Technical Note

Arthroscopic Anterior Cruciate Ligament Reconstruction Using Quadriceps Tendon Autograft and Bioabsorbable Cross-Pin Fixation

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Abstract: We describe a technique for arthroscopic anterior cruciate ligament (ACL) reconstruction using the middle third of the quadriceps tendon without a patellar bone block and absorbable tibial and femoral cross-pin fixation. The central part of the quadriceps tendon is harvested through a 5-cm long anterior skin incision without a patellar bone block. Tibial and femoral tunnels are prepared, the graft is passed up the tunnels, and is fixed both in the femur and the tibia using absorbable cross pins (Rigid Fix; Mitek, Johnson & Johnson, Norwood, MA). In this way, the graft is stabilized near the joint line, providing outlet fixation. In our practice, very good results have been obtained with the use of this technique. **Key Words:** ACL reconstruction—Cross pins—Fixation—Quadriceps tendon autograft.

Graft choice for anterior cruciate ligament (ACL) reconstruction remains a controversial issue, but most surgeons are using autografts and, especially, the bone–patellar tendon–bone (BPTB) graft and the hamstring tendon autograft (HTA). Donor-site morbidity from BPTB graft harvesting led to the use of other graft alternatives, such as the quadrupled hamstring tendons, the quadriceps tendon, and allografts.[1-3] During the last few years, the quadriceps tendon autograft (QTA) has been used with increasing frequency for both primary and revision ACL reconstruction.[4-8]

The QTA has several advantages and disadvantages.[4,5] The QTA is easy to harvest, can be obtained with or without a patellar bone block, and is adequately thick to accommodate an expanded tibial tunnel in revision operations. Disadvantages of the QTA include the under-reported donor-site morbidity, the need to perform an additional skin incision, the lack of long-term clinical studies using this type of graft, and the scarcity of data regarding the biomechanical properties of the quadriceps tendon and its fixation methods. A technique for arthroscopic ACL reconstruction using the middle third of the quadriceps tendon without a patellar bone block is described using absorbable cross pins to accomplish both femoral and tibial fixation.

OPERATIVE TECHNIQUE

The patient is placed supine on the operating table and, after induction of general or spinal anesthesia, a pneumatic tourniquet is inflated. The anterolateral

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Figure 1. The middle third of the quadriceps tendon in the left knee is separated from the rest of the tendon using parallel blades (star, patella).

viewing and the anteromedial working arthroscopic portals are then created. Diagnostic arthroscopy is initially performed and all secondary intra-articular injuries are recorded and addressed. The ACL remnants are debrided and the posterior and lateral aspect of the intercondylar notch is prepared. Limited notchplasty or lateral femoral wall plasty may be performed to eliminate graft impingement. The quadriceps tendon is harvested through a midline anterior, 3- to 5-cm long incision, starting at the proximal pole of the patella and extending proximally. A transverse skin incision may also be appropriate for graft harvesting. Skin flaps are raised, the entire width of the quadriceps tendon is exposed, and the central 8 to 10 cm of the tendon is harvested without a patellar bone block (Fig 1). The skin incision can be easily mobilized to facilitate graft harvesting. The quadriceps tendon is very thick and usually it is not necessary to harvest the posterior leaf of it, thus sparing the vastus intermedius tendon. The harvested quadriceps tendon autograft is usually 8 to 9 cm long, 10 mm wide, and 8 mm thick. If violated, the knee joint capsule is repaired with absorbable sutures and the tendon gap is closed with a continuous stitch. The free ends of the autograft are stitched on the back table using Fiberwire sutures (Arthrex, Naples, FL) to facilitate graft passage, and the diameter of the graft is measured. Unlike hamstring tendon, the quadriceps tendon is not looped (Fig 2). The tibial and femoral tunnels are drilled according to the diameter of the graft. The tibial tunnel is opened using a free hand guide, placing a guide pin at the posterolateral aspect of the native ACL stump. The tibial tunnel is then drilled by over-reaming with a cannulated drill of appropriate diameter. A dilator can then be passed up into the knee joint through the tibial tunnel to check for impingement in flexion and extension.

An offset guide is used to drill the femoral tunnel to the diameter of the graft and to a depth of 30 mm. The femoral tunnel is drilled close to the posterior femoral wall at the 10- or 2-o'clock position in the right or left knee, respectively, leaving a 1- to 2-mm thick posterior wall. A tight fit in both the femoral and tibial tunnels between the quadriceps tendon and the bony wall is desirable to improve ingrowth, while the edges of the bony tunnels are chamfered to avoid graft abrasion. The next step in the technique is to drill 2 transverse femoral holes to accommodate the cross pins. A guide rod of appropriate diameter is attached to an external targeting system and is inserted into the femoral tunnel either through the anteromedial arthroscopic portal or transtibially (Fig 3A). Using a special sleeve and drill, 2 parallel 3.3-mm holes are drilled through the lateral femoral condyle, crossing the femoral tunnel in a lateral to medial direction. The drill is removed and the sleeves remain within the lateral femoral condyle (Fig 3B). The 4-cm long cross pins will be inserted through these sleeves. Once the cross-pin sleeves are in the condyle, knee motion is not allowed to avoid sleeve bending caused by the iliotibial band.[6]

Preparation of the tibial fixation site follows using a similar targeting rod and the drill-sleeve system (Fig 4). Tibial fixation is carried out from anteromedial to

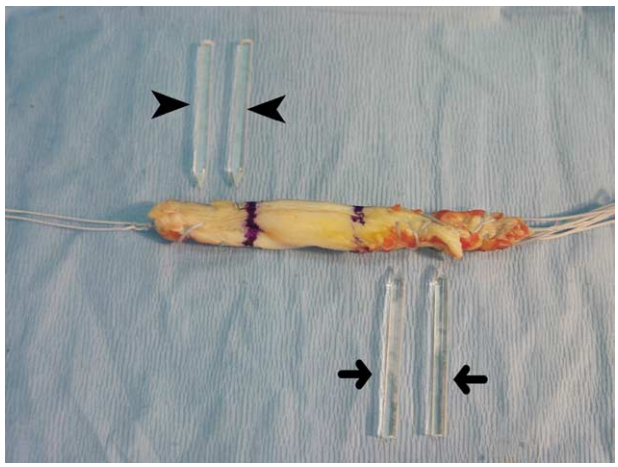

Figure 2. The quadriceps tendon autograft before implantation relative to the absorbable cross pins, with both ends whip stitched (arrows, tibial cross pins; arrowheads, femoral cross pins).

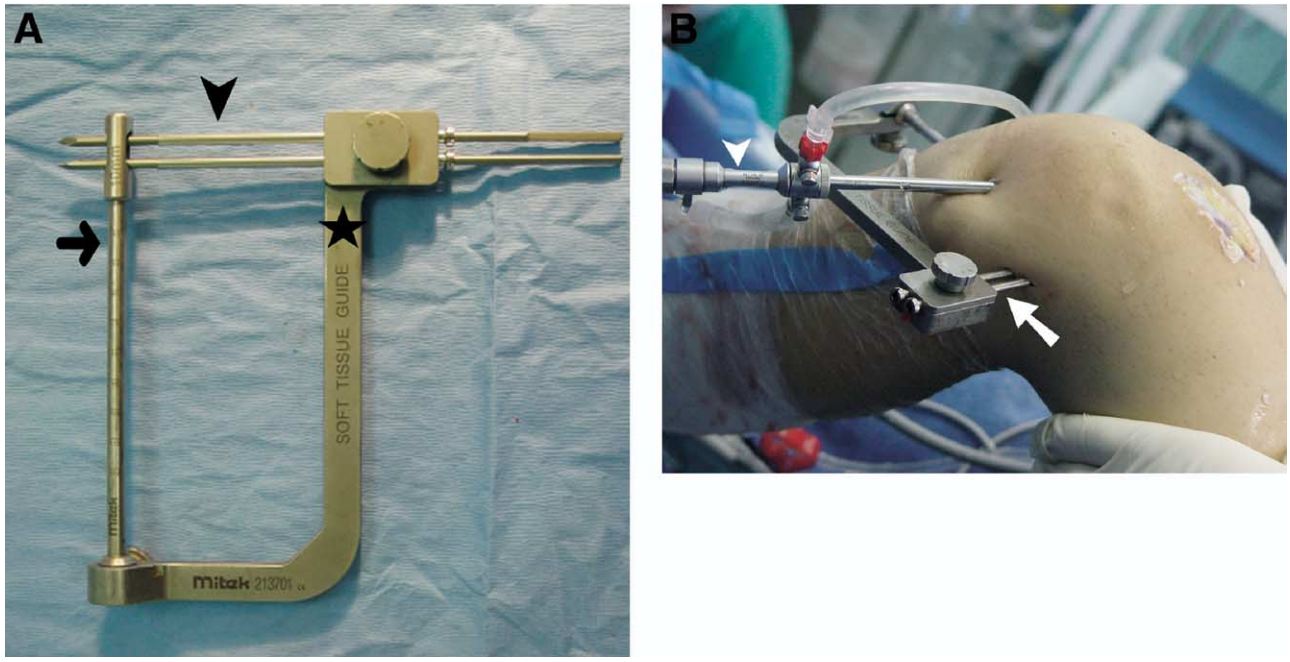

FIGURE 3. (A) The femoral targeting device. A cannulated rod of appropriate diameter (arrow) is inserted into the femoral tunnel. Drilling of 2 parallel drill holes is performed with an external targeting device (star) with 2 parallel drill sleeves (arrowhead). Once completed, the external guide is removed, leaving only the drill sleeves in the drill holes to facilitate cross-pin insertion. (B) The femoral targeting device in place in the left knee. The 2 parallel sleeves (arrow) are inserted into the lateral femoral condyle. Central placement of the drill holes is verified with the arthroscope (arrowhead) after removing the targeting device.

posterolateral. Two parallel, 3.3-mm holes are drilled between the medial and the lateral tibial condyle, crossing the tibial tunnel. The drill is withdrawn and the 2 parallel tibial sleeves remain in place. One must take care to ensure the presence of enough bone stock to avoid cross-pin protrusion through the posterolateral tibial cortex.

A long guide pin with an eyelet is then placed

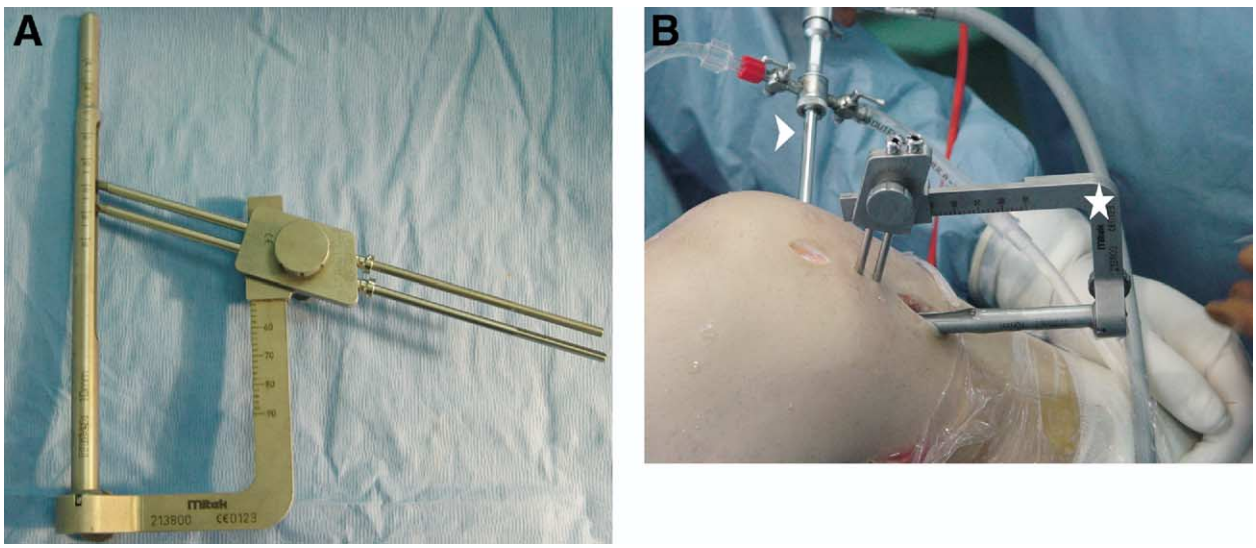

FIGURE 4. (A) The tibial targeting device is similar to the femoral one. A significant difference is the direction of the fixation pins (obliquely from anteromedial to posterolateral). (B) View of the medial aspect of the left knee (star, targeting device; arrowhead, arthroscope).

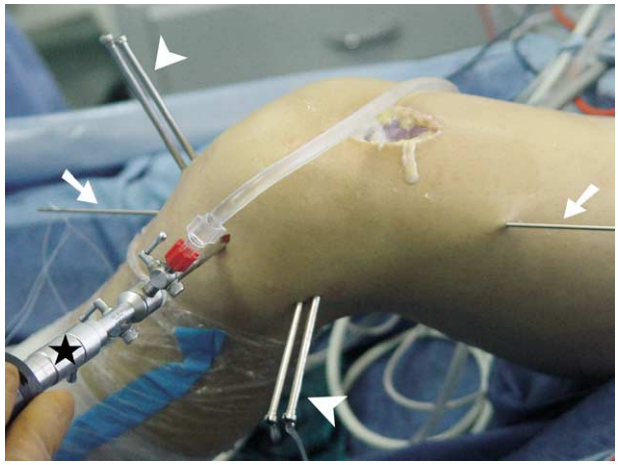

Figure 5. The left knee just before insertion of the QTA and accomplishment of graft fixation. A Beath pin (arrows) will pull the graft into the tunnels. The 2 couples of tibial and femoral pin sleeves (arrowheads) are in place. The procedure is arthroscopically supervised (star).

through both tibial and femoral tunnels and out through the lateral femoral cortex. The autografts' proximal end suture has already been threaded through the eyelet and the graft is pulled up into the knee joint and into the femoral tunnel (Fig 5). Femoral fixation is carried out first with 2 parallel cross pins (Rigid Fix; Mitek, Johnson & Johnson, Norwood, MA); while applying tension to the traction suture the cross pins skewer the quadriceps tendon graft. With the graft placed under tension by pulling the tibial side sutures, cycling through the full range of knee motion is carried out and the tibial cross pins are inserted in 30° of knee flexion. Postoperatively, the knee is protected in a knee brace, full weight bearing as tolerated is allowed, and an accelerated rehabilitation program is considered.

DISCUSSION

The clinical results of most ACL reconstructions using BPTB and HT autografts are equivalent.[9] One issue the surgeon must keep in mind when selecting a graft type is the accompanying donor-site morbidity, but the final graft choice depends primarily on the surgeon's preferences. The donor-site morbidity following QTA harvesting is not extensively reported but, in our experience, patients report considerable pain during the first 2 weeks and pain during flexion for the first 4 to 6 weeks, but in the long term no local symptoms are reported. QTA harvesting is straightforward and less time-consuming compared with the other autografts. The QTA is very useful, especially in revision cases, because of its greater thickness.[10]

The biomechanical and anatomic properties of the quadriceps tendon have been the subject of a number of detailed studies. Fulkerson and Langeland[4] have reported that the quadriceps tendon can be an effective graft source with or without proximal patellar bone as a primary reconstruction alternative. The ultimate tensile failure load of the QTA was shown to be 1.36 times that of a comparable BPTB graft.[11]

Cross-pin fixation for hamstring tendon ACL reconstruction provides good clinical results.[12] The Rigid Fix cross-pin fixation system is a reproducible technique used initially for femoral fixation of quadrupled hamstrings autografts. The cross pins used for hamstring tendon fixation are 3.3 mm in diameter, are made of poly-L-lactide, and are bioabsorbable. Poly-L-lactide may cause tissue reaction in some patients, although we have never encountered any serious problem related to the use of such implants for HTA or QTA fixation.[13] The pins are inserted as close to the joint line as possible to provide outlet graft fixation. The distance between the articular surface and the proximal absorbable pin measures about 15 mm. As with this system, the graft is stabilized near the joint on both sides (femur and tibia) and a graft length of about 8 or 9 cm is sufficient for ACL replacement. Additionally, posterior wall blow-out does not represent a serious problem because the graft is fixed within the tunnel proximal to its intra-articular outlet. Graft stabilization with absorbable pins inserted perpendicular to the femoral tunnel provides a secure fixation when compared with other soft-tissue fixation devices. The yield load of bioabsorbable Rigid Fix cross pins in a single-cycle load-to-failure test using human hamstring tendon was 868 $\pm$ 171 N, and the stiffness was 77 $\pm$ 17 N/mm.[14]

We usually harvest the QTA without a bone block. Not harvesting patellar bone block reduces the operative time and possible related complications, such as a patellar fracture. When the QTA is harvested with a patellar bone block, tibial fixation can be also performed using 2.7-mm absorbable cross pins or an interference screw.[15] Cross-pin fixation is contraindicated in tibial or femoral metaphysis osteopenia or cystic degeneration, as may be the case in ACL revision procedures. In conclusion, the technique we have described for arthroscopic ACL reconstruction is reliable and combines the advantage of using the middle third of quadriceps tendon and absorbable outlet fixation.

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