Anatomic Arthroscopic Ligamentum Teres Reconstruction for Hip Instability

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Abstract: There has been growing interest in recent years on the functional importance of the ligamentum teres and its role in hip stability. Partial or complete tearing has previously been treated with debridement or radiofrequency ablation with good results; however, a subset of patients will continue to experience persistent pain or instability with injury to this structure. Advances in arthroscopic instruments and techniques have led to our ability to provide improved care for these patients by performing a ligamentum teres reconstruction. The purpose of this technical note is to describe our method of ligamentum teres reconstruction with a tibialis anterior allograft.

The ligamentum teres (LT) is a pyramidal structure that acts as a static restraint between the femoral head and acetabular fossa, and is an important component in maintaining the stability of the hip. As the applications of hip arthroscopy continue to expand, so does the interest in the function and biomechanical properties of the LT, as well as associated symptoms after injury to this structure. Prior literature has shown its tensile strength to be similar to that of the anterior cruciate ligament,[1] and interestingly, the LT becomes taught with the hip in flexion, adduction, and external rotation, which corresponds to the position in which the hip is least stable.[2]

Injury of the LT is thought to be a potential source of pain, instability, and decreased function of the hip joint.[3] The incidence of LT tears in patients undergoing arthroscopy has been found to be as high as 51%. Tears are classified as type 1 (complete), type 2 (partial), or type 3 (degenerative).[4,5] In addition to injury of the ligament itself, continued instability after LT injury may lead to the development of labral tearing, osteochondral damage, or other degenerative changes. A recent study by Kaya et al.[6] found an association between LT injury and a characteristic pattern of articular cartilage damage involving the inferior middle part of the acetabulum and the apex of the femoral head.

The role of the LT may be especially important in patients with dysplasia of the hip or joint hypermobility,[7] because deficiency of the normal bony architecture and/or soft tissue restraints about the hip can lead to increased reliance on the LT as a secondary stabilizer.

Treatment of LT injuries has been the subject of much recent debate. Debridement of both complete and partial tears with radiofrequency ablation has shown excellent results in most individuals; however, there remains a subset of patients who continue to have persistent pain and instability in the setting of a complete LT tear. For these patients, reconstruction of the LT is indicated to restore stability and increase function.

The purpose of this technical note is to detail our surgical technique used to perform an LT reconstruction using a tibialis anterior allograft in the supine position.

Objective Diagnosis

Two clinical tests have been previously reported to evaluate LT pathology. The axial traction apprehension test and the external rotation dial test can be helpful in identifying hip laxity. Although these tests are not specific for detecting an injury to the LT, they can alert

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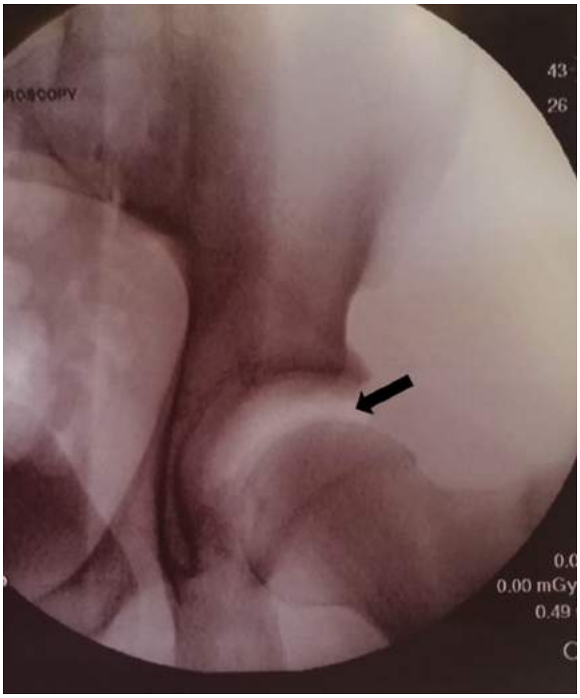


Fig 1. Intraoperative radiograph of a left hip verifying adequate joint distraction, as shown by the "vacuum" sign (arrow). A minimum of 10 mm of distraction is recommended for access to the central compartment to avoid chondral damage with instrument placement.

the examining physician to instability related to either LT or capsular deficiency.

Anteroposterior pelvis, cross-table lateral, and false profile radiographs are also obtained to assess for acetabular coverage, cam or pincer deformity, and remaining joint space. Magnetic resonance imaging scans are then obtained using a 3-tesla magnet without intra-articular contrast to evaluate for the presence of chondral, labral, or ligamentous pathology. In addition, magnetic resonance imaging allows for specific evaluation of the LT, including identification of complete or partial tears and scarring. Intraoperatively, a radiological "vacuum" sign, seen as a diastasis between the femoral head and the acetabulum with the application of traction on the lower extremity, can also be seen under anesthesia with limited manual axial traction.

Surgical Indications

Although there is no clearly defined consensus regarding indications for LT reconstruction, specific indications include persistent instability after debridement of the LT or in the setting of type 1 (complete) tears, as well as instability that has previously failed arthroscopic anterior capsular plication or capsular reconstruction. The only consistent contraindication for LT reconstruction is a remaining joint space < 2 mm.[8]

Surgical Technique

Patient Positioning and Portal Placement

In the operating room, a combined spinal-epidural is performed for analgesia and relaxation. Blood is withdrawn from a peripheral arm vein for later intra-articular platelet-rich plasma injection. The patient is placed supine on a traction table with all bony prominences well padded. An extra-wide perineal post is placed to minimize pressure on the pudendal nerve and to force the femoral head laterally, shifting the vector of forces. The arm on the operative side is crossed over the chest. The patient's feet are wrapped in cotton padding and placed securely into traction boots. Next, the operative leg is abducted and traction applied. It is then adducted to distract the femoral head from the acetabulum. This is confirmed with a "vacuum sign" and 1 cm of joint distraction on fluoroscopy (Fig 1). Our recommended patient positioning is shown in Figure 2.

After routine preparation and draping of the hip, the procedure is begun by establishing standard anterolateral and mid-anterior portals to allow access to the central compartment (Fig 3). A standard diagnostic arthroscopy is performed using a 70° arthroscope to

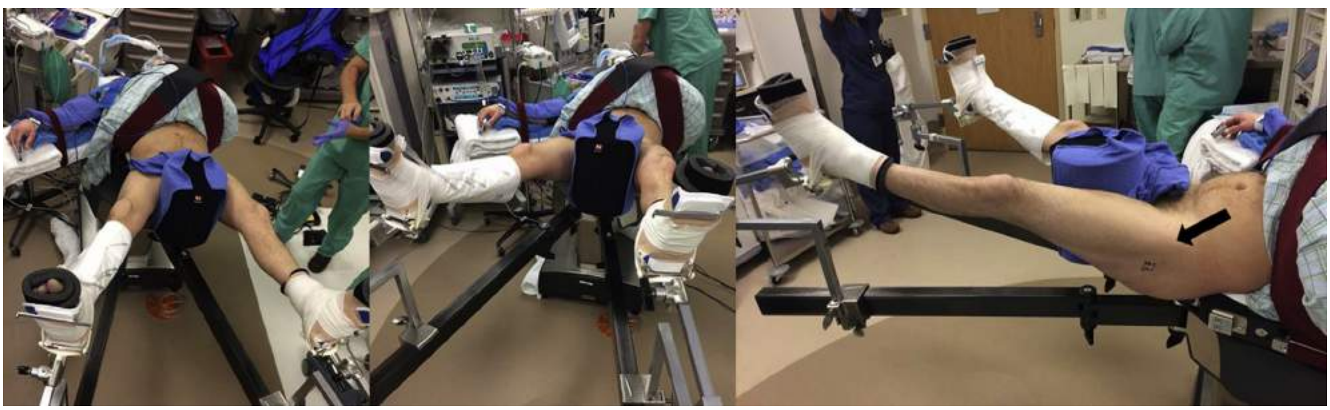


Fig 2. When positioning the patient supine on a traction table, the left operative leg (arrow) is placed in neutral alignment and approximately 15° of hip flexion. The right nonoperative leg is placed in 45°-60° of abduction with slight hip flexion.

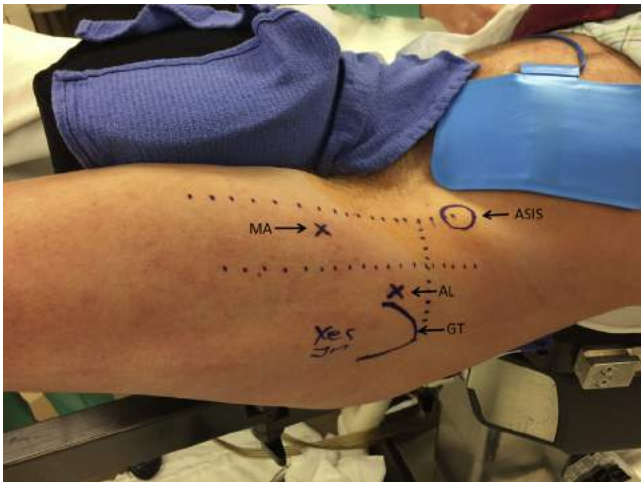


Fig 3. Landmarks for portal placement are identified. The anterolateral portal (AL) is first placed slightly anterior and approximately 1 cm distal to the tip of the greater trochanter (GT). The mid-anterior portal (MA) is then located 45° distal and anterior to the anterolateral portal, and 2-3 cm lateral to a line drawn from the anterior superior iliac spine (ASIS) to the center of the patella. There is typically a soft spot found in this location lateral to the border of the tensor fascia lata.

evaluate the LT and any other concomitant pathology (Video 1). When a complete LT tear is confirmed, and no other sources of instability are present, we proceed with reconstruction of the ligament.

Graft Preparation and Femoral Tunnel Placement

On a sterile back table, a robust tibialis anterior allograft measuring at least 120 mm in length with a diameter of 7 to 8 mm is prepared. It is placed on a Graftmaster (Acufex Graftmaster III, Smith & Nephew, Andover, MA) for pretensioning, and the ends are reinforced with a 2-0 absorbable suture.

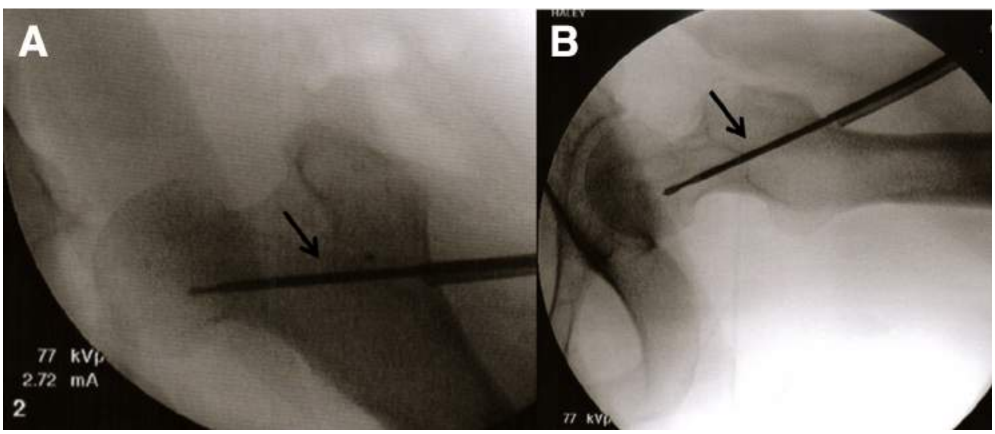
A 2.4-mm guidewire (Smith & Nephew) is placed in a retrograde fashion through the femoral neck using fluoroscopic guidance and direct arthroscopic visualization (Fig 4). On the anteroposterior view (Fig 4A), the wire is placed along the inferior femoral neck in line with the fovea capitis, and centered within the neck on the lateral view (Fig 4B). The proximal exit point of the wire through the footprint of the LT is confirmed arthroscopically. A 2- to 3-cm incision is then made over the greater trochanter at the entry point of the wire, and dissection is carefully performed through the soft tissues down to the lateral cortex. Using a 7-mm reamer (Arthrex, Naples, FL) over the guidewire, the femoral tunnel is created (Fig 5). The origin of the LT in the cotyloid fossa is debrided of any remaining soft tissue using a combination of a radiofrequency probe (E-flex, Smith & Nephew) and a mechanical shaver (Smith & Nephew).

Graft Placement and Fixation

Once the femoral tunnel is complete, a double-loaded 2.9-mm biocomposite suture anchor (OsteoRaptor; Smith & Nephew) is placed in the footprint of the LT. The anchor is passed trans-trochanterically through the femoral tunnel so that the suture tails exit the tunnel laterally through the prior skin incision (Fig 6). The suture limbs are passed through the proximal end of the graft with a free needle, and a second No. 2 suture is placed through the distal end for later use. The graft is then gently shuttled through the tunnel with a knot pusher, and secured to the cotyloid fossa using a series of alternating half hitch knots.

After the proximal graft is firmly secured to the acetabulum, traction is released and the leg is placed in external rotation (50° to 60°) and extension (10° to 20°). Placement of the leg in this position before fixation of the distal end of the graft helps achieve ideal tensioning of the graft because it avoids overtightening and loss of movement in this common position. The No. 2 suture that was previously passed through the distal

Fig 4. Anteroposterior (A) and lateral (B) intraoperative radiographic images of guide pin placement (arrows) in a left hip. On the anteroposterior view, the guide pin is placed along the inferior femoral neck in line with the fovea capitis, and centered within the neck on the lateral view.



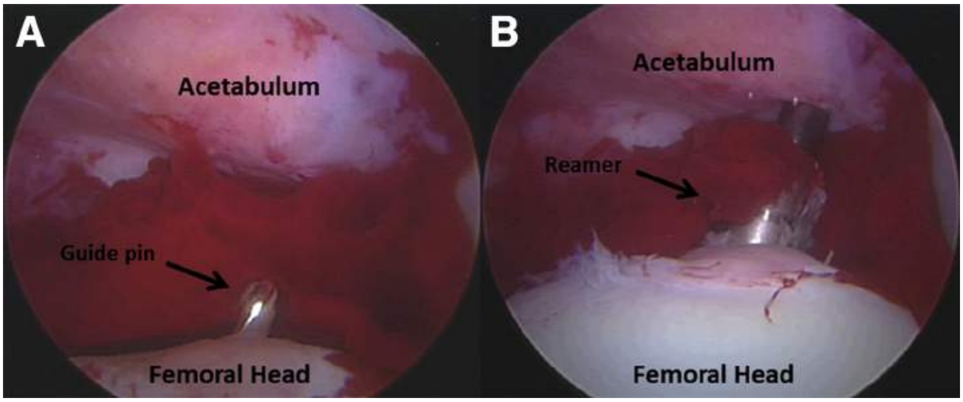


Fig 5. Arthroscopic images of a left hip viewed through the mid-anterior portal showing a guide pin emerging from the femoral head (A) and subsequent reaming with a 7-mm reamer over the guide pin to create the femoral tunnel (B).

end is now used to properly tension the graft with the leg in the appropriate position. The distal portion of the graft is secured within the femoral tunnel using a 6 mm × 25 mm biocomposite interference screw (Arthrex) placed over a guidewire and the excess graft is trimmed. It is crucial to ensure that the screw is inserted completely so it is flushed with the lateral femoral cortex. This avoids further irritation of the overlying soft tissues and subsequent lateral hip pain postoperatively. After it is secured at both ends, the graft is again visualized arthroscopically to confirm proper placement and tension (Fig 7). The hip is taken through full range of motion to assess for stability. The hip capsule is then closed arthroscopically using a heavy absorbable suture.

The hip is then drained of arthroscopic fluid. A cannula is placed through the anterolateral portal, and the previously withdrawn platelet-rich plasma is injected into the joint through the mid-anterior portal. The portal sites are closed with 3-0 nylon in a horizontal mattress fashion. In addition, a layered closure of the lateral incision is performed. An abduction pillow is placed, and then the patient is taken to the recovery room.

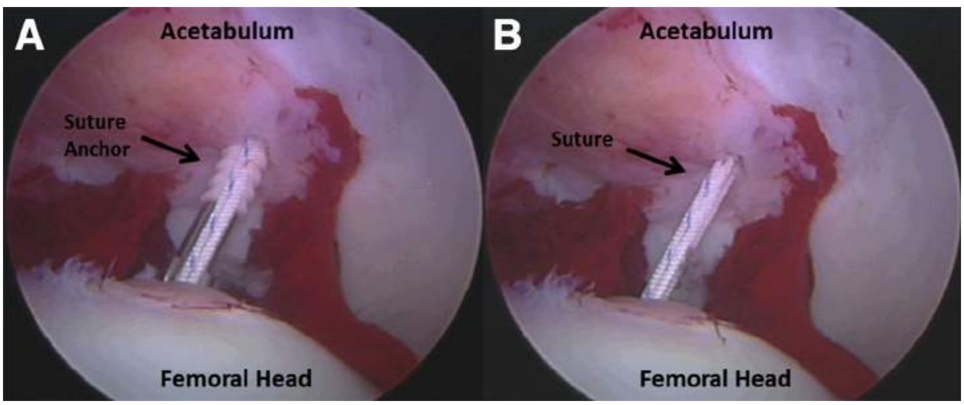
Postoperative Recovery and Rehabilitation

The patient is allowed partial flatfoot weight bearing for 6 weeks postoperatively, who then slowly advances to weight bearing as tolerated. To protect the reconstructed LT, an abduction brace is placed during the first 6 weeks as well to prevent abduction beyond 15° and extension past neutral. External rotation is also limited from 0° to 20° to protect the capsular closure. Early motion is initiated on the day of surgery and is essential in preventing adhesions and scar formation. A continuous passive motion device is used 2 hours daily for 6 weeks along with gentle hip circumduction exercises. The patient participates in supervised physical therapy daily for the first 2 weeks, and then 2 to 3 times per week thereafter for a minimum of 8 weeks postoperatively.

Discussion

Pathologic processes attributable to the LT have only recently begun to be understood, and the precise function of this structure remains nebulous.[2,9-11] Although clinical examination maneuvers and advanced imaging to detect specific LT pathology remain elusive, the advancement in arthroscopic

Fig 6. Arthroscopic images of a left hip viewed through the mid-anterior portal showing placement of a double-loaded 2.9-mm biocomposite suture anchor in the footprint of the ligamentum teres through the previously drilled femoral tunnel (A), and the suture tails exiting the tunnel laterally out through the prior skin incision (B).



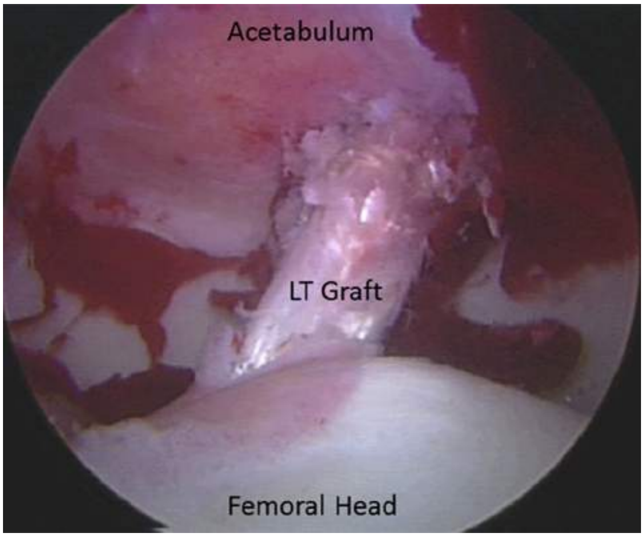


Fig 7. Final arthroscopic image of a left hip viewed through the mid-anterior portal to confirm proper graft placement and tension. (LT, ligamentum teres.)

techniques to address intra-articular pathology of the hip has led to increased understanding of this structure.[6,12-15]

Tears of the LT can be identified arthroscopically, and are generally classified as type 1 (complete tear), type 2 (partial tear), or type 3 (degenerative).[6,16,17] The contribution of LT tears to both pain and instability remains a point of debate among authors; however, recent reports have shown relief of pain with arthroscopic debridement of LT tears,[17,18] suggesting a significant contribution of the LT as an intra-articular pain generator. In addition, despite its proposed function as a static stabilizer of the hip, studies to date have generally not shown induction of iatrogenic hip instability after LT debridement.[17-19] This may be caused by the inherent congruity and bony containment of the femoroacetabular joint.[7,18,20]

Although this bony anatomy likely plays a significant role in maintaining stability of the hip, it also limits range of motion and can predispose a subset of patients to impingement and instability under extraphysiologic forces. Under these circumstances, the LT and associated capsular structures may play a crucial role in opposing subluxation and instability events. Despite the success of arthroscopic debridement in most patients, a small subset of patients have persistent subjective and objective findings of pain and instability in the setting of an absent or torn LT. In these patients, in whom other intra-articular pathology has been addressed and symptomatic instability persists, LT reconstruction remains a viable option.

Several authors[8,13-15] have proposed methods for LT reconstruction, and short-term outcome results are promising in appropriately selected patients.[8,18] Techniques have varied with fixation using knotless or knotted anchors and reconstruction with a semitendinosus allograft or an iliotibial band autograft.[8,13-15] We recommend reconstruction of the LT in patients with persistent and symptomatic instability of the hip using a stout tibialis anterior allograft and biocompatible hydroxyapatite composite anchors. This technique allows for reconstruction of the LT in an anatomic location with potential for biologic incorporation of all implants (Table 1).

Although the aforementioned studies regarding LT reconstruction have shown promising results, one concern regarding this technique is its high technical demand and steep learning curve. Advantages, however, include an anatomic reconstruction that can improve hip stability and function (Table 2). Because of this, as well as its relative infancy in the orthopaedic literature, long-term studies should be performed to ensure the maintenance of the restoration, stability, and functionality of the hip. This technique will continue to be studied and evaluated within our group; however, we encourage other surgeons to further evaluate the validity of this technique and to perform continued assessment for long-term results.

Table 1. Pearls and Pitfalls

Pearls	Pitfalls
Magnetic resonance imaging obtained with a 3-tesla magnet without intra-articular contrast is helpful to evaluate for the presence of ligamentum teres pathology.	Failure to adequately distract the joint can lead to difficulty accessing the central compartment, as well as iatrogenic chondral injury.
Confirm adequate joint distraction by identifying the "vacuum" sign with at least 1 cm of joint space via fluoroscopy.	After securing the graft to the cotyloid fossa, traction must be released and the leg placed in external rotation (50°-60°) and extension (10°-20°) before fixation of the distal end of the graft to avoid overtightening and loss of movement in these positions.
Use a tibialis anterior allograft with a diameter of 7-8 mm and approximately 120 mm in length.	Leaving the femoral screw proud can lead to irritation of the soft tissues.
Postoperatively, use an abduction brace to prevent abduction beyond 15° and extension past neutral.	
Postoperatively, limit external rotation from 0° to 20° to protect the capsular closure.	

Table 2. Advantages and Limitations

Advantages	Limitations
Decrease pain	Long-term outcomes not well documented
Improve stability and function	Although the senior author (M.J.P., blinded for review) routinely uses platelet-rich plasma, we realize that this is not an option for many patients. This same technique can be performed without the use of platelet-rich plasma when unavailable.
Anatomic reconstruction	High technical demand and steep learning curve

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