

Technical Note

Arthroscopic-Assisted Lateral Meniscal Allograft Transplantation With Open Ligamentous Extra-Articular Tenodesis

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Abstract: Lateral meniscus allograft transplantation is performed in predominantly young, active patients and is an option to stabilize the joint in lateral meniscus–deficient patients after anterior cruciate ligament reconstruction. The lateral meniscus functions as an important restraint to anterior tibial translation, and meniscal transplant in such a patient may improve survivability of the graft in addition to preserving the patient’s articular cartilage in the long term. A ligamentous extra-articular tenodesis procedure may be performed simultaneously to augment rotational stability of the joint, particularly in a patient with underlying ligamentous hyperlaxity.

Meniscectomy is undesirable but may be necessary to relieve mechanical symptoms in a patient with an unreparable tear. An intact meniscus cushions forces across the knee by absorbing them as hoop stresses via its circumferential fibers.¹ Meniscectomy subjects the joint to the consequences of decreased congruency, decreased articular surface contact area, increased contact pressures, and impaired load transmission and results in a less stable joint. Robotic work has demonstrated that the lateral meniscus acts an important restraint to anterior tibial translation (ATT), especially during valgus and rotatory loading, as seen in a pivot-shift test.² It has furthermore been reported that meniscal deficiency is the single most significant predictor of anterior cruciate ligament reconstruction (ACLR) failure.³

Rotational stability is another major concern in ACL grafts, and a significant proportion of patients report persistent rotatory instability after ACLR.⁴ Recent biomechanical work has demonstrated that the anterolateral structures of the knee, including the anterolateral ligament, fibular collateral ligament, and Kaplan’s fibers

(which connect the distal iliotibial band [ITB] with the lateral condyle of the femur) all contribute to rotatory stability,⁵ and ligamentous extra-articular tenodesis (LET) procedures concurrent with ACLR significantly decrease forces on the graft.⁶ This information suggests LET procedures may be used to protect the ACL graft from rotational forces,⁴ particularly in patients with deficiency of the lateral meniscus.

Given the deleterious effects of meniscectomy, especially on young and active patients, consideration may be given to an ipsilateral meniscal allograft transplant (Table 1). Indications for such a procedure are isolated pain in the compartment of meniscectomy, along with radiographic evidence of osteoarthritis. In patients with an ACL graft and meniscus deficiency, evidence of laxity or stretching of the graft should be carefully screened with physical examination findings and patient history. Evaluation should use Lachman, posterior drawer, pivot shift, and varus and valgus stress testing at minimum. Varus and valgus stress radiographs should be compared with baseline from the original

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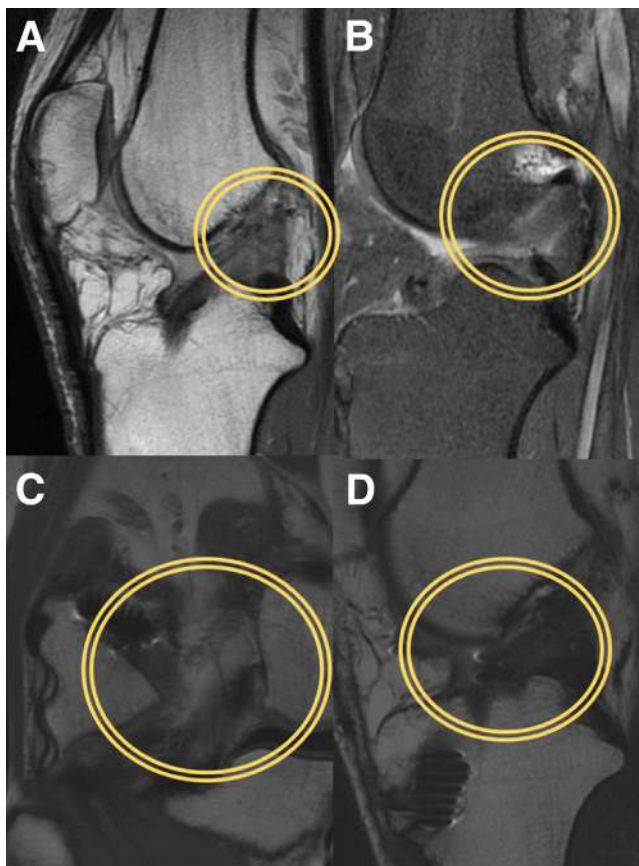


Fig 1. Preoperative MRI demonstrating proximal anterior cruciate ligament graft attenuation (right knee). (A) Sagittal proton-dense view. (B) Sagittal proton-dense fat-suppressed view. (C) Coronal proton-dense view. (D) Sagittal T2 oblique view. In a ligament reconstruction patient with partial or complete meniscectomy, anterior tibial translational forces on the ligament grafts increase, along with rotatory instability. Careful evaluation with physical examination tests and MRI is necessary to evaluate for graft attenuation or stretching. (MRI, magnetic resonance imaging.)

meniscectomy or ACLR, and magnetic resonance imaging demonstrates tunnel and graft integrity (Fig 1).

Surgical Procedure (With Video Illustration)

The procedure is detailed in Video 1. The patient is induced under general anesthesia and a high thigh

tourniquet placed. A physical examination under anesthesia is undertaken before beginning the procedure. Lachman's test, pivot shift, varus and valgus gapping with stress, and posterior drawer tests are evaluated.

The arthroscopic part of the procedure is commenced first through medial and lateral parapatellar portals. After saline insufflation, a standard diagnostic arthroscopy is performed, looking for signs of chondromalacia, arthritic changes, and integrity of any grafts. The bony trough for securing the allograft bone plug is next prepared. Any remnant meniscus is removed using biters and an arthroscopic shaver (Smith & Nephew, London, UK) to a 1-mm rim and a curette is used to outline the location of the tibial bone trough (Fig 2).

The lateral incision is then created to prepare for an LET procedure. The inferior border of the distal ITB is first identified. The interval anterior to the lateral gastrocnemius tendon and proximal to the biceps femoris tendon's insertion is developed and a retractor or spoon is placed. The surgeon will outline a 10-cm long by 1-cm wide strip of the inferior ITB, amputate it proximally, and free the strip to its distal attachment. This strip is then passed under the fibular collateral ligament. The area around the distal group of Kaplan's fibers attached to the femur is cleared for the later tenodesis procedure, avoiding the lateral superior geniculate artery (Table 2 and Fig 3).

A lateral arthrotomy is incised, through which a custom trough device (Biomet, Warsaw, IN) is inserted to create the bony trough previously outlined on the tibia. A curette and pituitary rongeur are used to clean out this space of remaining debris, and a Tunnel Dilator (Biomet) ensures the desired depth of 1 cm in the trough is achieved. Four FiberLink sutures (Arthrex, Naples, FL) are passed through the posterior capsule and tagged with numbered (#1-4) hemostats to facilitate later identification.

The meniscal allograft (JRF Ortho, Centennial, CO) is prepared on the back table to form a trapezoidal bony piece to fit the lateral tibial plateau trough using a custom tibial cutting guide and sizer (Biomet). Four passing sutures (#2 FiberWire; Arthrex) are placed in the posterior aspect of the meniscal transplant, and

Table 1. Indications and Contraindications for Lateral Meniscal Allograft Transplant

Indications	Contraindications
Isolated lateral-compartment knee pain with postactivity effusion in postmeniscectomy patient.	Open physes—risk of arrest
Other evidence of evolving lateral compartment arthrosis in postmeniscectomy patient	Valgus malalignment—must be neutralized first or simultaneously
Evolving failure of ACL graft in postmeniscectomy patient	Obesity—relative contraindication
Postmeniscectomy patient with desired high levels of low-impact athletic activity	Grade IV chondromalacia (especially “kissing lesions”)

ACL, anterior cruciate ligament.

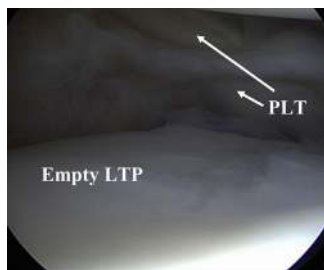


Fig 2. Right knee: Arthroscopic photo looking at the lateral tibial plateau demonstrating deficiency of the lateral meniscus, with popliteus tendon in the background. The absence of an ipsilateral meniscus increases forces across the joint dramatically both in the axial plane and in the form of increased anterior tibial translation. This arthroscopic picture also demonstrates the area of the lateral tibial plateau in which a bony trough is cut in cases of lateral meniscus allograft transplantation. (LTP, lateral tibial plateau; PLT, popliteus tendon.)

three passing sutures are placed in the anterior horn of the meniscal transplant.

The lateral meniscal allograft is pulled into place using the posterior aspect sutures, and the trapezoidal bony piece is tapped into the tibial trough (Fig 4). The sutures on the posterior aspect of the graft are tied to the posterior capsular sutures in a horizontal fashion, with #1 tied to #2, and #3 to #4. It is important at this point to probe the posterior horn of the transplanted meniscus to verify its stability.

A free needle is then used to tie the sutures in the anterior horn of the meniscus transplant to the anterior capsule. In addition, 6 vertical mattress sutures are placed inside-out (SharpShooter; Stryker, Kalamazoo, MI) to further reinforce the attachment of the lateral meniscus to the capsule (Fig 5).

The LET graft is secured to the femur with the knee in 30° of flexion and neutral rotation. A small Richards staple is inserted to secure the ITB strip to the femur at the distal Kaplan's fibers area and proximal to the attachment of the lateral gastrocnemius. The remaining

ITB strip is brought back onto itself and sutured in place.

After deflating the tourniquet, deep closure is with 0 and 2-0 VICRYL sutures (Johnson & Johnson, New Brunswick, NJ) followed by MONOCRYL (Johnson & Johnson). Steri-Strips are loosely applied followed by a sterile dressing and knee immobilizer in full extension.

The patient will be nonweight-bearing on the operative extremity for the first 6 weeks. Flexion is limited to 90° for the first 2 weeks, then the patient may increase range of motion as tolerated. At the 6-week point, the patient may initiate a weight-bearing program and slowly wean off of crutches until ambulatory without a limp. The patient should continue using an ACL brace to protect the reconstruction after weaning off crutches. Physical therapy begins immediately the day after surgery, focusing initially on quadriceps activation, edema control and range of motion. Anteroposterior and lateral radiographs are taken to establish a baseline on the day after surgery. Deep vein thrombosis prophylaxis is with enoxaparin for 2 weeks before transition to aspirin and TED hose until commencement of weightbearing.

Discussion

The lateral meniscus takes up to 70% of the contact loads of the lateral tibial plateau, and after meniscectomy the force across the lateral compartment with axial loading increases dramatically. Robotic models have suggested that the lateral meniscus plays an important role in stabilizing the axial, sagittal, and rotational forces experienced in daily activities and athletics.² By acting as a restraint to anterior tibial translation and contributing to rotatory stability, the lateral meniscus emerges as a crucial secondary stabilizer of the knee.² In patients with ACL deficiency and a lateral meniscus injury, repair of the lateral meniscus is important to protect the ACL graft and prevent stretching or rupture (Table 3). If a significant lateral meniscectomy has been performed, the patient should

Table 2. Pearls and Pitfalls

Pearls	Pitfalls
Leave a 1-mm rim of remnant tissue to securely suture the allograft	Clear the meniscal allograft of excess soft tissue to prevent difficult graft passage
While a number of retractors are available to guard the interval between the biceps tendon and the lateral gastrocnemius, a spoon may serve just as well	Ensure appropriate dilation and sizing of the trough to avoid fracture of the bone block.
Six inside-out vertical mattress sutures are preferred to fasten allograft to the lateral capsule.	Avoid or cauterize the superior lateral geniculate artery which courses distal to the distal Kaplan's fibers
Verify construct stability by probing the horns of the meniscal transplant thoroughly	Use caution not to amputate the iliotibial band strip too distally
The LET graft is fixed 3 cm proximal to the FCL at the anatomic insertion of the distal Kaplan's fibers.	Avoid confusion by using numbered hemostats for suture management and later identification

FCL, fibular collateral ligament; LET, ligamentous extra-articular tenodesis.

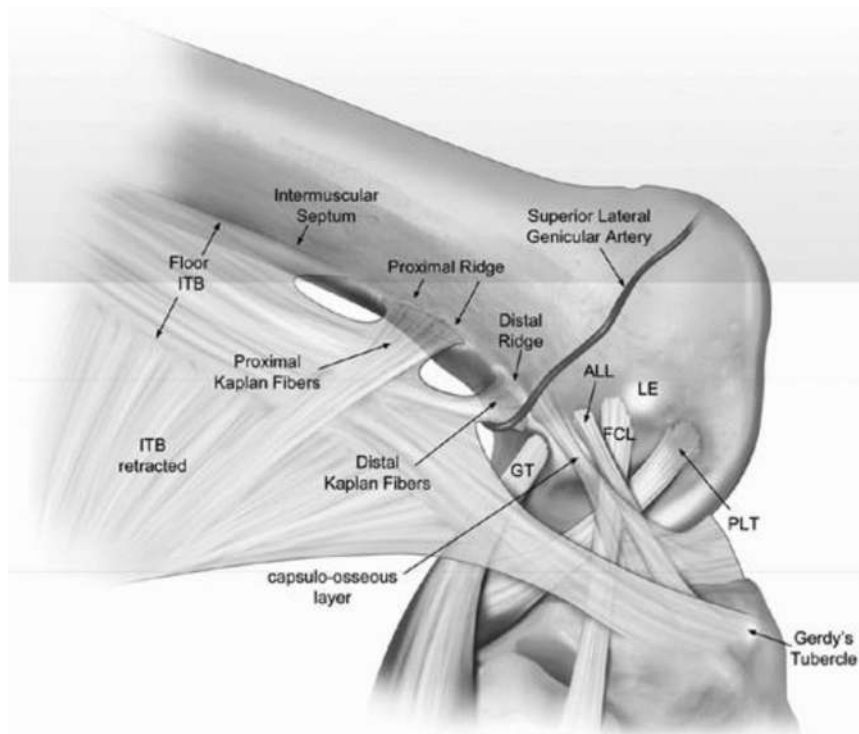


Fig 3. Lateral aspect of the knee with associated structures. The ITB is retracted in this illustration, demonstrating the attachments of Kaplan's fibers and the course of the superior lateral genicular artery. In lateral extra-articular tenodesis procedures, a 10-cm \times 1-cm strip of the ITB will be freed to its distal attachment and routed under the FCL before being secured to the femur at the distal Kaplan's area. This procedure is intended to improve anterolateral rotatory instability of the knee. (ALL, anterolateral ligament; FCL, fibular collateral ligament; GT, gastrocnemius tendon; ITB, iliotibial band; LE, lateral epicondyle; PLT, popliteus tendon.)

be carefully monitored for signs of increasing instability and ATT, in which case lateral meniscal transplantation should be considered.

Zhang et al.⁷ reported on 19 meniscal allograft transplantation patients, 7 of whom had combined ACLR. All patients had improved pain and function scores, with nearly equivalent results between

isolated and combined procedures in Lysholm, visual analog scale on pain and satisfaction, and Knee Injury and Osteoarthritis Outcome Score. Despite a high rate of reoperation reported in the literature, recent studies have demonstrated a low rate of conversion to total knee arthroplasty in meniscus allograft patients.⁸



Fig 4. Right knee: lateral meniscus allograft arthroscopic view (left) after insertion into the joint space and a bony trough previously created; and (right) in preparation for insertion with traction applied to passing sutures placed in the posterior aspect of the meniscal allograft. A large parapatellar incision is required for an open lateral meniscus allograft transplantation; while the procedure can be done arthroscopically, an open procedure is preferred in cases with concurrent ligament grafts and altered anatomy. This increases the accuracy of measuring the lateral tibial plateau and creating an appropriately sized bony trough for the allograft, as well as increasing speed in securing the allograft. (LMAT, lateral meniscus allograft transplantation.)

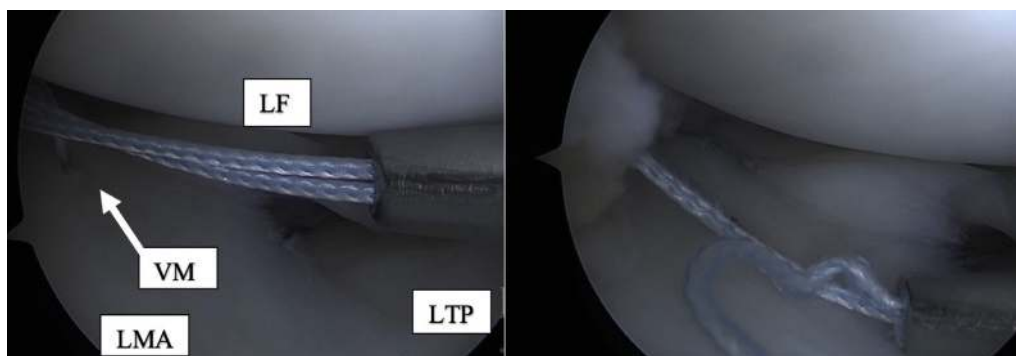


Fig 5. Arthroscopic meniscus graft fixation, right knee: Six vertical mattress sutures are used to fasten a lateral meniscus allograft to the lateral capsule after anterior and posterior capsular sutures are tied. Having appropriately measured the lateral tibial plateau and appropriately sized the allograft, a firm fixation to the tibial plateau and joint capsule is essential. The principles of meniscus repair apply, including preference for inside-out suturing. (LF, lateral femoral condyle; LMA, lateral meniscal allograft, LTP, lateral tibial plateau; VM, vertical mattress suture.) .

A recent cadaveric study reported that a combined ACLR and LET procedure resulted in less ATT and transferred some of the load on the ACL graft to the LET construct.⁹ Geeslin et al.⁴ reported on the results of a robotic study, finding that LET procedures carried out concurrently with ACLR significantly reduced residual laxity and tibiofemoral motion while also decreasing internal rotation compared to isolated ACLR. These findings, along with recent advances in understand of the distal iliotibial band structures and their biomechanical properties, suggest that an LET procedure may provide additional protection from ATT and rotational force on the ACL graft.¹⁰

Meniscal deficiencies increase translational and rotatory forces on an ACL graft. In patients with lateral meniscus deficiency specifically, increased ATT and rotational forces increases the chances of graft failure.¹¹

Table 3. Pros and Cons of Meniscal Transplantation

Pros of Meniscal Allograft Transplant	Disadvantages and Limitations
Restore ability to engage in low-impact athletic activities	A large incision is required with the recommended open procedure
Restores biomechanical role of meniscus in the knee	Root insertions cannot be altered if the allograft size is not correctly measured
May delay onset of osteoarthritis in meniscus deficient knee	Trough blowout or graft-size mismatch can occur if the tibial plateau is not adequately measured and the appropriate calibrated device used
In ligament-reconstructed knees, meniscus transplant can preserve grafts by restoring normal biomechanics of joint	Stiffness can occur if physical therapy regimen is not strictly followed.

In active, younger patients, Lateral meniscal allograft transplant should be considered postmeniscectomy to prevent the need for revision ACLR. In addition, in patients with hyperlaxity or evidence of evolving ACLR graft laxity, a concurrent LET procedure should be considered.

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