for the Trendelenburg inclination.[26] A spinal needle is then introduced into the joint under fluoroscopy, and the joint is vented, achieving further distention.

Portal Placement

The anterolateral portal is created with a No. 11 blade. The spinal needle is reinserted to ensure avoidance of the labrum and femoral head. An over-the-guidewire technique is used to place a 70° arthroscope through a 4.5-mm cannula. This same technique is repeated to place a 5-mm cannula through the midanterior portal. A Beaver blade (BVI Medical, Waltham, MA) is used to perform an interportal capsulotomy, incising the intact part of the capsule parallel to the acetabular rim to connect the 2 portals. In addition, a distal anterolateral accessory portal is made to provide a better angle for capsular elevation and capsular closure.

Diagnostic Arthroscopy

Diagnostic arthroscopy of the hip, when performed, may show the presence of a labral tear (Seldes type I or II)[27] (Fig 2A) that might not be reparable. Varying grades of acetabular labrum articular disruption (ALAD) and/or Outerbridge acetabular cartilage lesions of significant dimensions (grade 2 or above)[28] can be identified in the 1- to 3-o'clock zone. Additionally, there may be a femoral head cartilage lesion of varying dimensions (Outerbridge grade 2 or above)[28] in the 9- to 11-o'clock zone consistent with anterior instability (Fig 2 B and C). An anterior capsular defect may be present that will enable us to see the iliopsoas tendon easily in the foreground, along with

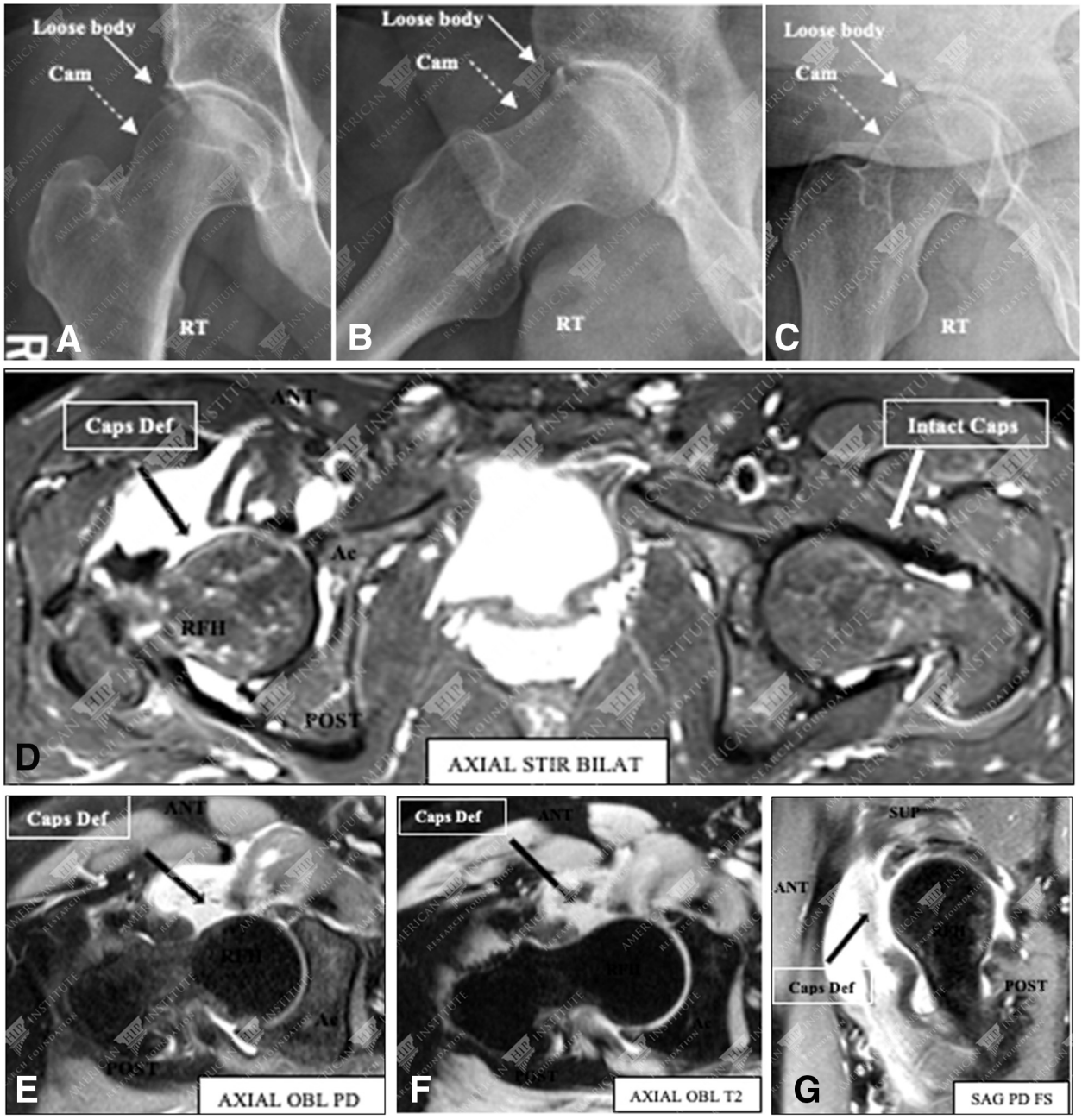

Fig 1. Preoperative plain radiographs of right hip: anteroposterior view (A), Dunn lateral view (B), and false-profile view (C) showing cam morphology (dashed arrows) with capsular avulsion loose fragment at superior aspect (solid arrows). (D-G) Magnetic resonance arthrogram of right hip: axial short tau inversion recovery (STIR) bilateral (BILAT), axial oblique (OBL) proton density (PD), axial oblique (OBL) T2, and sagittal (SAG) proton density (PD)—fat saturation (FS) images depicting anterior capsular defect (Caps Def) in right hip (black arrows) and intact anterior capsule (Caps) in left hip (arrows). (Ac, acetabulum; ANT, anterior; POST, posterior; RFH, right femoral head; RT, right; SUP, superior.)

a full-thickness tear of the LT that may coexist (Fig 2). Occasionally, a loose body may be identified, which could have resulted from an acetabular rim fracture. In the peripheral compartment, there may be a residual cam morphology that can be visualized.

Loose Body Removal

The loose body, if identified, is removed using an arthroscopic grasper. Remnant suture material from the suture anchors of the previous labral repair, if found, is also removed.

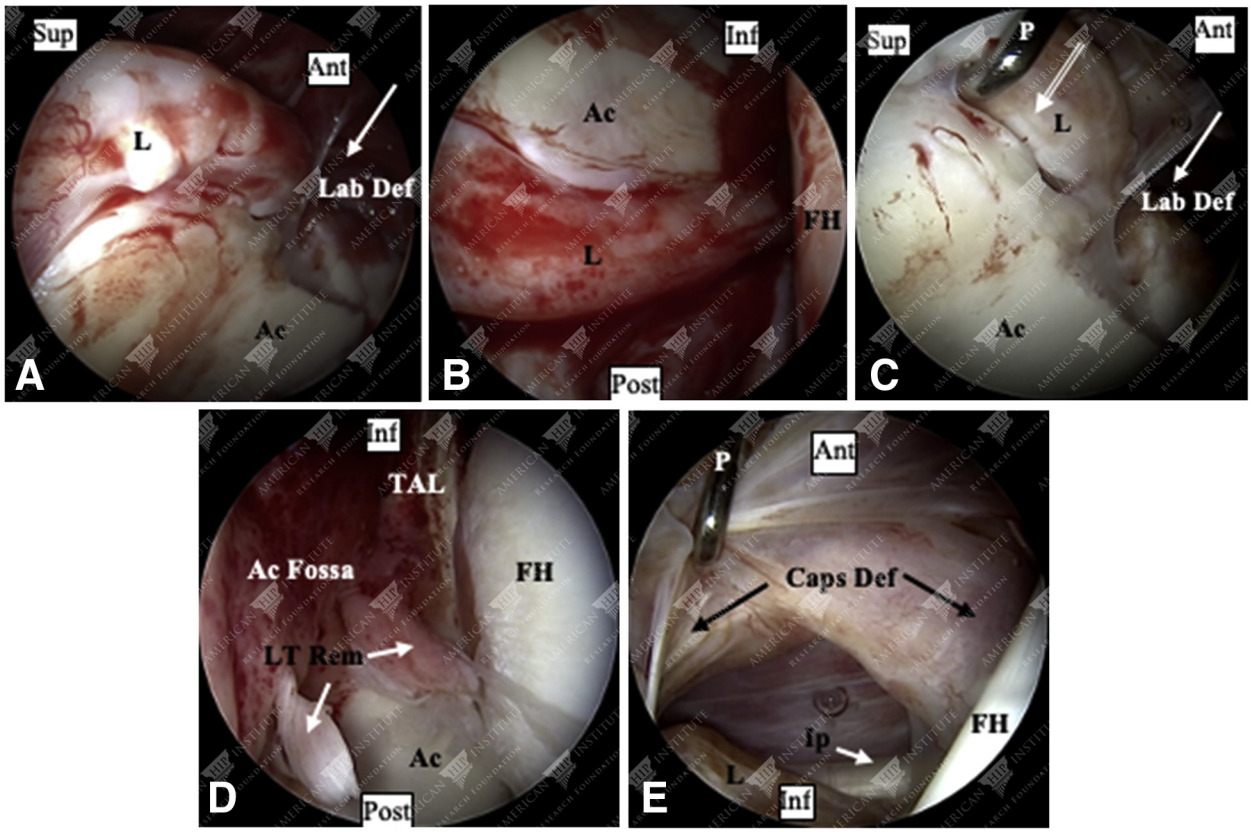

Fig 2. Revision arthroscopic images of right hip. (A, B) Dry view showing labral tear with large capsular-labral separation and segmental defect (arrow) in 12- to 3-o'clock zone (A) and 8- to 12-o'clock zone (B). (C) Large capsular-labral separation (double-line arrow) and segmental defect (single-line arrow) (1- to 4-o'clock zone). (D) Arthroscopic view of right hip showing completely torn ligamentum teres with remnants (arrows). (E) Deficient anterosuperior joint capsule (black arrows). The iliopsoas tendon (Ip, white arrow) is easily seen in the foreground at the bottom of the image. Orientations are marked for reference. (Ac, acetabulum; Ant, anterior; Caps Def, capsular defect; FH, femoral head; Inf, inferior; L, labrum; Lab Def, labral defect; LT Rem, ligamentum teres remnants; P, probe; Post, posterior; Sup, superior; TAL, transverse acetabular ligament.)

Arthroscopic Rim Trimming and Femoroplasty

After the capsule is elevated using an ablator radiofrequency wand, acetabular rim trimming is performed with a 5.5-mm burr under fluoroscopic guidance to create a bleeding edge of bone and encourage healing. Next, the arthroscope and a curved shaver are moved into the peripheral compartment as the traction is released, and the hip is flexed to 45°. Femoroplasty is then performed using a 5.5-mm burr with extensive fluoroscopic visualization.[29]

Arthroscopic Labral Reconstruction With Allograft

Traction is reapplied. The irreparable labrum is removed, and the rim is prepared. An allograft (tibialis posterior tendon) is taken to the back table and prepared in a single-stranded fashion. The anterior end of the graft is anchored first at the 5-o'clock zone, near the anterior end of the transverse acetabular ligament. The graft is then secured with anchors placed sequentially from anterior to posterior, using a total of 6 anchors (1.8-mm knotless FiberTak; Arthrex, Naples, FL). The excess graft is cut off with the Beaver blade and pulled out through the posterolateral portal. Excellent restoration of the continuous labrum is achieved in this fashion (Fig 3, Video 1).[15,16]

Arthroscopic LT Reconstruction With Allograft

The torn LT stump is debrided using an ablation device. A distal inferolateral incision is made, and a trans-trochanteric bone tunnel is drilled over a guidewire exiting through the foveal footprint of the LT under biplanar fluoroscopic guidance. The soft tissue is removed from the cotyloid fossa with the shaver and ablation device, and the LT footprint is decorticated with the burr to create a bleeding bed of bone for healing. A double-stranded tibialis posterior tendon allograft is prepared. The fixation on the acetabular side is kept ready by passing two 1.8-mm knotless FiberTak anchors in a posteroinferior direction at the inferior end of the cotyloid fossa in the footprint of the LT attachment. A passing suture is placed through the anterior portal and retrieved through the femoral tunnel. The graft is then introduced through the anterior portal. The graft is cinched

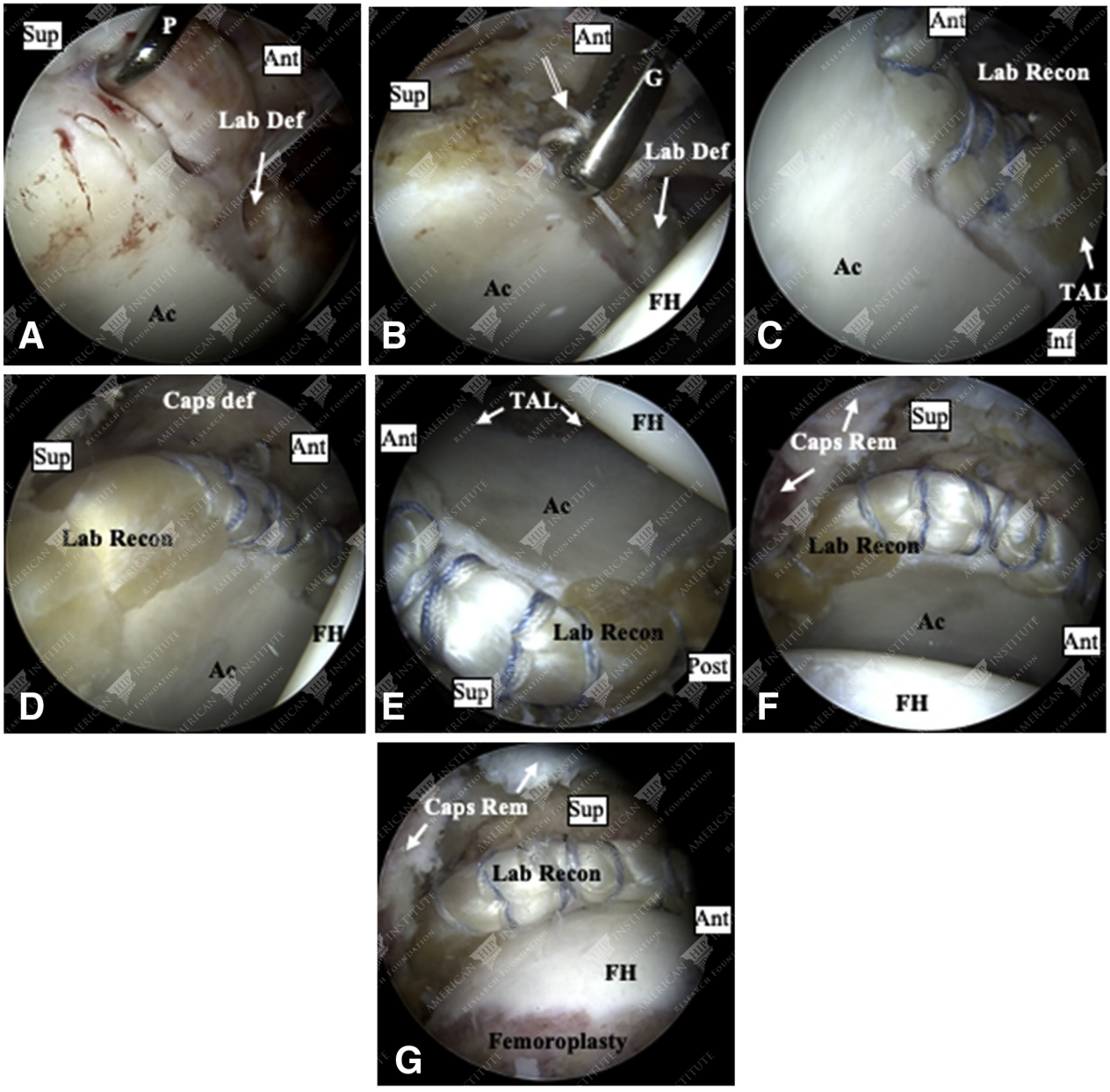

Fig 3. Revision arthroscopic images of right hip. (A) Labral tear with large capsular-labral separation (probe [P] in place) and segmental defect (arrow) (Fig 2C repeated for orientation). (B) Excised labral remnants with residual suture strands held with grasper (double-line arrow) from prior labral repair. The single-line arrow indicates the labral defect. (C-E) Bird's-eye view of circumferential labral reconstruction, from TAL (arrows) insertion points, at 5-o'clock position anteriorly to 7-o'clock position posteriorly. (F, G) Arthroscopic bird's-eye view of circumferential labral reconstruction with traction (F) and without traction (G) in right hip, showing restoration of suction seal against spherical femoroplasty. The arrows indicate the capsular remnant. (Ac, acetabulum; Ant, anterior; Caps def, capsular defect; Caps Rem, capsular remnant; FH, femoral head; G, grasper; Inf, inferior; Lab Def, labral defect; Lab Recon, labral reconstruction; Post, posterior; Sup, superior; TAL, transverse acetabular ligament.)

and secured to the footprint on the cotyloid fossa. The femoral side of the graft is then pulled into the femoral tunnel with the passing suture and fixed with a PEEK (polyether ether ketone) interference screw while the tension on the graft is maintained with the hip in 60° of external rotation. The graft is well positioned in this manner and verified to have appropriate tension when examined through internal and external rotation (Fig 4, Video 1).[30]

Arthroscopic Capsular Reconstruction

The incompetent remnants of the capsule, including the involved parts of the iliofemoral ligament, are excised. The capsular defect is then

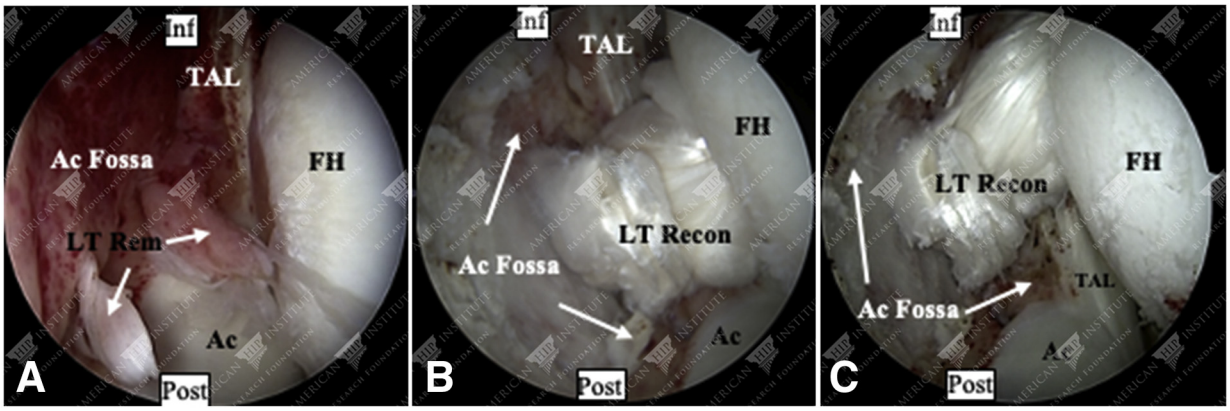

Fig 4. Revision arthroscopic images of acetabular floor in right hip. (A) Completely torn ligamentum teres with remnants (arrows) (Fig 2D repeated for orientation). (B, C) Ligamentum teres reconstruction with hip in neutral rotation (B) and hip in full external rotation (C), showing ligamentum teres fibers' differential tensioning. The arrows indicate the acetabular fossa. (Ac, acetabulum; FH, femoral head; Inf, inferior; LT Rem, ligamentum teres remnants; LT Recon, ligamentum teres reconstruction; Post, posterior; TAL, transverse acetabular ligament.)

measured using a measuring probe. A dermal allograft patch (Arthroflex; Arthrex) is sutured to the free edges of the native capsule using No. 2 SutureTape (Arthrex) to complete the capsular reconstruction. Excellent fill of the capsular defect is achieved in this fashion (Fig 5, Video 1).[31]

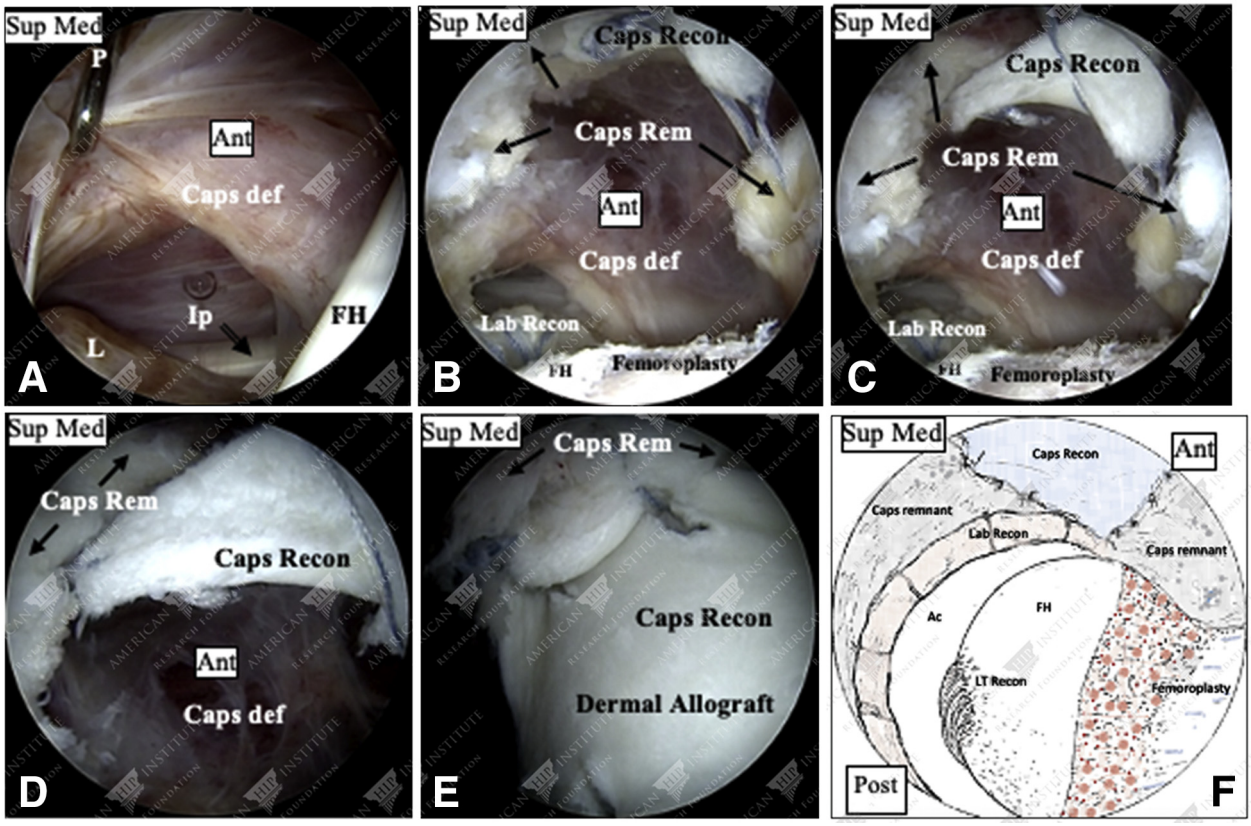

Fig 5. Revision arthroscopic images of right hip. (A) Complete anterosuperior capsular defect area in center and top of image (Fig 2E repeated for orientation). (B-D) Initial steps of capsular reconstruction using dermal allograft (with femoral head at bottom of images). (E) Final step of capsular reconstruction. (F) Triple reconstruction of soft-tissue stabilizers of hip (labral reconstruction, ligamentum teres reconstruction [LT Recon], and capsular reconstruction) (artistic rendering). (Ac, acetabulum; Ant, anterior; Caps def, capsular defect; Caps Rem, capsular remnant; Caps Recon, capsular reconstruction; FH, femoral head; Ip, iliopsoas; L, labrum; Lab Recon, labral reconstruction; P, probe; Post, posterior; Sup Med, superomedial.)

Table 1. Indications and Contraindications for Arthroscopic Triple Reconstruction of Soft-Tissue Stabilizers in Hip Joint

Indications
Iatrogenic and complex triple hip instability with all 3 major static stabilizers compromised
Contraindications
Lack of experience with each reconstruction procedure
Inadequate acetabular bony coverage
Arthritis or significant chondral damage

Closure

The joint is lavaged and sucked dry of fluid. All instruments are withdrawn from the joint. The portals are closed using No. 3-0 nylon sutures. Steri-Strips (3M, St. Paul, MN) and sterile dressings are applied, and the hip is placed in a hip brace locked in 0° to 90° of flexion. The patient is safely awakened and extubated and is taken to the recovery room in stable condition.

Postoperative Rehabilitation

The patient is advised to remain partially weight bearing (20 lb) on the operated extremity using crutches for 6 weeks while continuing to wear the hip brace for postoperative stability for 6 weeks. Physical therapy begins the day after surgery, following all 4 phases as per our previously published protocol.[32,33]

Discussion

This Technical Note describes our preferred method of treatment for triple hip instability if a patient presents with a defective hip joint capsule, labrum, and LT that require reconstruction (Video 1). Gross instability in a non-dysplastic hip is either post-traumatic or, more often, iatrogenic from prior arthroscopy[4-11] with disruption of the soft-tissue stabilizers.[1-3] While commenting on iatrogenic instability, Byrd[11] identified 6 contributing factors. The patient may have all of these factors, placing him or her at increased risk of complex hip instability. First, there may be a loose fragment resulting from the capsular avulsion, putting the hip at risk of becoming under-covered. Second, the labrum may be diminutive, from either repeated injury or aggressive labral debridement during previous hip arthroscopy. Third, the LT could be completely torn. Fourth, there may be a capsular defect that might have resulted from either failed repair or excessive resection during prior arthroscopy in addition to violation from avulsion, resulting in a capsular breach. Fifth, the patient could have been preconditioned to be at risk owing to previous hip arthroscopy. Finally, a new traumatic injury could occur in the patient and could trigger the aforementioned cascade of events. We strongly believe that to effectively manage this type of patient, it is important to recognize complex instability in the setting of revision hip arthroscopy.

A painful limp and a feeling of recurrent subluxation in the affected hip joint are the usual mode of presentation owing to disruption of all the static stabilizers. The primary stabilizers of the hip joint are the capsuloligamentous structures, whereas the labrum and the LT act as secondary stabilizers.[1-3] The hip joint labrum has proprioceptive and nociceptive functions and aids in load distribution. The aim of the different hip labral restoration techniques—repair, augmentation, or reconstruction[34–36]—is to help maintain intra-articular fluid pressurization.[12-14] Torn labra with viable tissue quality and good volume can be repaired to restore the transition zone and suction seal.[35,37] However, it is not too uncommon for most of the

Table 2. Advantages and Disadvantages of Arthroscopic Triple Reconstruction of Soft-Tissue Stabilizers in Hip Joint

Advantages
Addresses complex triple hip instability by restoring all static stabilizers
Follows principles of restoration of anatomy
Single-stage procedure
Disadvantages
Technically demanding procedure with steep learning curve
Potential for major complications with individual and combined procedures
- Labral reconstruction: sciatic neurapraxia from traction (early) and/or iatrogenic dysplasia from over-resection
- LT reconstruction: pelvic floor neurovascular injury (early) and/or stress injury to femoral neck
- Capsular reconstruction: abdominal compartment syndrome (early) and/or postoperative instability

LT, ligamentum teres.

Table 3. Pearls and Pitfalls for Arthroscopic Triple Reconstruction of Soft-Tissue Stabilizers in Hip Joint

Pearls
Femoroplasty before reconstruction
Multiple allografts simultaneously kept readily available in operating room
LT reconstruction first, followed by labral reconstruction and, finally, capsular reconstruction
Intermittent release of traction during and between the 3 reconstruction procedures
Pitfalls
Risk of prolonged surgery and anesthesia time
Complex nature of procedure with 3 major reconstructions
Multiple allografts needed
Steep learning curve

LT, ligamentum teres.

Table 4. Risk and Limitations of Arthroscopic Triple Reconstruction of Soft-Tissue Stabilizers in Hip Joint

Risks
Risk of sciatic nerve injury if traction time is prolonged
Abdominal compartment syndrome if intra-abdominal fluid extravasation occurs
Limitations
Cost and availability of various graft sources
Inability to compensate for deficient acetabular bony coverage

soft-tissue stabilizers to be grossly damaged and irreparable in the revision setting.

Reconstruction may be indicated for a degenerative labrum with a calcified or ossified labral segment or a labrum that is irreparably torn with nonviable tissue.[36,38] Likewise, a hypotrophic labrum, a previously debrided labrum that is reduced in effective depth and volume, or a segmental defect that disrupts the labral seal may be addressed with labral reconstruction.[15,16,39-41] Segmental labral reconstruction is an option when there is a missing section of labral tissue or a segment with no viable fibers.[12,13,39] Circumferential labral reconstruction is a technically reproducible and reliable method that not only maintains continuous hoop stress circumferentially but also replaces potentially pain-generating damaged native labral tissue.[15,16,34] However, it has a steep learning curve and is technically demanding.

In addition to the labrum, the capsuloligamentous structures are primary stabilizers that deter any dislocating force on the hip joint.[1-3] After breakage of the suction seal, the capsule may be the most important structure resisting distraction.[1,3,9,42] Various capsular management strategies concerning repair of the iliofemoral ligament and avoidance of zona orbicularis injury were described earlier in the literature and remain valid options in the primary hip arthroscopy setting.[20-23] However, reports of iatrogenic hip dislocation or recurrent subluxation after hip arthroscopy may relate to underlying damage to the hip joint capsule from aggressive resection or inefficient capsular management strategies.[4-11] The resulting capsular defect thus precludes definitive repair. Capsular reconstruction is a valid option in this setting, and different graft choices are available, each with its advantages and disadvantages.[31,43-46] Finally, the role of the LT in adding to hip joint stability has been well recognized.[1,17] Several studies have reported the efficacy of LT debridement, making it an accepted standard of care in earlier published reports.[18,47,48] However, LT reconstruction has gained popularity recently.[17,19,30,49] Reconstruction of the torn LT has become an established method to add secondary stability while addressing labral defects in hip microinstability.[19,24,30]

Hip joint capsular defects, a completely torn LT, and an irreparable labrum together may present as a grossly unstable hip. We believe that our method is a safe and effective method that is reproducible when performed using the proper, stepwise technique for arthroscopic triple reconstruction of the labrum, LT, and capsule described in this article. There are some contraindications for this technique, as well as a few disadvantages, pitfalls, risks, and limitations, as addressed in Tables 1 through 4.

In conclusion, complex instability of the hip from combined damage to primary (capsuloligamentous structures) and secondary (labrum and LT) stabilizers can present as hip pain with recurrent subluxation. The cause of this type of presentation can be post-traumatic or, more often, iatrogenic after previous hip arthroscopy. Concomitant reconstruction of the damaged labrum, LT, and capsule is the definitive treatment for this type of triple instability. This approach not only ensures joint stability by restoring the anatomy but also prevents further damage to the articular cartilage.

References

1. Ng KCG, Jeffers JRT, Beaulé PE. Hip joint capsular anatomy, mechanics, and surgical management. *J Bone Joint Surg Am* 2019;101:2141-2151.
2. Bsat S, Frei H, Beaulé PE. The acetabular labrum: A review of its function. *Bone Jt J* 2016;98-B:730-735.
3. Telleria JJM, Lindsey DP, Giori NJ, Safran MR. A quantitative assessment of the insertional footprints of the hip joint capsular ligaments and their spanning fibers for reconstruction. *Clin Anat* 2014;27:489-497.
4. Matsuda DK. Acute iatrogenic dislocation following hip impingement arthroscopic surgery. *Arthroscopy* 2009;25:400-404.
5. Benali Y, Katthagen BD. Hip subluxation as a complication of arthroscopic debridement. *Arthroscopy* 2009;25:405-407.
6. Sansone M, Ahldén M, Jónasson P, Swärd L, Eriksson T, Karlsson J. Total dislocation of the hip joint after arthroscopy and ileopsoas tenotomy. *Knee Surg Sports Traumatol Arthrosc* 2013;21:420-423.
7. Austin DC, Horneff JG, Kelly JD. Anterior hip dislocation 5 months after hip arthroscopy. *Arthroscopy* 2014;30:1380-1382.
8. Wylie JD, Beckmann JT, Aoki SK. Dislocation after hip arthroscopy for cam-type femoroacetabular impingement leading to progressive arthritis. *JBJS Case Connect* 2015;5:e80.
9. Duplantier NL, McCulloch PC, Nho SJ, Mather RC III, Lewis BD, Harris JD. Hip dislocation or subluxation after hip arthroscopy: A systematic review. *Arthroscopy* 2016;32:1428-1434.
10. Yeung M, Memon M, Simunovic N, Belzile E, Philippon MJ, Ayeni OR. Gross instability after hip arthroscopy: An analysis of case reports evaluating surgical and patient factors. *Arthroscopy* 2016;32:1196-1204.e1.
11. Byrd JWT. Editorial commentary: Iatrogenic instability of the hip: A perfect storm. *Arthroscopy* 2016;32:1205-1206.
12. Philippon MJ, Nepple JJ, Campbell KJ, et al. The hip fluid seal—Part I: The effect of an acetabular labral tear, repair, resection, and reconstruction on hip fluid pressurization. *Knee Surg Sports Traumatol Arthrosc* 2014;22:722-729.
13. Nepple JJ, Philippon MJ, Campbell KJ, et al. The hip fluid seal—Part II: The effect of an acetabular labral tear, repair, resection, and reconstruction on hip stability to distraction. *Knee Surg Sports Traumatol Arthrosc* 2014;22:730-736.
14. Cadet ER, Chan AK, Vorys GC, Gardner T, Yin B. Investigation of the preservation of the fluid seal effect in the repaired, partially resected, and reconstructed acetabular labrum in a cadaveric hip model. *Am J Sports Med* 2012;40:2218-2223.

15. Maldonado DR, Lall AC, Walker-Santiago R, et al. Hip labral reconstruction: Consensus study on indications, graft type and technique among high-volume surgeons. *J Hip Preserv Surg* 2019;6:41-49.
16. Domb BG, Kyin C, Rosinsky PJ, et al. Circumferential labral reconstruction for irreparable labral tears in the primary setting: Minimum 2-year outcomes with a nested matched-pair labral repair control group. *Arthroscopy* 2020;36:2583-2597.
17. de Sa D, Phillips M, Philippon MJ, Letkemann S, Simunovic N, Ayeni OR. Ligamentum teres injuries of the hip: A systematic review examining surgical indications, treatment options, and outcomes. *Arthroscopy* 2014;30: 1634-1641.
18. Amenabar T, O'Donnell J. Successful treatment of isolated, partial thickness ligamentum teres (LT) tears with debridement and capsulorrhaphy. *Hip Int* 2013;23:576-582.
19. O'Donnell J, Klaber I, Takla A. Ligamentum teres reconstruction: Indications, technique and minimum 1-year results in nine patients. *J Hip Preserv Surg* 2020;7: 140-146.
20. Bedi A, Galano G, Walsh C, Kelly BT. Capsular management during hip arthroscopy: From femoroacetabular impingement to instability. *Arthroscopy* 2011;27:1720-1731.
21. Harris JD. Capsular management in hip arthroscopy. *Clin Sports Med* 2016;35:373-389.
22. Ekhtiari S, de Sa D, Haldane CE, et al. Hip arthroscopic capsulotomy techniques and capsular management strategies: A systematic review. *Knee Surg Sports Traumatol Arthrosc* 2017;25:9-23.
23. Domb BG, Philippon MJ, Giordano BD. Arthroscopic capsulotomy, capsular repair, and capsular plication of the hip: Relation to atraumatic instability. *Arthroscopy* 2013;29:162-173.
24. Chandrasekaran S, Martin TJ, Close MR, Suarez-Ahedo C, Lodhia P, Domb BG. Arthroscopic reconstruction of the ligamentum teres: A case series in four patients with connective tissue disorders and generalized ligamentous laxity. *J Hip Preserv Surg* 2016;3:358-367.
25. Maldonado DR, Chen JW, Yelton MJ, et al. Achieving successful outcomes of hip arthroscopy in the setting of generalized ligamentous laxity with labral preservation and appropriate capsular management: A propensity matched controlled study. *Am J Sports Med* 2020;48:1625-1635.
26. Lall AC, Saadat AA, Battaglia MR, Maldonado DR, Perets I, Domb BG. Perineal pressure during hip arthroscopy is reduced by use of Trendelenburg: A prospective study with randomized order of positioning. *Clin Orthop Relat Res* 2019;477:1851-1857.
27. Seldes RM, Tan V, Hunt J, Katz M, Winiarsky R, Fitzgerald RH. Anatomy, histologic features, and vascularity of the adult acetabular labrum. *Clin Orthop Relat Res* 2001;(382):232-240.
28. Outerbridge RE. The etiology of chondromalacia patellae. *J Bone Joint Surg Br* 1961;43-B:752-757.
29. Lall AC, Annin S, Chen JW, et al. Achieving a perfectly spherical femoroplasty: Pearls, pitfalls, and optimal surgical technique. *Arthrosc Tech* 2020;9:e303-e313.
30. Maldonado DR, Chen JW, Lall AC, et al. Arthroscopic ligamentum teres reconstruction using anterior tibialis allograft and the tension-slide technique. *Arthrosc Tech* 2019;8:e1075-e1083.
31. Perets I, Hartigan DE, Walsh JP, Chaharbakhshi E, Close MR, Domb BG. Arthroscopic capsular reconstruction of the hip with acellular dermal extracellular matrix: Surgical technique. *Arthrosc Tech* 2016;5:e1001-e1005.
32. Domb BG, Sgroi TA, VanDevender JC. Physical therapy protocol after hip arthroscopy: Clinical guidelines supported by 2-year outcomes. *Sports Health* 2016;8: 347-354.
33. Ankem HK, Yelton MJ, Lall AC, et al. Structured physical therapy protocols following hip arthroscopy and their effect on patient-reported outcomes—A systematic review of the literature. *J Hip Preserv Surg* 2020;7:357-377.
34. Domb BG, El Bitar YF, Stake CE, Trenga AP, Jackson TJ, Lindner D. Arthroscopic labral reconstruction is superior to segmental resection for irreparable labral tears in the hip: A matched-pair controlled study with minimum 2-year follow-up. *Am J Sports Med* 2014;42:122-130.
35. Domb BG, Yuen LC, Ortiz-Declet V, Litrenta J, Perets I, Chen AW. Arthroscopic labral base repair in the hip: 5-Year minimum clinical outcomes. *Am J Sports Med* 2017;45:2882-2890.
36. Locks R, Chahla J, Frank JM, Anavian J, Godin JA, Philippon MJ. Arthroscopic hip labral augmentation technique with iliotibial band graft. *Arthrosc Tech* 2017;6: e351-e356.
37. Maldonado DR, Chen SL, Chen JW, et al. Prospective analysis of arthroscopic hip anatomic labral repair utilizing knotless suture anchor technology: The controlled-tension anatomic technique at minimum 2-year follow-up. *Orthop J Sports Med* 2020;8: 232596712093507.
38. Godin JA, Fagotti L, Briggs KK, Philippon MJ. Labral augmentation with native tissue preservation with a 7.5-year follow-up: A case report. *JBJS Case Connect* 2018;8:e21.
39. Lee S, Wuerz TH, Shewman E, et al. Labral reconstruction with iliotibial band autografts and semitendinosus allografts improves hip joint contact area and contact pressure: An in vitro analysis. *Am J Sports Med* 2015;43:98-104.
40. Atzmon R, Radparvar JR, Sharfman ZT, Dallich AA, Amar E, Rath E. Graft choices for acetabular labral reconstruction. *J Hip Preserv Surg* 2018;5:329-338.
41. Chahla J, Soares E, Bhatia S, Mitchell JJ, Philippon MJ. Arthroscopic technique for acetabular labral reconstruction using iliotibial band autograft. *Arthrosc Tech* 2016;5: e671-e677.
42. Kalisvaart MM, Safran MR. Microinstability of the hip-it does exist: Etiology, diagnosis and treatment. *J Hip Preserv Surg* 2015;2:123-135.

43. Chahla J, Dean CS, Soares E, Mook WR, Philippon MJ. Hip capsular reconstruction using dermal allograft. *Arthrosc Tech* 2016;5:e365-e369.
44. Trindade CAC, Sawyer GA, Fukui K, Briggs KK, Philippon MJ. Arthroscopic capsule reconstruction in the hip using iliotibial band allograft. *Arthrosc Tech* 2015;4:e71-e74.
45. Fagotti L, Kemler BR, Utsunomiya H, et al. Effects of capsular reconstruction with an iliotibial band allograft on distractive stability of the hip joint: A biomechanical study. *Am J Sports Med* 2018;46:3429-3436.
46. Kurz AZ, Memon M, Williams D, Ayeni OR. Anterior capsule reconstruction of the native hip: A technique guide. *Arthrosc Tech* 2019;8:e1247-e1253.
47. Byrd JWT, Jones KS. Traumatic rupture of the ligamentum teres as a source of hip pain. *Arthroscopy* 2004;20:385-391.
48. Haviv B, O'Donnell J. Arthroscopic debridement of the isolated ligamentum teres rupture. *Knee Surg Sports Traumatol Arthrosc* 2011;19:1510-1513.
49. Brady AW, Chahla J, Locks R, et al. Arthroscopic reconstruction of the ligamentum teres: A guide to safe tunnel placement. *Arthroscopy* 2018;34:144-151.