

# Multiligament Repair With Suture Augmentation in a Knee Dislocation With Medial-Sided Injury



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**Abstract:** Knee dislocations often result in a severe multiligament injured knee (MLIK) with complex instability. Multiligament reconstruction can successfully restore knee stability and is commonly recommended, although surgical morbidity is induced by graft harvesting and tunnel drilling, and convergence of multiple tunnels can complicate the surgery. Therefore, as an alternative, primary repair of knee ligaments is currently reconsidered. The main advantages of primary repair consist of tissue preservation and decrease of surgical morbidity, which might improve knee functionality. Techniques in which avulsed ligaments are reapproximated to their anatomic origin have resulted in good clinical outcomes in selected patients over the past decade. More recently, repaired ligaments have been augmented with suture tape, to protect them from excessive stretch, which can improve healing and allows early rehabilitation. The surgical technique of primary repair in the multiligament injured knee has not yet been described. The purpose of this Technical Note is to explain suture augmented primary repair in KDIII-M injury, including the anterior cruciate ligament, posterior cruciate ligament, and medial collateral ligament.

Multiligament injured knees (MLIKs) often result from a traumatic knee dislocation (KD) and include various injury patterns, which can be described using the Schenck classification.<sup>1</sup> KDIII-M injuries involve the anterior cruciate ligament (ACL), posterior cruciate ligament (PCL), and medial collateral ligament (MCL), and are commonly treated with acute reconstruction of all ligaments.<sup>2,3</sup> Although reconstruction is reliable in restoring stability of the knee, the surgery is associated with postoperative arthrofibrosis, muscle weakness, and high risk of osteoarthritis (OA).<sup>2,4</sup>

Recently, primary repair of knee ligaments has regained interest.<sup>5-7</sup> As native ligaments are reattached at their

anatomic origins, graft harvesting and tunnel drilling are avoided (Table 1). Outcomes of primary repair have significantly improved over the past decade due to selection of avulsed ligaments and progression of surgical techniques, including arthroscopy. More recently, it has been advocated to add augmentation to repaired ligaments to protect the ligament during healing and prevent elongation with subsequent laxity or failure.<sup>3,8</sup>

The purpose of this article is to present our technique of suture augmented primary repair of all injured ligaments in a KDIII-M injured knee with proximal tears using open MCL repair, and arthroscopic ACL and PCL repairs.

## Surgical Technique

### Patient Selection

Eligibility for primary repair is based on tissue length and quality. Preoperatively, magnetic resonance imaging can be used to evaluate the severity and site of injury. Proximal and distal avulsion tears are deemed potentially repairable (Table 2). Van der List et al.<sup>9,10</sup> reported that 43% of all isolated ACL tears were located proximally, and that most of the proximal tears were repairable in their patient cohort. Goiney et al.<sup>7</sup> were able to repair 44% of all PCL tears in MLIKs, and Twaddle et al.<sup>11</sup> reported the ability to repair 51% of PCL, 64% of MCL, and 84% of lateral collateral ligament tears.

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**Table 1.** Advantages and Disadvantages of Primary Repair With Suture Augmentation in the Multiligament Injured Knee

Advantages	Disadvantages
Preservation of native ligaments with blood supply and proprioceptive function	Selectively in patients with eligible avulsion tears
Preservation of bone stock	Tissue quality is time dependent
No risk of tunnel convergence	Unknown long-term outcomes
No graft harvesting or use of allografts	
Faster rehabilitation	
No increase in complexity of revision reconstruction	

### General Preparation

All patients are counseled and consented for both primary repair and reconstruction, as the final treatment decision is based on intraoperative findings. If the ligament has sufficient length and tissue quality, primary repair will be performed instead of standard reconstruction.<sup>10</sup> Patients receive preoperative antibiotics, and both general and regional anesthesia, after which they are placed in the supine position. Examination under anesthesia is performed on both knees to confirm injuries of the affected leg. Finally, a tourniquet is applied around the proximal thigh, and the leg is prepped and draped in a sterile fashion.

### Open MCL Repair With Suture Augmentation

Surgery is started on the medial side to enable fluid control during later knee arthroscopy (Video 1). A small incision is made over the medial femoral condyle at the origin of the MCL. While dissecting, saphenous nerve branches should be identified and protected. The sartorial fascia is opened to reach the second layer, which contains the superficial medial collateral ligament (sMCL) (Fig 1A).

The injured sMCL is sutured in a Bunnell-type pattern, after which the suture limbs are passed through the eyelet of a 4.75-mm Vented BioComposite SwiveLock suture anchor (Arthrex, Naples, FL) that is preloaded with FiberTape (Arthrex). A socket is punched and tapped at the posterior part of the medial femoral condyle in which the anchor is subsequently deployed. Prior to fixation, the sMCL is tensioned with a slight varus force on the knee in 60° of flexion.

Next, a curved clamp is passed under the fascia and an additional incision is made over the distal tibial insertion of the sMCL to retrieve the FiberTape distally (Fig 1B). A second socket is punched and tapped at the distal insertion, in which the next 4.75-mm anchor is partially deployed. This anchor is preloaded with the

free end of the FiberTape, which is tensioned with the knee in 30° of flexion. Prior to final fixation, valgus stability and range of motion (ROM) are tested. Then, the anchor is fully deployed, after which the sMCL repair with suture augmentation has been completed (Video 1).

### Arthroscopic ACL and PCL Repair With Suture Augmentation

First, an anteromedial (AM) working portal and anterolateral (AL) scoping portal are created, and routine joint inspection is performed (Video 1). The ACL and PCL are then grasped and reapproximated to their anatomic position to assess if ligament length is sufficient to reach the femoral wall and if tissue quality is adequate to bear sutures. Concurrently, an anterior drawer force is applied to prevent tibial sagging, which can make the PCL appear too short. If the ACL and PCL are both amenable for primary repair, the ACL is preferably repaired prior to the PCL to allow better visualization of the PCL. In addition, the ACL is augmented first, in full extension, to prevent anterior tibial shift.

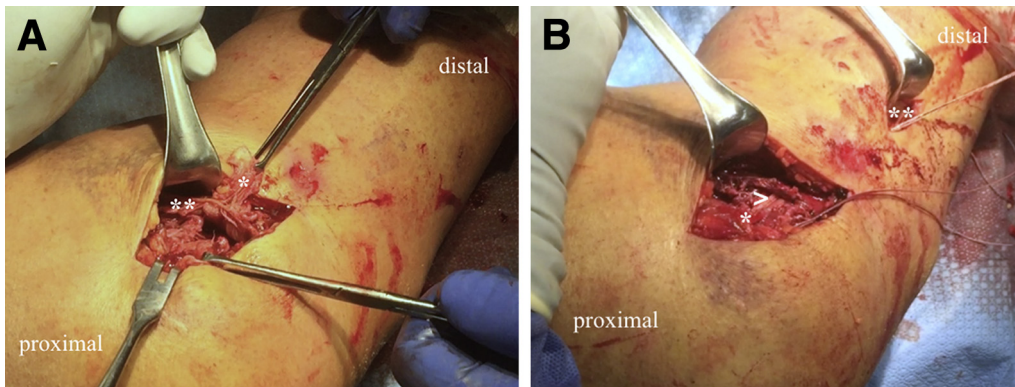
To start ACL repair, a Passport Button Cannula (Arthrex) is placed in the medial portal to facilitate suture management. Bunnell-type suture patterns are created in both bundles of the ACL with a reloadable Scorpion suture passer (Arthrex). Transection of previous suture passes should be avoided, and final suture passes should exit toward the femoral wall. The AM and posterolateral bundle are sutured separately, using a No 2. FiberWire and No 2. TigerWire suture (Arthrex), respectively, after which all sutures ends are parked away through a stab incision above the medial portal.

Next, the knee is flexed to 90° and an accessory AM portal is created to access the ACL footprint. The footprint is debrided, after which a socket is drilled, tapped,

**Table 2.** Indications and Contraindications of Primary Repair With Suture Augmentation in the Multiligament Injured Knee

Indications	Contraindications
All MLIK injury patterns	Previously repaired or reconstructed ligaments
ACL, PCL, MCL, and LCL avulsion tears	Midsubstance tears
Tears with good tissue quality	Chronic tears with retraction or resorption
All age groups	Poor tissue quality (severe intrasubstance injury, fraying of fibers)

ACL, anterior cruciate ligament; LCL, lateral collateral ligament; MCL, medial collateral ligament; MLIK, multiligament injured knee; PCL, posterior cruciate ligament.



**Fig 1.** (A) View on the medial side of a right knee in 90° of flexion. A proximally avulsed superficial medial collateral ligament (sMCL) is seen (\*), together with a proximal avulsion of the capsule (\*\*). (B) View on the medial side of a right knee in 90° of flexion. The sMCL is reattached at the medial femoral condyle (\*) with a suture anchor. The FiberTape (>) is running along the sMCL and has been shuttled underneath the deep fascia toward the tibia, where it will be attached at the distal tibial insertion of the sMCL (\*\*).

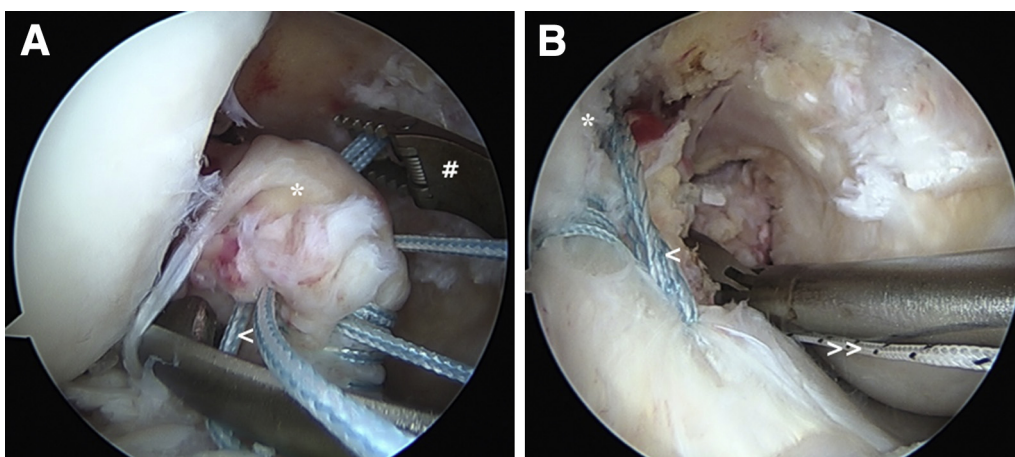
or punched (depending on bone quality). The suture limbs of the AM bundle are retrieved first and passed through the eyelet of a 4.75-mm anchor (Arthrex), which is preloaded with FiberTape and is subsequently deployed. Similarly, the PL bundle is fixated with an unloaded 4.75-mm anchor, with the knee in 115° of flexion. Both bundles are tensioned prior to fixation while an anterior drawer force is applied. After reattachment of both bundles, all free suture ends are cut with an open-ended suture cutter.

To complete ACL augmentation, an ACL drill guide is used to drill from the AM cortex into the ACL insertion, which allows insertion of a straight Micro SutureLasso (Arthrex). The FiberTape is passed through the nitinol loop outside the AM portal, after which it is shuttled

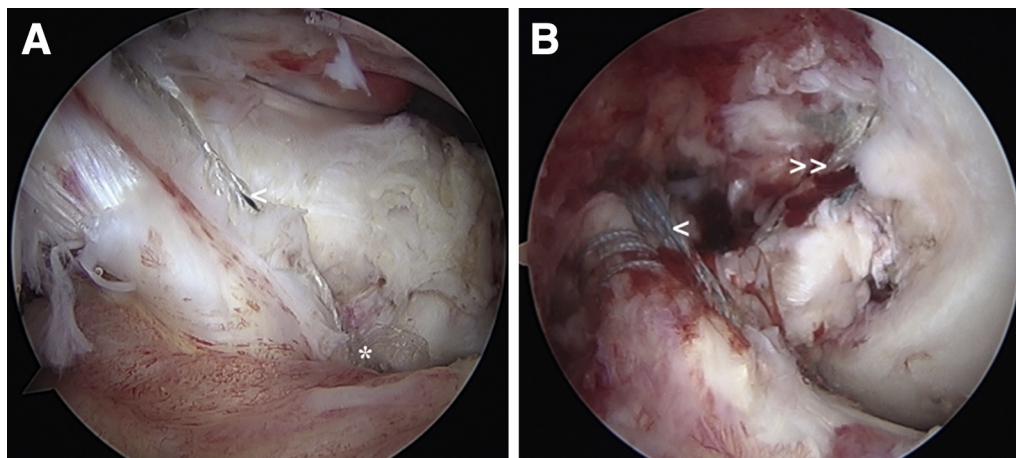
along the ACL and through the tibia. It is left for later fixation following PCL repair.

PCL repair is now performed in a similar technique to ACL repair (Fig 2B). Bunnell-type interlocking suture patterns are passed through the AL and posteromedial (PM) bundle with separate sutures, using a No. 2 FiberWire and No. 2 TigerWire suture, respectively. After suturing, the AM portal is used as scoping portal and the knee is flexed to 90° to access the femoral footprint through the AL portal. The footprint is debrided, after which the AL bundle is fixated with addition of TigerTape (Arthrex), followed by fixation of the PM bundle.

Then, PCL augmentation is performed. A PM scoping portal is used to visualize the tibial PCL insertion (Video 1).



**Fig 2.** (A) Arthroscopic view of a right knee, viewed from the anterolateral portal with the patient supine and the knee in 90° of flexion. A Scorpion Suture Passer (#) is used to pass a No. 2 FiberWire (<) suture in a Bunnell-type suture pattern through the anteromedial bundle. The suture is advanced from distal to the proximally avulsed end (\*) of the ligament. (B) Arthroscopic view of a right knee, viewed from the anterolateral portal with the patient supine and the knee in 90° of flexion. On the left, the anterior cruciate ligament has been reattached at its femoral footprint (\*) and the FiberTape (<) is running along the ligament. In the center, a Scorpion Suture Passer is used to pass a No. 2 TigerWire (>>) suture through the posterior cruciate ligament.



**Fig 3.** (A) Arthroscopic view of a right knee, viewed from the posteromedial portal with the patient supine and the knee in 90° of flexion. The TigerTape (<) is running along the posterior cruciate ligament and is retrieved distally through the tibia (\*). (B) Arthroscopic view of a right knee, viewed from the anterolateral portal with the patient supine and the knee in 90° of flexion. The repair of both the anterior cruciate ligament and the posterior cruciate ligament is complete, and the ligaments are augmented with FiberTape (<) and TigerTape (>>), respectively.

A tibial PCL guide is used to drill from the AM cortex into the PCL insertion to insert a straight Micro SutureLasso and shuttle the TigerTape through the tibia (Fig 3A). The ACL augmenting FiberTape is tensioned first with the knee near full extension and is fixated at the tibial cortex. The PCL augmenting TigerTape is tensioned with the knee in 90° of flexion and is fixated with a separate anchor. Now, the repaired ACL and PCL (Fig 3B) are tested for tension with a probe. Finally, the knee is examined and surgical incisions are closed.

### Rehabilitation

Following surgery, all patients wear a brace, which is locked in extension during ambulation, and start ROM exercises without weight bearing. The brace can be unlocked when protective quadriceps strength has returned, which takes approximately 4 to 8 weeks. Until then, the brace is only unlocked for moderate exercises. Immediate weightbearing and mobilization are allowed, but the intensity depends on individual progress, along with concomitant injuries. After 4 to 8 weeks, exercises are intensified with physical therapy to gain further ROM and strength.

### Discussion

Numerous treatments have been proposed to restore stability of the MLIK while minimizing surgical morbidity. However, arthrofibrosis has remained the most frequent complication after surgical treatment.<sup>2,3,5</sup> Consequently, optimal surgical timing, surgical technique, and postoperative management remain controversial.<sup>2,3</sup>

Recent studies have shown promising results of primary repair, in which graft harvesting and tunnel drilling were avoided, and early rehabilitation was

implemented. Hua et al.<sup>6</sup> performed open repairs of all ligaments in 18 MLIKs and noted no knee laxity at mean follow-up of 4.8 years, together with a mean Lysholm score of 87.5, extension loss of 1.7°, and flexion loss of 17.1°. Furthermore, Owens et al.<sup>5</sup> evaluated 28 MLIKs that were fully treated with primary repair and reported all stable knees at 13 to 82 months of follow-up, with a mean postoperative Lysholm score of 89.0, extension loss of 1.9°, and flexion loss of 10.2°.

In addition, primary repair might fasten rehabilitation and reduce long-term OA.<sup>12-14</sup> Van der List and DiFelice<sup>12</sup> compared ACL repair with reconstruction, reporting greater ROM up to 3 months postoperatively and earlier return to full ROM. Murray and Fleming<sup>14</sup> performed a preclinical study on Yucatan mini-pigs and noted significantly less OA after primary repair, and biomechanical properties of repaired ligaments were equally as good as grafts.

Limitations of this technique are also present. It should be noted that current literature consists of small case series and preclinical studies, and longer-term follow-up studies are needed to assess the outcomes of suture augmented repair. Furthermore, primary repair of cruciate ligaments can only be performed in proximal or distal avulsion type tears, making repair not possible for all patients. Finally, concerns exist about residual instability, which is mostly based on historical studies. It is thought that strict patient selection, arthroscopic surgery, early rehabilitation, and the addition of suture augmentation will prevent residual laxity.

In conclusion, this article described the surgical technique of primary repair of all injured ligaments in KDIII-M injury, with implementation of additional suture

augmentation. Patients with avulsion tears with sufficient tissue length and good tissue quality are potential candidates for this surgical technique. Eligibility for primary repair can be predicted with magnetic resonance imaging findings, after which intraoperative assessment defines definite feasibility of repair. In severe injuries such as KDIII-M, additional suture augmentation is commonly used to protect ligaments.

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