Endoscopic ACL Reconstruction - Mitek Anchor Surgical Technique

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Techniques for the repair and reconstruction of the anterior cruciate ligament (ACL) have advanced rapidly in the last decade. The procedure for ACL reconstruction and its equipment have become progressively sophisticated from what was once an open surgery requiring dislocation of the patella to the point where ACL reconstruction surgery can now be performed endoscopically through one small incision. By avoiding a superior/lateral incision through the quadriceps muscle, the endoscopic technique provides the advantages of reduced soft tissue morbidity, reduced pain and improved cosmetic appearance for the patient, and reduced costs[1] due to the fact that the procedure can be performed on an outpatient basis. However, the success of the procedure in restoring normal stability and function to the knee is still based on the variables of graft type, placement, tension, and fixation, as well as postoperative rehabilitation. Numerous studies have provided valuable information regarding advancements in the surgical technique[2,3,4,5,6,7] and rehabilitation[8,9,10] for ACL reconstruction surgery. Regardless, variable success rates continue to be reported. For failures occurring within the first six months after surgery, graft fixation failure has been shown to be the major cause.[2,11]

The graft fixation method chosen should provide enough strength and stability to withstand the forces of the recommended rehabilitation regimen. The fixation strength must remain high until the replacement tissue can become incorporated within the bone tunnels. Currently available fixation devices for either bone to bone fixation or soft tissue to bone fixation include staples, screw and washers, interference screws, buttons, and anchors. Several studies have evaluated the pull-out strength at the time of implantation of many of the fixation, methods. The ultimate strength of the natural ACL has been documented to

be in the range of 600 N[4,7,12] to 1730 N[12] depending on the age of the specimen tested. In comparison, the weakest fixation method in terms of strength as documented by Robertson et al[5] and Kurosaka et al[2] is the staple fixation with pull-out strengths between 60 N and 150 N. The strongest fixation strength was shown to be a screw with washer technique with pull-out strengths between 223 N and 821 N depending on the type of graft tissue used.[5,7] The pull-out strength for interference screws, buttons, and anchors were in the range of 123 N to 475 N.[2,4,13,14,15] In addition to pull-out strength, each fixation method offers its own advantages and disadvantages. For instance, interference screws can be difficult to place endoscopically within the bone tunnel and may loosen their fixation within the tunnel over time. Interference screws also reduce the area of exposed graft tissue within the tunnel which can retard bone growth to the graft. Devices such as staples and screws with washers are placed extra-articularly and can cause irritation under the skin of the patient. Buttons have no solid fixation to the bone and require sutures to interface to the ligamentous tissue which reduces fixation strength and may require additional protection during the rehabilitation phases. The anchors are a relatively new device to ACL reconstruction surgery. They rely on Dacron tape to interface with the bone or soft tissue of the replacement graft. The Dacron tape provides a stronger interface than sutures, yet allows more surface area of the graft to be exposed to the bone tunnel thus encouraging bone ingrowth into the graft. Longer tendon type grafts may be attached directly to the device by threading the graft through the loop on the anchor. The anchors have wire "arcs" that allow the anchor to be fixed or "anchored" directly to the bone. If necessary, anchors can be easily removed via a lateral thigh incision and do not necessitate joint arthrotomy.

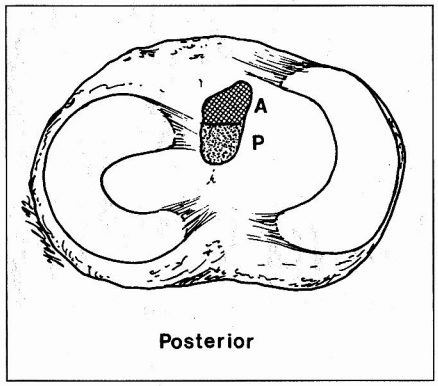

Figure 1: Position of tibial tunnel. Tibial tunnel should be located in the posterior one-half of the normal attachment site of the ACL on the tibial plateau.

The purpose of this paper is to describe the surgical techniques for ACL reconstruction using a Mitek Ligament Anchor for femoral fixation. A description of the procedure for a bone- tendon-bone graft and for a soft tissue graft will be presented.

SURGICAL PROCEDURE

Notchplasty

After performing a thorough diagnostic arthroscopy and any necessary chondral or meniscus work, the intercondylar notch is debrided of remaining ACL ligamentous tissue, as well as the ligamentum mucosa and overhanging fat pad. Depending on the shape and size of the intercondylar notch, a notchplasty, including the superior and lateral walls of the femur, is performed. Care is taken to open the distal portion of the notch and to not remove any portion of the lateral wall or change the normal attachment site of the ACL. The amount of notchplasty can be minimized by accurate placement of the graft.

Graft Harvest and Preparation

After the notchplasty is completed, the ligament graft is harvested and prepared. Autografts of patellar, semitendinosus, or gracilis tendons, as well as Achilles or patellar tendon allografts can be used with the ligament anchor. Soft tissue grafts are attached to the anchor either directly or with Dacron tape. If the surgeon prefers "bone to bone" healing, a length of 3-5 mm Dacron tape is threaded through drilled holes in the patellar tendon bone block or Achilles tendon calcaneus bone block and then tied directly to the metal loop of the anchor.

Tibial Tunnel

It is important that the position of the tibial tunnel, as it enters the knee, be accurately located in relationship to the intercondylar notch (Fig. 1). Although the position "anterior medial" to the normal anterior cruciate ligament attachment has been popularized in the past, this is an undesirable position. It is better

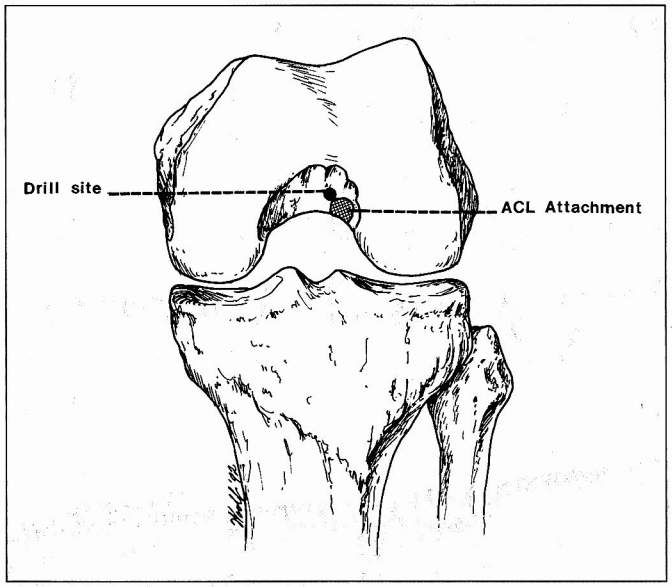

Figure 2: Position of femoral tunnel in relation to ACL femoral attachment.

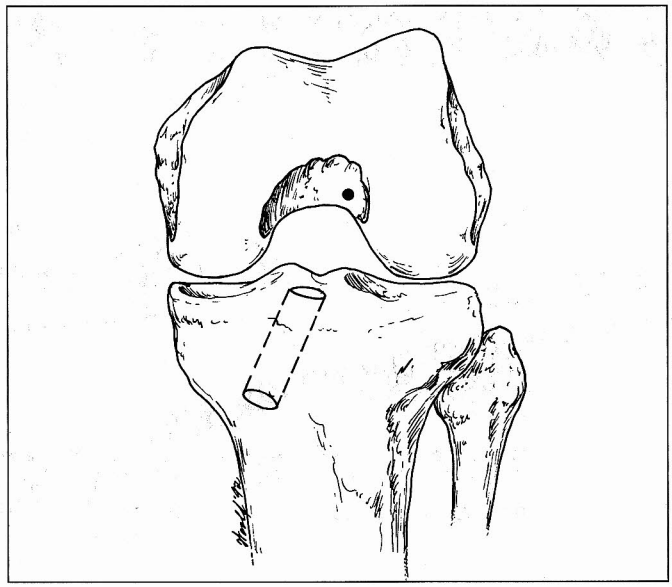

Figure 3: Position of femoral tunnel in relation to tibial tunnel location.

to have the tibial tunnel located in the posterior one- half of the normal attachment site of the ACL on the tibial plateau. This more posterior position minimizes the need for superior or lateral notchplasty and helps reduce the tendency of abrasion on the graft from the intercondylar ridge. Once this position has been located, a tibial drill guide is used to place the guide pin through the tibia from distal to proximal. The harvested graft is then sized and the appropriate diameter reamer is used to drill the tibial tunnel over the guide pin. The tibial tunnel is then debrided at both ends and the sharp edges are chamfered using a bone rasp.

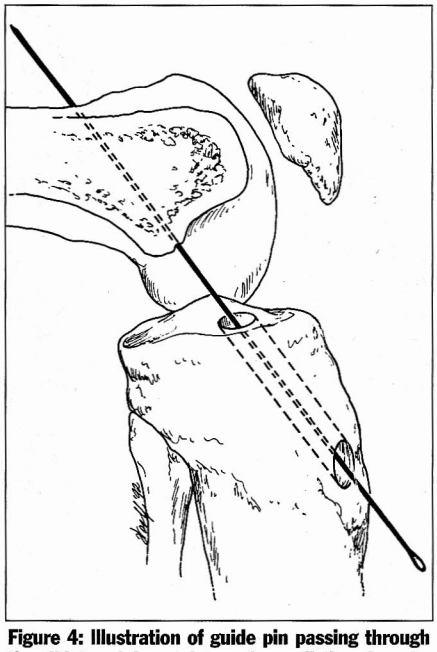

Figure 4: Illustration of guide pin passing through the tibial and femoral tunnels, until the pin exits the lateral femoral cortex.

Femoral Tunnel

The femoral attachment site of the ACL on the lateral intercondylar notch is identified. The use of anatomic landmarks, either under direct vision or radiographically, can be very difficult. This is particularly true if the intercondylar notch shape is affected by anatomic variation, previous surgery, or osteophyte formation. A position that is approximately 5 mm from the "over-the-top" area of the posterior notch (eleven o'clock or one o'clock position within the notch) is identified (Fig. 2, 3). An Isotac (Acufex, Mansfield, MA) with sutures attached to it is implanted at the identified position. The sutures are then brought through the tibial tunnel and attached to an isometer. The knee is brought through a range of motion and the maximum displacement of the suture as measured with the isometer is recorded for both flexion and extension. A position that allows 2-4 mm displacement in extension and 0-2 mm displacement in flexion is recommended for optimal graft function within the notch. An experienced surgeon will be able to visually identify the position for the femoral tunnel, however, the use of an isometer allows quantitative documentation of tunnel placement. Once the position in the proximal intercondylar notch is located, a guide pin is passed through the previously drilled tibial tunnel, through the point on the lateral condyle (Fig. 4) until the pin exits the lateral femoral cortex. Normal femoral tunnel length will vary from 4 to 6.5 cm. When using the Mitek Ligament Anchor, it is preferable to have a longer tunnel so that the tip of the anchor, which lies outside of the lateral femoral cortex, does not irritate the more mobile tissues closer to the patella. The length of the tunnel can be varied by changing the angle of the guide pin and also by changing the knee flexion angle. To lengthen the femoral tunnel, the knee is placed in more extension as the guide wire is passed through the femur. Care must be taken to avoid damage to the posterior cortex due to either an "overly posterior" pin placement or use of too large a femoral socket reamer.

Femoral Tunnel and Socket Preparation

After the guide pin has been positioned in the femur, a 6 mm diameter endoscopic drill is passed over the pin. Care is taken to slowly penetrate the lateral femur to avoid damage to the cortex (Fig. 5). The 6 mm diameter tunnel accommodates the Mitek ligament anchor. The 6 mm drill is removed along with the guide pin. The

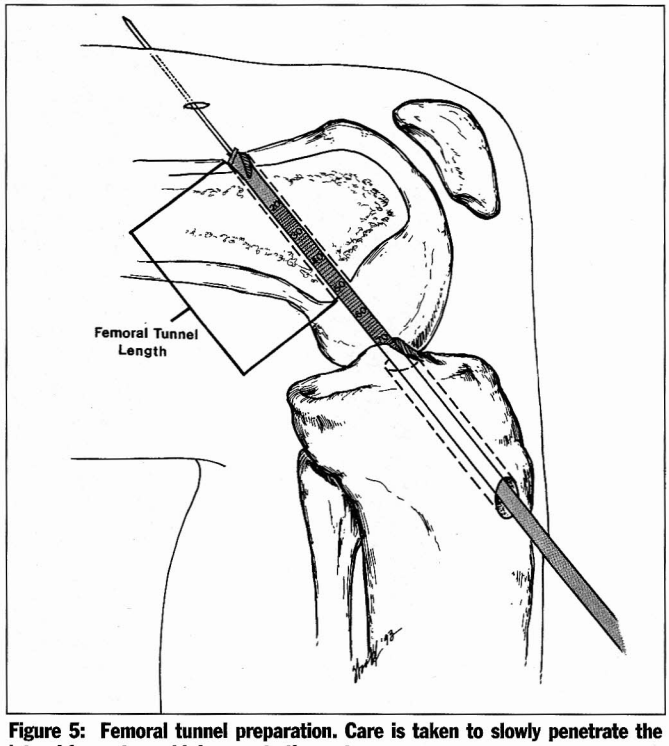

Figure 5: Femoral tunnel preparation. Care is taken to slowly penetrate the lateral femur to avoid damage to the cortex.

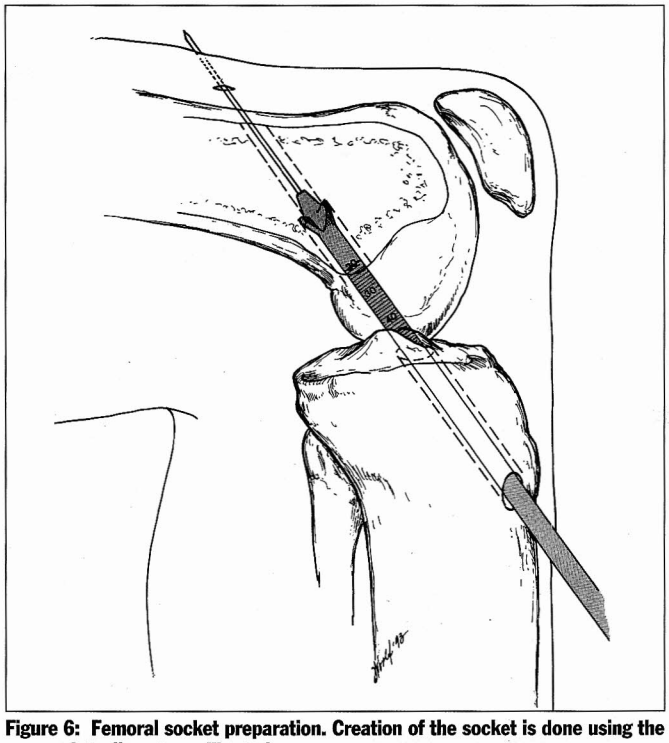

Figure 6: Femoral socket preparation. Creation of the socket is done using the appropriate diameter calibrated reamer.

length of the femoral tunnel is measured with a depth gauge and the guide pin is then reinserted.

Once the femoral tunnel length has been determined, the ligament "socket" can be created using the appropriate diameter calibrated reamer (Fig. 6). The length of the socket is influenced by the amount of graft length the surgeon wants in the tunnel. The length of the anchor/Dacron tape assembly should then be adjusted to fit within the remaining length of the femoral tunnel (beyond the socket) (Fig. 7).

After the socket reamer has been removed, the guide pin is pulled superiorly until the distal end enters the femoral tunnel. This allows for cleaning and irrigation of all debris, as well as smoothing or chamfering of any sharp edges of the tunnel opening. Once complete, the guide pin should be repositioned so it exits distally at the tibial skin incision.

Preparation of the Graft/Anchor Assembly

The graft diameter is sized by using the graft sizing block provided by the manufacturer to check dimensions and to ensure the assembly can be inserted within the prepared socket diameter. The sized (diameter and length) graft is laid out with the anchor to establish assembly dimensions with respect to the femoral tunnel length and socket depth.

The attachment of soft tissue grafts to the anchor can be accomplished directly or by means of Dacron Tape. For direct application, the tendon is looped through the anchor body. Alternatively, Dacron tape is tied at one end to the mid portion of the tendon and at the other end to the anchor. Soft tissue grafts that have been doubled over can be sutured together to facilitate handling and insertion of the anchor/graft assembly into the femoral tunnel. The attachment of bone block grafts to the anchor is accomplished indirectly with Dacron tape. The Dacron tape is connected at one end to the anchor and at the other end it is passed through drill holes in the bone block portion of the graft. Once

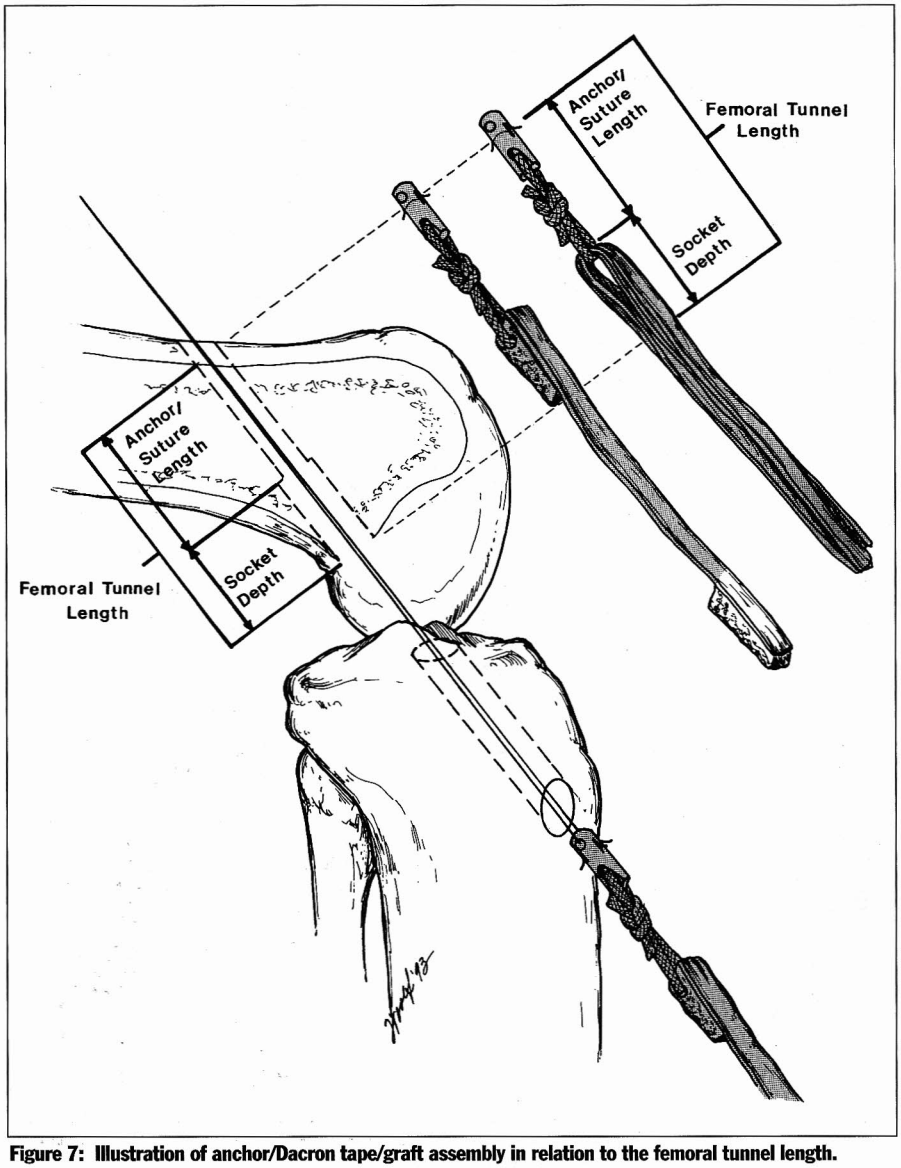

Figure 7: Illustration of anchor/Dacron tape/graft assembly in relation to the femoral tunnel length.

Figure 8a: Lateral view radiograph depicting ideal anchor position. Anchor arcs are both above and below the lateral cortex.

Figure 8b: Lateral view radiograph depicting non-ideal anchor position. All four anchro arcs are protruding from the cortex.

attached to the anchor, either directly or via the Dacron tape, the anchor/graft assembly should be pulled in tension and the distance from the etched line on the anchor to the point on the graft where the surgeon wants the graft to exit the tunnel should be measured. This distance should be compared with the length of the socket and femoral tunnel to verify that the length of the anchor/graft assembly is correct. The point on the graft where it will exit the tunnel should be marked with ink directly on the graft to facilitate proper graft placement within the tunnel.

Ligament and Anchor Placement

A #5 traction suture is provided attached to the nose of the Mitek ligament anchor. This suture is threaded through the slotted distal end of the guide pin. The pin is pulled proximally out the skin of the lateral thigh to deliver the traction suture which is then gripped with a surgical clamp or pliers. The suture is pulled proximally through the femoral tunnel, drawing the anchor and its attached graft carefully through the tibial tunnel and into the intercondylar notch. Once the anchor is visualized in the intercondylar notch, an arthroscopic probe is used to position the tip of the anchor such that it will enter the femoral tunnel without damaging the PCL or other structures. While observing the anchor with the arthroscope, the traction sutures are pulled proximally to draw the anchor/graft assembly through the femoral tunnel until the anchor arcs just exit the lateral femoral cortex. If the length of the femoral tunnel had been marked on the graft with vital dye, the surgeon will also have confirmation that the arcs of the anchor have just exited the lateral femoral cortex. If a soft tissue graft with length of 6-8 mm is being used, caution should be taken not to pull the graft through the socket into the femoral tunnel (anchor hole) allowing the anchor to protrude into the quadriceps muscle. To "set" the anchor into the cortex, the anchor/graft assembly is pulled back toward the femur. Approximately 25 lbs of traction are recommended[13] to set the anchor arcs into the femoral cortex. The ideal anchor position is one in which the anchor arcs are both above and below the lateral cortex (Fig.8a). If all four anchor arcs protrude from the cortex (Fig. 8b), then there will more likely be soft tissue irritation. If a longer tunnel has been drilled, as previously discussed, then this will not be a problem.

Tibial Fixation of the ACL Graft

After the ligament has been pulled into position and the anchor is set, the graft is tensioned and visualized with the arthroscope in the lateral portal, as the knee is brought through a range of motion. Any notch impingement should be corrected by further notchplasty at this time.

The position of the knee and the tension applied to the graft at the time of tibial fixation should be determined by the surgeon. Bone-tendon-bone preparations require less tension than tendon preparations, and fixation near extension is safer in regards to achieving a complete range of motion postoperatively.

The ACL graft is then fixed on the tibia depending on the type of graft chosen. If a bone-tendon-bone graft is used, an interference screw can be inserted in the typical fashion. If a soft tissue graft has been used or the distal bone portion of a graft extends beyond the tibial tunnel, a screw and washer can be employed with equal confidence (Fig. 9).

After tibial fixation of the graft has been achieved, the traction suture, used to pull the anchor and graft into position, is simply removed by cutting one end and sliding it out of the anchor and through the skin.

Anchor Removal

In the event that the anchor must be removed, its cortical location on the femur facilitates access. The anchor is approached through a lateral femoral incision (approximately one inch in length). Dissection through the quadriceps and the placement of retractors will expose the tip of the anchor (a small osteotome can be used to facilitate exposure). The anchor has a 2.4 mm central cannulation to allow access to sever any suture, tape, or soft tissue within the metal loop of the anchor. Once this step is completed, the anchor can be extracted by grasping it with a surgical clamp or pliers, or using wire traction.

Postoperative Care/ Rehabilitation

The postoperative rehabilitation protocol will vary depending on surgeon preference. However, the Mitek Ligament Anchor with tape provides a strong femoral fixation and thus early range of motion exercises and more rapid recovery time similar to interference screw fixation can be employed.

DISCUSSION

The Mitek anchor provides the surgeon with a unique capability to perform single tunnel ACL reconstructions through one small incision. As a result,

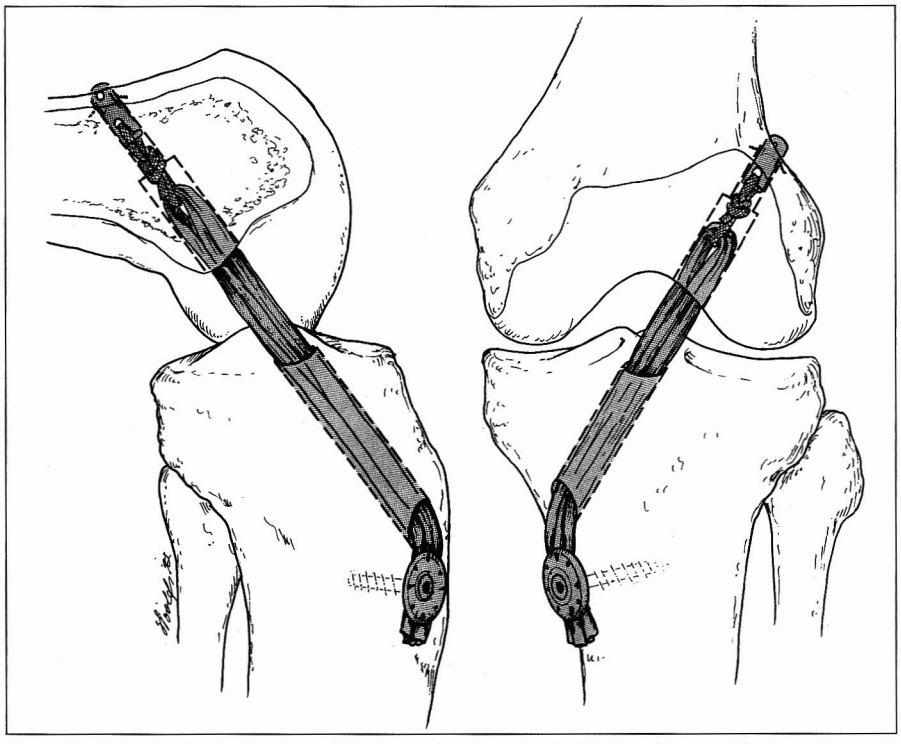

Figure 9: Lateral and anterior views of final graft location showing tibial and femoral fixation with a soft tissue graft.

the patient experiences less pain and scarring. In addition, operating room times are shorter and the patient can be treated on an outpatient basis, thus keeping costs to a minimum.

Similar to any surgical technique, the Mitek anchor fixation is not guaranteed. Since the barbs or arcs on the anchor body must be secured to the femoral cortex which results in the superior end of the anchor being slightly proud, it is important that the anchor be placed well into the thigh and under the quadriceps musculature, away from the patellar sulcus and rectus tendon. If the anchor is placed more distal, near the patellar sulcus and rectus tendon, irritation can ensue from the prominence of the anchor. The ideal location for the anchor is to have two barbs outside of the lateral femoral cortex and two barbs within the cortex, such that the prominence of the anchor is lessened and the fixation strength is increased.

It should be noted that if a small soft tissue graft is used with the anchor, it is possible to pull the graft into the five millimeter tunnel extending from the ligament socket. It is therefore imperative that the ligament be marked with vital dye at the point where the surgeon wants the ligament to exit the tunnel. When the surgeon observes the marked line reaching the appropriate position in the intercondylar notch at the entrance of the femoral tunnel, no further force should be applied. Once the ligament is pulled into position, based on this marking, distal traction should be applied to set the barbs into the femoral cortex. If the tissue tends to slide back into the tunnel and the ligament mark proceeds more distal, the anchor has not been properly engaged into the femoral cortex. The ligament should be pulled back into position with more force until the anchor can be set and the ligament no longer travels distal with distal traction.

Rehabilitation of the patient after performing this surgical technique is rapid and equal to those rehabilitation protocols using central third patellar tendon. Because the fixation with the Mitek anchor proximally and a screw and ligament washer distally is very firm, there should be no fear of allowing full range of motion and immediate weight bearing. As with all ligament procedures, the patient's joint should be pain free, with no effusion and with good muscular strength, before returning to sports activities. In our experience, this takes approximately six to nine months. STO

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