Technical Note

Hip Capsular Reconstruction With Indirect Head of the Rectus Femoris Tendon

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Abstract: Hip capsulotomy is performed during arthroscopic hip procedures to achieve adequate visualization of the joint and instrument access. The hip capsule, and in particular the iliofemoral ligament, is an important stabilizer of the hip joint, and patients who undergo capsulotomy without subsequent repair may experience hip pain and instability, with increased risk of requiring revision hip arthroscopy. Therefore, restoring watertight closure of the capsule is necessary to restore native biomechanics and achieve desired postoperative outcomes. Although primary repair or plication suffice in most cases, capsule reconstruction may instead be necessary when there is insufficient tissue, often due to capsular insufficiency following index surgery. The purpose of this Technical Note is to describe the authors' current technique for arthroscopic hip capsular reconstruction using the indirect head of the rectus femoris tendon in the setting of capsular iatrogenic hip instability, as well as its advantages and disadvantages and technical pearls and pitfalls.

Arthroscopic hip joint preservation procedures have increased dramatically in the past decade as a treatment to a wide range of intra-articular conditions, primarily femoroacetabular impingement (FAI) and labral pathology.[1-3] An important procedural step in hip arthroscopy is the capsulotomy, which allows for appropriate visualization and necessary instrument access.[4,5] The hip capsule and in particular the iliofemoral ligament, however, are important static stabilizers of the hip joint. Consequently, as the number of hip arthroscopy cases grows, so too does the incidence of capsular iatrogenic hip instability.[6-8]

In light of this scenario, capsular management during hip arthroscopy has been a subject of great discussion. While historically the capsule had been left unrepaired following hip arthroscopy, there has been a paradigm shift to a growing tendency favoring complete capsular repair, as the biomechanical role of the capsule and the clinical benefit of repair are increasingly highlighted in recent literature.[9-13] Although frank hip dislocation is uncommon, patients with capsular insufficiency will experience microinstability of the hip, which often causes hip pain and subjective instability.[6,14] This pattern of increased micromotion leads to degeneration of the articular cartilage and labrum, ultimately resulting in hip osteoarthritis.[7] In addition, current literature shows that those undergoing complete repair of T-capsulotomy have demonstrated significantly improved patient-reported outcomes over those who underwent only partial repair.[10,11] Furthermore, recent evidence demonstrates that patients who underwent capsular closure after hip arthroscopy for FAI had a greater probability of achieving clinically significant improvement in hip-specific function than those who underwent capsulotomy without repair.[15,16]

While most cases are managed with primary capsule repair or plication, larger capsular defects may require a

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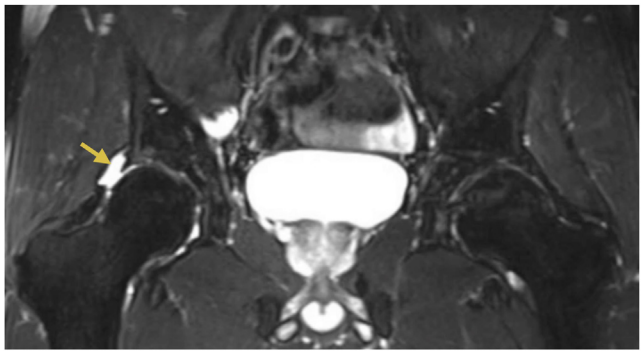

Fig 1. Magnetic resonance image of right hip capsular deficiency, visualized as fluid extravasation on T2-weighted coronal cut.

reconstruction to obtain watertight closure and thus restore native hip stability.[9,17] Although there is still no consensus in terms of indications, capsular reconstruction is recommended in patients with a symptomatic capsular deficiency, when removal of capsular adhesions results in deficiency, or in patients reporting pain and range of motion deficits due to capsular adhesions.[17]

In this Technical Note, we describe a technique for arthroscopic hip capsular reconstruction using the indirect head of the rectus femoris tendon (Video 1), as well as its advantages and disadvantages and technical pearls and pitfalls.

Surgical Technique (With Video Illustration)

Preoperative Patient Evaluation

Patient history commonly consists of lack of improvement or persisting symptoms following primary hip arthroscopy. Patients with microinstability of the hip can report a history of clicking, locking, catching, giving way or anterior pain in the affected hip, particularly with extension and external rotation.[3,18] During physical examination, more than 70% of patients will exhibit pain, laxity, or apprehension upon axial distraction test.[6] A positive dial test also has been found to correlate with capsular insufficiency.[18,19] Preoperative radiographs must include a classic anteroposterior view with center-edge angle measured, as well as a 45° Dunn view with alpha angle measured to detect features compatible of remaining

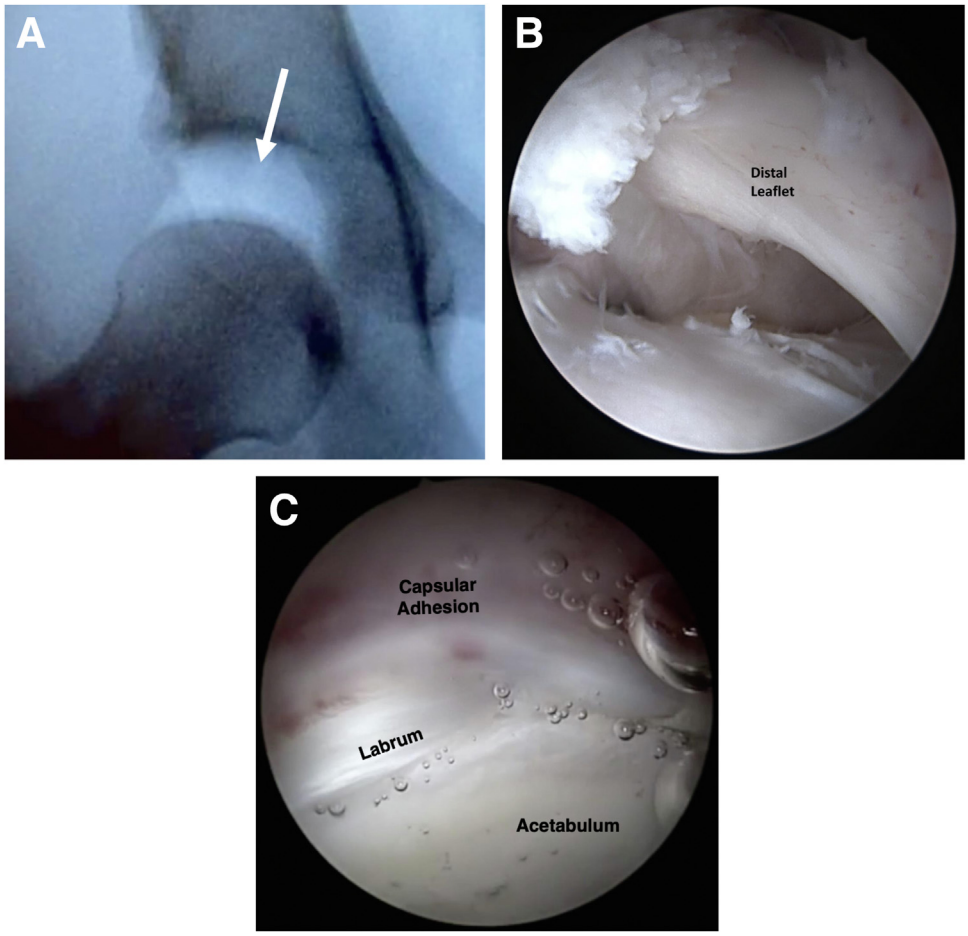

Fig 2. Right hip capsular insufficiency and instability to distraction forces, reflected by ample joint space opening even upon gentle distraction on the hip arthroscopy table (A). Diagnostic arthroscopy will reveal retracted capsular leaflets (B) from unrepaired capsulotomy during index surgery, as well as capsular adhesions occluding the plane between labrum and capsule (C).

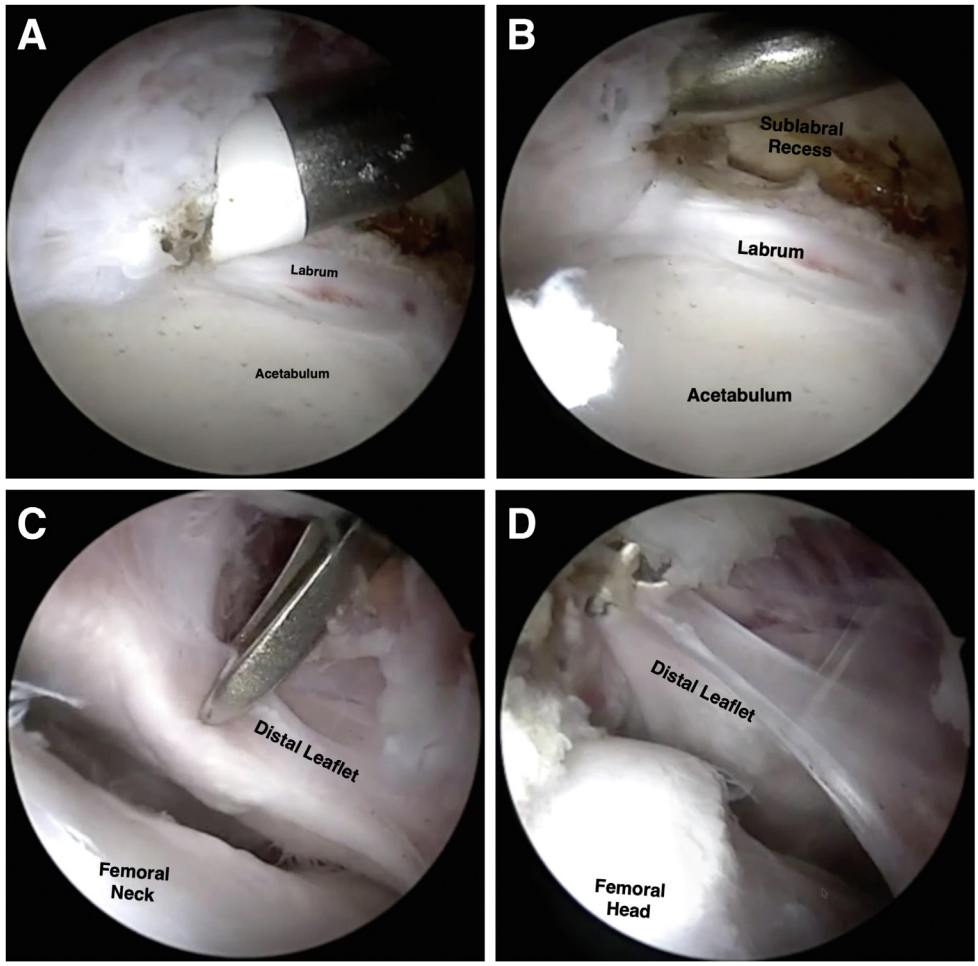

Fig 3. Right hip release of adhesions and mobilization of the remaining capsular tissue. The proximal leaflet should be dissected off the labrum (A and B), while the distal leaflet is dissected off the extracapsular surface in order to achieve maximum mobilization (C and D).

femoroacetabular impingement.[6,20] In addition, a magnetic resonance imaging (MRI) study will often reveal substantial extravasation of fluid indicative of capsular insufficiency (Fig 1). Concomitant articular pathology that will need to be addressed such as labral tears and cartilage damage can be ascertained on MRI.[7,21] If capsular insufficiency is associated with a history of a previous procedure, intraoperative arthroscopic images from the previous surgery must always be obtained for review of the capsular management during index surgery.

Anesthesia and Positioning

The patient is placed supine on a standard hip arthroscopy table, under general endotracheal anesthesia. To secure the patient's position during distraction and throughout the case, either a padded perineal post or a post-free pink pad device may be used (Smith & Nephew, London, United Kingdom).[5] In the setting of capsular insufficiency, ample distraction of the joint will be achieved with minimal effort, reflecting loss of the biomechanical resistance to distraction (Fig 2A).

Approach and Exposure

We routinely use a 3-portal technique with a standard anterolateral portal, a modified mid-anterior portal, and a distal anterolateral accessory portal. A thorough diagnostic arthroscopy is performed. Optimal exposure of the native capsule remnants is crucial, ensuring that the quality of the remaining tissue is adequately evaluated. Meticulous dissection of adipose and muscle tissue off of proximal and distal leaflets of the capsule are frequently required. Capsular defects and retracted capsular leaflets (Fig 2B) are then visualized and sized. These will be often accompanied by capsular adhesions (Fig 2C), which can occlude the plane between labrum and capsule. Scar tissue should be debrided, preferably with the use of a radiofrequency wand, to minimize damage to intact viable tissue.

Central Compartment

With the hip still in traction, central compartment pathology can be identified and addressed. In cases in which there is remaining pincer deformity, acetabuloplasty is performed in standard fashion. Adequate rim

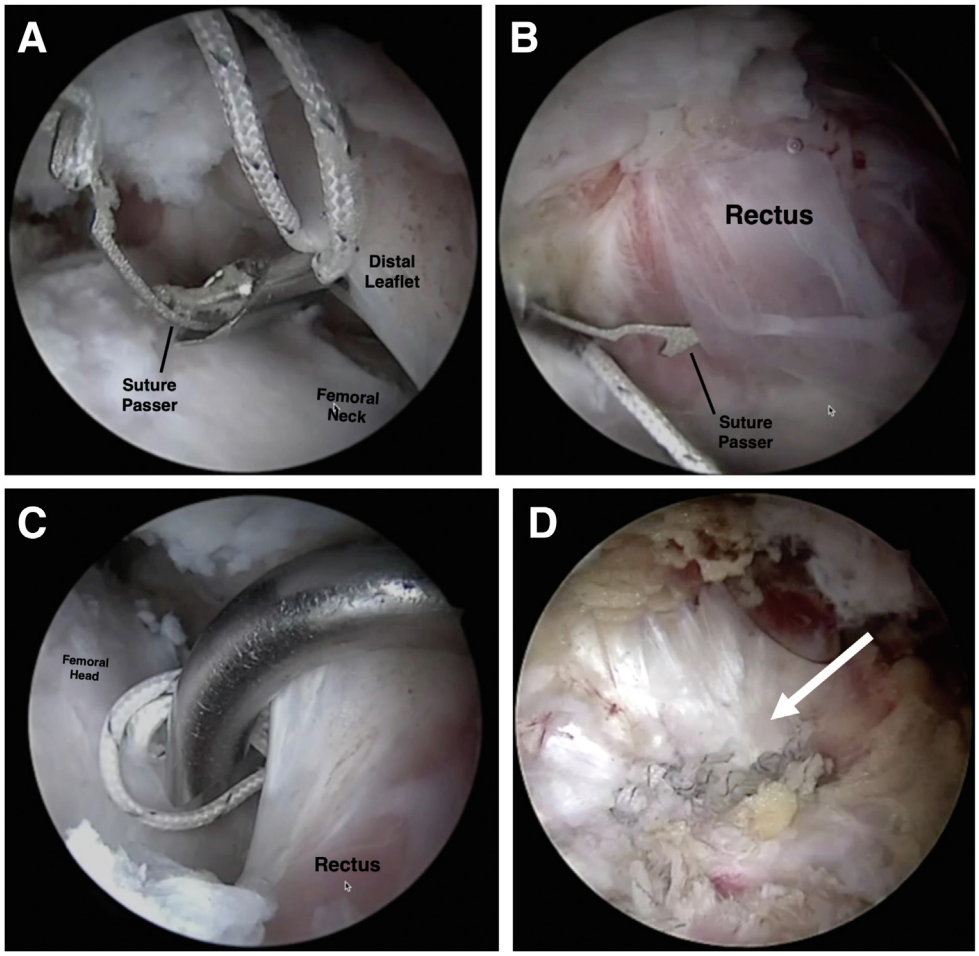

Fig 4. Right hip capsular reconstruction. Sequential closure of the capsule with the aid of a suture passer through the distal leaflet (A) and using the indirect head of the rectus tendon to replace the proximal leaflet in the construct (B). Sequential closure (C) is carried out until watertight closure is achieved (D).

preparation also should be confirmed or carried out where labral pathology exists prior to repair. In the context of revision hip arthroscopy, there is the added risk of the remaining labral tissue being hypoplastic or containing segmental defects, and thus not being amenable to simple repair. The labrum can then be augmented or reconstructed, depending on the quality of the tissue and the status of the suction seal.

Peripheral Compartment

Once labral and other intra-articular pathologies are addressed, hip traction is released. Abnormal bony morphology of the femur consistent with persistent cam-type FAI should be addressed with balanced femoroplasty. Dynamic examination of fluoroscopic imaging in extension and flexion, each combined with neutral, internal, and external rotation, is used to confirm that the entire cam deformity has been excised and that no evidence of bony impingement remains.

Mobilization and Reconstruction of the Capsule

With the hip brought into flexion, the capsule is then thoroughly debrided until healthy tissue is observed proximally and distally, with attention to both the intra-articular and extra-articular aspects. The native capsular leaflets are examined to determine tissue quality and viability for use in primary repair or plication. In cases where a deficient proximal capsule is seen and the distal (lateral) leaflet is sitting laterally, a reconstruction of the capsular tissue can be performed using the indirect head of the rectus femoris as the capsular defect matches the position of the tendon (Fig 2B). Adhesions are then debrided to allow for maximum tissue mobilization (Fig 3 A-D). On the proximal acetabular side, the remaining viable tissue should be dissected off the labrum and rectus tendon, whereas on the distal femoral side, the remaining capsule is debrided on the extracapsular space. The indirect head of the rectus femoris tendon is identified medially while viewing from the modified mid-anterior portal and used to replace the proximal leaflet. The anterolateral portal serves here as the main working portal. Sequential passage of high-strength sutures (ULTRABRAID; Smith & Nephew) is carried out with aid of a 70° suture passer (CAP-FIX, Smith & Nephew) and injector (Pivot Injector II; Stryker, Kalamazoo, MI),

Table 1. Pearls and Pitfalls

Pearls
• Thorough debridement of scar tissue and dissection of the capsule leaflets to maximize tissue mobilization
• Preferential use of radiofrequency to minimize damage to viable remaining capsule
• Use of curved/angulated suture passer
• Use of arthroscopic cannula to prevent soft-tissue bridge and suture entanglement
• Dynamic fluoroscopic assessment with distraction before and after reconstruction
• After the reconstruction, put the hip through gentle range of motion to ascertain capsule tension and prevent loss of extension
Pitfalls
• Failure to release adhesions and adequately mobilize the entirety of the remaining viable tissue, thus overestimating the capsular defect size
• Relying on degenerative and suboptimal tissue for primary capsular repair
• Excessive capsule tension, resulting in loss of range of motion

incorporating the rectus tendon in the construct (Fig 4 A-C). Each suture is secured with manual knot tying aided by an arthroscopic knot pusher and cutter. The number of sutures necessary will depend on the size of the defect and achievement of a watertight closure (Fig 4D). It is paramount that the joint is taken through gentle range of motion, whereas a direct arthroscopic view ensures construct stability and no excessive tension restricting hip extension. Re-establishment of the hip stability can be confirmed through distraction under dynamic fluoroscopy.

Postoperative Care

Initially, weight-bearing restrictions are to 20 lbs of foot flat weight bearing for 3 weeks. A hip brace is worn to limit excessive extension and external rotation until the patient discontinues the use of crutches—generally approximately 3 to 4 weeks when gait is pain-free and noncompensatory. Night-time padding is additionally used during the first 2 weeks to prevent accidental rotation while asleep. Physical therapy should start ideally on postoperative day 1. Within the constraints of capsule protection, there should be an emphasis on early passive hip mobilization in an effort to prevent adhesions. A continuous passive motion machine may be used, initially set at 30° of extension to 70° of flexion, with maximum daily increments of 7-8° as tolerated. Extension and external rotation are limited to 0° and 30°, respectively, during the first 3 weeks. Symmetric range of motion should be attained at 6 to 8 weeks.

Progression of exercises is carried out in a gradual manner, with more functional exercises generally allowed after 8 weeks if the patient exhibits good control. Transition to running usually takes place at 4 months postsurgery, whereas sports-specific gestures and full participation is not advised before 6 to 8 months.

Table 2. Advantages and Disadvantages

Advantages
• Restores resistance to distraction, minimizing the risk of postoperative microinstability
• Decreased operating time relative to free graft techniques, as graft preparation and insertion are obviated
• Not limited by allograft availability or elevated cost
• Does not require additional portals, which frequently are needed in alternative capsule reconstruction techniques
• Does not require the use of additional implants
Disadvantages
• Applicable to focal capsular defects only (and not global deficiency)
• Potential weakening of the attachment of the indirect head of the rectus
• Limited outcome data in the literature
• Technically demanding procedure

Discussion

The integrity of the hip capsule has become a cornerstone in hip-preservation surgery as the result of increasing evidence on the role of the capsule in maintaining native hip biomechanics.[11] The capsular status is one of the crucial factors in the ability of the hip to resist distraction forces, second only to the suction seal mechanism of the chondrolabral junction against the femoral head.[1] Furthermore, the iliofemoral ligament, the strongest of the described capsule components, restrains anterior translation, particularly with hip extension and external rotation.[3,22]

Emerging evidence has demonstrated that large capsulotomies, and absent or inefficient capsular closure, correlate with iatrogenic instability following primary hip arthroscopy.[2,23] A recent study by Cancienne et al.[8] found that more than one half of patients undergoing revision hip arthroscopy had MRI or intraoperative evidence of capsular incompetence.

As a part of the growing literature highlighting capsular management in the setting of iatrogenic insufficiency, several techniques have been described to reconstruct the hip capsule. Multiple biomechanical investigations have found that capsular reconstruction is able to provide significant increases in distractive and rotational stability, restoring hip kinematics to a state comparable with intact or repaired capsules.[24-26] A recent study by Fagotti et al.[27] has echoed those ex vivo biomechanical findings, showing postoperative improvement in clinical outcomes after hip capsular reconstruction at 2-year follow up. A wide array of graft and technical approaches have been described as options for reconstruction, including the use of dermal allograft[17,19,28] iliotibial band allograft,[29,30] Achilles allograft,[31] and bioinductive collagen implants,[32] among others.

This Technical Note describes the use of the proximal rectus femoris for hip capsule reconstruction, which capitalizes on the close anatomical relation of its

indirect head, attached to the superior acetabular ridge and the hip joint capsule.[33] Our proposed technique provides a reconstruction option not limited by cost or availability of implants and allografts, does not require additional portals or incisions, and ultimately may result in decreased operative time relative to the previously described techniques for reconstruction—as the graft preparation and intra-articular insertion steps are obviated (Tables 1 and 2). Biomechanical investigation of the construct's stability relative to alternative methods, as well as subjective and objective patient outcome studies, are needed to adequately validate hip capsule reconstruction with the indirect head of the rectus femoris tendon.

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