

# A Technique for Anterior Cruciate Ligament Reconstruction in the Setting of Unicompartmental Knee Arthroplasty



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**Abstract:** Unicompartmental knee arthroplasty (UKA) is becoming a more prevalent treatment for medial-compartment arthritis. Traditionally, a competent anterior cruciate ligament (ACL) is required to achieve satisfactory results. This leads to the question of treatment for medial-compartment arthritis in the setting of an incompetent ACL. A treatment option for this subset of patients is concurrent UKA and ACL reconstruction; however, this technique addresses the cohort of patients with a previously stable UKA who sustain an injury to the ACL, leading to symptomatic instability. The purpose of this article is to detail a technique for ACL reconstruction in the setting of a previous UKA.

Total knee arthroplasty (TKA) is a widely accepted treatment option with a high success rate for tri-compartmental arthritis.<sup>1-3</sup> However, the treatment of medial-compartment osteoarthritis in the young active patient is more challenging and debated. In this cohort of patients with single-compartment arthritis, treatment options include high tibial osteotomy (HTO) with or without anterior cruciate ligament (ACL) reconstruction, unicompartmental knee arthroplasty (UKA), or TKA.

TKA may not be the best option in this cohort because of concern for excessive wear leading to failure. Furthermore, different surgical options are more bone conserving and may be more advantageous in this cohort of patients. Conservative bone resection is essential because it may mitigate tibial bone loss that could require augmentations or stemmed implants,

thereby decreasing the complexity of conversion from UKA to TKA.<sup>4,5</sup> Furthermore, research has shown that UKA has better knee kinematics, reduced invasiveness, and less blood loss with a lower transfusion rate and quicker recovery time compared with TKA, as well as a shorter duration of hospitalization.<sup>6-10</sup> Thus, patients with unicompartmental arthritis treated with UKA are more able to maintain functionally demanding lifestyles.

Previous research comparing UKA and HTO has suggested that both procedures have acceptable clinical outcomes. A recent meta-analysis reported that patients undergoing UKA had a lower revision rate, fewer complications, and less postoperative pain than patients undergoing HTO.<sup>11</sup> Conversely, the HTO patients achieved better range of motion. There were no differences between groups in terms of functional scores. Krych et al.<sup>12</sup> reported a comparative cohort study of patients aged between 18 and 55 years with unicompartmental arthritis treated with UKA versus proximal tibial osteotomy. This study showed that patients treated with UKA reached a higher level of activity early after surgery to mid-term clinical follow-up.

Traditional indications for UKA include single-compartment degenerative arthritis, age older than 60 years, body weight lower than 82 kg, low-demand activities, range of motion greater than 90°, flexion contracture less than 5°, and angular deformity less than 15°, without inflammatory arthritis.<sup>13</sup> Further research has indicated that ACL deficiency may be a relative contraindication to UKA.<sup>14</sup> A recent biomechanical study showed that there is increased contact stress on the polyethylene insert and the lateral articular cartilage

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in ACL-deficient knees as compared with a medial UKA model without ligamentous deficiency.<sup>15</sup> However, according to research by Engh and Ammeen,<sup>16</sup> at 6-year follow-up, ACL deficiency in patients without clinical symptoms of knee instability did not impact UKA survival compared with patients with intact ACLs.

Several articles regarding concurrent medial UKA and ACL reconstruction have been written to date.<sup>17-19</sup> However, this technique addresses the cohort of patients with a previously stable UKA who sustain an acute injury to the ACL, leading to symptomatic instability. Thus, the purpose of this article is to describe a technique for ACL reconstruction in the setting of a previous UKA (Video 1).

## Surgical Technique

### Indications

The indications for ACL reconstruction in the setting of a UKA include acute ACL rupture in a previously stable UKA leading to mechanical symptoms. Other causes of UKA failure, such as prosthetic joint infection, aseptic loosening, periprosthetic fracture, osteolysis, and polyethylene failure, must be excluded.

### Patient Evaluation

A detailed history should be taken, and a detailed physical examination should be performed. If there is an acute inciting event, patient satisfaction and mechanical symptoms before and after the injury should be solicited and compared. The history should include the timing of the onset of symptoms, as well as the frequency, specific location, quality, and severity of symptoms. It should also include aggravating and alleviating factors.

During the physical examination, inspection for effusion, erythema, or altered gait mechanics is performed. Palpation is performed to assess crepitus, abnormal motion, and tenderness to palpation. The examiner must be sure to perform provocative testing of the ACL, including the anterior drawer, Lachman, and pivot-shift tests. Care must be taken to evaluate for meniscal injury or concomitant ligamentous injuries.

### Imaging

Plain radiographs should be obtained. Overall alignment, polyethylene wear, and signs of UKA component loosening should be evaluated. Periprosthetic fracture should be excluded. The deep sulcus sign, a classic radiographic sign of ACL injury, will likely be difficult to visualize because of the UKA component.

Magnetic resonance imaging should be performed. Metal artifact reduction sequences should be considered. Evaluation for ACL fiber discontinuity or abnormal orientation is performed. Care should be taken to evaluate for meniscal injuries or concomitant ligamentous injuries.

### Patient Setup

The patient is placed on the operative table in the supine position. A lateral stress post (Innomed, Savannah, GA) is placed lateral to the mid thigh to allow for valgus stress through the knee to better access the medial compartment. Prior to preparation and draping, the patient is examined under anesthesia. The patient is then prepared and draped in the usual sterile fashion.

### Incision

Standard anterolateral and anteromedial arthroscopic incisions are made to the anterior aspect of the knee. A diagnostic knee arthroscopy is performed. All concurrent intra-articular pathology is addressed at this time. Once an ACL tear is confirmed via arthroscopy, attention is turned to graft harvest.

### Graft Harvest and Preparation

Hamstring harvest is performed by standard techniques. A 3-cm vertical incision is made 3 fingerbreadths inferior to the medial joint line and 1 fingerbreadth medial to the tibial tubercle. Layer 1, defined as the sartorius and associated fascia, should be identified. The gracilis and semitendinosus are located between medial layers 1 and 2.<sup>20</sup> The sartorial fascia is incised at the most lateral aspect. The sartorius with underlying gracilis and semitendinosus is elevated as a flap. Care must be taken to avoid the saphenous nerve, which is also located between layers 1 and 2. The semitendinosus should be identified and carefully dissected from the overlying sartorius. The sartorius and gracilis should be protected while the semitendinosus is harvested with a looped tendon stripper. Next, with the looped tendon stripper left in place, the FiberStick sheath (Arthrex, Naples, FL) is inserted, without suture, inside the tendon stripper. The appropriate dose of bupivacaine is injected along the sheath (Fig 1). Next, the graft is prepared in standard GraftLink fashion (Arthrex) (Fig 2). The graft is further augmented with the addition of SutureTape (Arthrex) as previously described.<sup>21-23</sup>

### Femoral Tunnel Preparation

The anatomic footprint of the ACL is noted on both the lateral femoral condyle and the tibial plateau. The femoral tunnel is then drilled by an outside-in technique. Tunnel placement on the lateral femoral condyle is performed as follows: A proximal-to-distal measurement is taken, and the tunnel is placed at 43% of that distance. From anterior to posterior, the tunnel is placed at  $r$  (radius of graft) + 2.5 mm from the posterior articular cartilage.<sup>24</sup> A lateral incision is made with care to sufficiently incise the iliotibial band to reduce soft-tissue interference throughout the procedure. The femoral tunnel is then reamed using a FlipCutter (Arthrex). A shuttling suture is placed in an outside-in manner through the lateral knee incision and shuttled out the medial portal.

**Fig 1.** The patient is in the supine position with the knee in approximately 90° of flexion. During hamstring graft harvest, a vertical incision is made 3 fingerbreadths inferior to the medial joint line and 1 fingerbreadth medial to the tibial tubercle. A TigerStick (Arthrex) is placed in the tract of the harvested semitendinosus. Local anesthetic can now be injected along the sheath for improved postoperative pain control.



### Tibial Tunnel Preparation

Attention is then turned to the tibial tunnel. By use of an ACL guide, the center of the tibial ACL is noted. The center of the guide is placed at the center in the ACL footprint. The starting point on the tibia is shifted slightly lateral, creating a more vertical tunnel, to avoid the unicompartmental tibial baseplate and associated cement mantle. Fluoroscopy may be used to guide tunnel placement to avoid the tibial baseplate and cement mantle. The tibial tunnel is then reamed with a FlipCutter. A shuttling suture is placed through the tibial tunnel and retrieved through the inferomedial portal. Care must be taken to avoid a soft-tissue bridge between the femoral and tibial tunnel shuttling sutures. To avoid this, a cannula may be used. We prefer to use a “zip-line” technique in which tension is maintained on the femoral shuttling stitch as a ring grasper is slid down the femoral suture to retrieve the tibial tunnel stitch.

### Graft Passage

The graft is now passed through the inferomedial portal. Femoral sutures are passed until the button is flipped and flush with the lateral cortex. Care must be taken to ensure the button is not entrapped superficial to the iliotibial band. This can further be confirmed by directly visualizing the button with the arthroscope or digital palpation. The graft is then drawn into the femoral tunnel, stopping 2 mm from the end of the

femoral tunnel. The graft is brought into the tibial tunnel. Care is taken to ensure that the tibial graft does not bottom out. The knee is now brought into full extension to verify that the ACL is not impinging on the anterior intercondylar notch.

### Graft and SutureTape Fixation

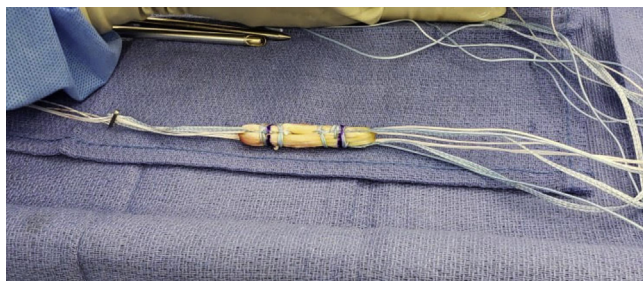
The SutureTape, which is secured through a TightRope button (Arthrex) over the lateral femoral cortex, is now secured independently of the graft. It is secured in full extension, with the assistant applying a posterior drawer force, using a 4.75-mm SwiveLock anchor (Arthrex) distal to the tibial tunnel. The suture anchor should not be unloaded at this point. The tibial side of the graft is secured with an Arthrex ABS button. The tibial TightRope is now tensioned with the knee in 30° of flexion with a posterior drawer force in place. This is followed by tightening the femoral TightRope. The knee is then cycled through the range of motion to condition the graft.<sup>25,26</sup> The graft is again tensioned in 30° of flexion. The arthroscope is reintroduced into the knee, and the graft is probed and examined. The tibial fixation is backed up with a 4.75-mm SwiveLock anchor. This suture anchor should not be unloaded. The femoral TightRope sutures are now tied over the button to prevent loosening.

### Fascia Repair

Attention is now turned to repair of the sartorial fascia and gracilis. The 2 FiberWire sutures (Arthrex) from the previously used SwiveLock anchors are passed through the gracilis and sartorius and tied. As a result, the sartorius and gracilis are restored to their anatomic location on the tibia (Fig 3).

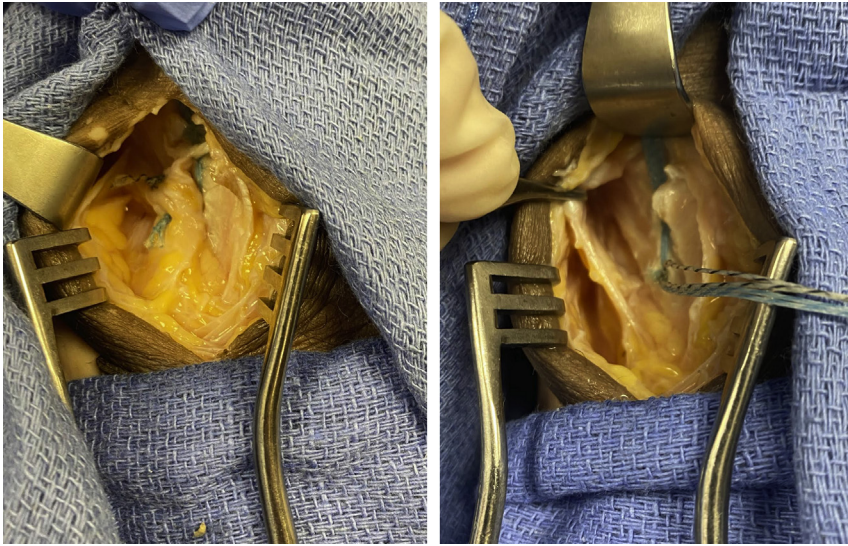
### Postoperative Care

A standard ACL rehabilitation protocol is implemented, which includes weight bearing as tolerated with progressive range-of-motion exercises. There should be an emphasis on full extension, quadriceps strengthening, and patellar mobility. A gradual return to previous activities is allowed as rehabilitation continues to progress.



**Fig 2.** Quadruple looped semitendinosus graft prepared in GraftLink fashion. It should be noted that the graft is augmented with SutureTape.





**Fig 3.** Sartorius repair in cadaveric model. The cadaver is in the supine position with the knee in full extension. The vertical incision, placed 3 fingerbreadths inferior to the medial joint line and 1 fingerbreadth medial to the tibial tubercle, which was used for hamstring graft harvest, is viewed with the aid of a self-retaining retractor. Two FiberWire sutures from the previously used SwiveLock anchors, 1 from the TightRope construct and 1 from the tibial reinforcement, are passed through the gracilis and sartorius and tied. As a result, the sartorius and gracilis are restored to their anatomic location on the tibia.

### Technical Pearls and Pitfalls

The following technical pearls and pitfalls should be noted (Table 1):

1. During portal positioning and scope introduction, care must be taken to avoid iatrogenic damage to the UKA. This can be accomplished by ensuring correct medial portal placement with needle localization. Furthermore, direct visualization should be performed during insertion of instruments through the medial portal.
2. Donor-site pain can be decreased with the following technique: During harvest of the hamstring, the hamstring stripper is replaced with a red cannulated FiberStick and local anesthetic is injected along the tendon sheath, as illustrated in Figure 1.
3. A sufficient lateral femoral incision through the iliotibial band should be made to reduce soft-tissue interference throughout the case. A T-type incision through the iliotibial band can be created to help decrease the risk of soft-tissue interposition throughout the procedure. Verification of button placement can be performed by finger palpation, by insertion of an arthroscope for direct visualization, or with radiographs.
4. The tibial tunnel should be oriented in a more vertical fashion with a more lateral starting point on the tibial metaphysis compared with standard ACL reconstruction. This is done to avoid the uni-compartmental tibial baseplate and cement mantle. This also helps to avoid a stress riser, which could lead to subsequent fractures. Fluoroscopy can be used during this portion of the case.
5. We prefer to use a zip-line technique in which tension is maintained on 1 suture. A ring grasper is then slid down that suture while tension is maintained,

- and the second suture is retrieved. This allows the ring grasper to break through potential soft-tissue bridges while simultaneously creating a single tract.
6. Regarding sartorius repair, the 2 FiberWire sutures from the previously used SwiveLock anchors, 1 from the TightRope construct and 1 from the tibial reinforcement, are passed through the gracilis and sartorius and tied. As a result, the sartorius and gracilis are restored to their anatomic location on the tibia, as illustrated in Figure 3.

### Discussion

UKA is becoming a more prevalent treatment for isolated medial-compartment arthritis. ACL deficiency was traditionally considered a contraindication to performing a UKA because of increased contact stress on the polyethylene insert and altered mechanics. The question remains as to the best treatment option for the cohorts of patients with a previously stable UKA who sustain an acute rupture to the ACL, leading to symptomatic instability. This article details a technique for ACL reconstruction in the setting of a previous UKA.

There are several risks associated with the aforementioned procedure. During portal positioning and scope introduction, there is a risk of iatrogenic damage to the UKA. This risk can be decreased by using needle localization during medial portal placement. Furthermore, direct visualization should be performed during insertion of instruments through the medial portal.

Additional risks with this procedure are periprosthetic tibial plateau fracture and disruption of the UKA baseplate or cement mantle. The tibial tunnel should be oriented in a more vertical fashion with a more lateral point on the tibial metaphysis compared with standard ACL reconstruction. Fluoroscopy can be used during

**Table 1.** Technical Pearls and Pitfalls

Pitfalls	Pearls
Iatrogenic damage to UKA	Iatrogenic damage to the UKA can be avoided by using needle localization during medial portal placement. Furthermore, direct visualization should be performed during insertion of instruments through the medial portal.
Donor-site pain from hamstring harvest	Donor-site pain can be decreased with the following technique: During hamstring harvest, the hamstring stripper is replaced with a red cannulated FiberStick and local anesthetic is injected along the tendon sheath, as illustrated in <a href="#">Figure 1</a> .
Suture button entrapped superficial to iliotibial band	A T-type incision through the iliotibial band can be created to help decrease the risk of soft-tissue interposition throughout the procedure. Verification of button placement can be performed by finger palpation, by insertion of an arthroscope for direct visualization, or with radiographs.
Tibial tunnel placement	The tibial tunnel should be oriented in a more vertical fashion with a more lateral starting point on the tibial metaphysis compared with standard ACL reconstruction. This is done to avoid the unicompartmental tibial baseplate and cement mantle. This also helps to avoid a stress riser, which could lead to subsequent fractures. Fluoroscopy can be used during this portion of the case.
Soft-tissue bridges with suture retrieval	We prefer to use a zip-line technique in which tension is maintained on 1 suture. A ring grasper is then slid down that suture while tension is maintained, and the second suture is retrieved. This allows the ring grasper to break through potential soft-tissue bridges while simultaneously creating a single tract.
Sartorius repair	The 2 FiberWire sutures from the previously used SwiveLock anchors, 1 from the TightRope construct and 1 from the tibial reinforcement, are passed through the gracilis and sartorius and tied. As a result, the sartorius and gracilis are restored to their anatomic location on the tibia, as illustrated in <a href="#">Figure 3</a> .

UKA, unicompartmental knee arthroplasty.

this portion of the case to avoid the tibial baseplate and cement mantle. This tibial tunnel orientation could result in a vertical orientation of the ACL, leading to continued rotational instability, although this is classically associated with vertical femoral tunnel placement.

There are several limitations to this technique. First, this technique would not be indicated in the cohort of patients who present with progressing arthritis in the lateral and patellofemoral compartments. Moreover, the utility of this technique for asymptomatic ACL rupture found incidentally is not fully understood. Further prospective studies with long-term follow-up are needed to delineate the true indications and outcomes.

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