Quadriceps Tendon-Patellar Bone Autograft for Anterior Cruciate Ligament Reconstruction

A Technical Note

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Abstract

The quadriceps tendon autograft can be used for primary and revision anterior cruciate ligament (ACL) reconstruction. Despite several successful clinical reports, graft fixation issues remain, and the ideal technique for fixation continues to be controversial. We present a technique of ACL reconstruction with quadriceps tendon autograft (QTA) using a patellar bone block. The tendon end is fixed in the femoral tunnel and the bone plug in the tibial tunnel using reabsorbable interference screws. The advantages of this technique are related to the increase in stiffness of the graft, the achievement of a more anatomic fixation, and a reduction in synovial fluid leakage.

The autologous grafts most frequently used for anterior cruciate ligament (ACL) reconstruction are the central one-third of the bone-patellar tendon-bone (BPTB) and the hamstring (semitendinosus and gracilis, STG).1 The central one-third of the BPTB is a commonly used graft because of its strength and associated short healing period.1,2 However, the use of a BPTB graft can cause anterior knee pain, pain on kneeling, patellar tendon rupture, patellar fracture, and fat pad herniation.1,5 The use of the hamstring tendons avoids disruption of the extensor mechanism but can lead to hamstring muscle weakness, requires a longer amount of time for incorporation into the bone tunnels, and may induce ACL agonist weakness and disruption of the protective ACL proprioceptive arc.1,5

The quadriceps tendon autograft (QTA) is becoming a popular graft for primary and revision ACL reconstruction.6 The QTA is easy to harvest,7,8 can be obtained with7 or without8 a patellar bone block, is adequately thick to accommodate an expanded tibial tunnel in revision operations,9 produces fewer donor site problems than if the patellar tendon is harvested,6,9,10,11 has excellent mechanical characteristics,6,8,10,11 is attributed with a larger cross-section area when compared to the patellar tendon,7,9,12,14 and induces minimal quadriceps inhibition after the quadriceps harvest.13 The residual strength of the extensor mechanism is less impaired by central QTA harvest than by harvest of a BPTB graft.6 QTA is an alternative to BPTB, especially in patients who spend much time on their knees or who require deep flexion of the knee,7,9,13 but fixation issues remain.7,9,12,14

Anatomic graft fixation is important for achieving acceptable postoperative knee stability after ACL reconstruction. Secure graft fixation, graft tension during fixation, and graft fixation level are crucial aspects in ACL reconstruction.13,15 Anatomic graft fixation provides the greatest initial stability for the reconstructed knee13,15 and results in minimal graft elongation with early postoperative range of motion, leading to less pathological laxity in the long term.13,15 An ACL graft, positioned and fixed at the anatomic origin and insertion of the original ACL will minimize graft length change and graft tension, avoid anterior to posterior sagittal windshield-wiper graft motion, and produce low laxity measurements through the whole of the range of motion of the knee.7

We present a technique of ACL reconstruction with QTA using a patellar bone block. The tendon end is fixed in the femoral tunnel and the bone plug in the tibial tunnel using reabsorbable interference screws. The advantages of this technique are related to the increase in the stiffness of the...
Surgical Technique

A suprapatellar incision, about 5 cm long, is performed (Fig. 1). Skin flaps are raised, exposing the entire width of the quadriceps tendon (Fig. 2), and the central portion of the tendon is harvested with a patellar bone block (Fig. 3). The quadriceps tendon is prepared, and the free end is stitched on the back table using FiberWire® sutures (Arthrex, Naples, Florida) to facilitate graft passage. The diameter of the graft is measured. The bone plug should be 20 mm long, 9 to 10 mm wide, and 8 mm thick. The tendon portion should be 70 to 80 mm long, 10 mm wide, and 6 to 7 mm thick, allowing passage in an 8 mm diameter template.

After the graft is harvested, the following procedural steps take place:

• The tibial footprint of the ACL should be identified. The residual ACL is then debrided with a shaver. A limited notchplasty should be performed to allow adequate visualization of the posterior border of the intercondylar notch.
• The tibial tunnel should be placed in the posterior half and medial-lateral center of the native ACL tibial footprint. The tibial drill guide should be adjusted to a 50° angle, and the tibial tunnel should be reamed with a 10 mm cannulated reamer. We drill the femoral tunnel 1 mm smaller than the desired size and enlarge it with the appropriate size drill.
• After having measured the femoral and tibial tunnel length, the graft is positioned at the superior edge of the bone plug into the tibial socket at the level of the tibial plateau, and the tendon edge inside the femoral tunnel (Fig. 4).
• Under arthroscopic control, we check that the bony extremity of the graft advances in the tibial tunnel to reach the level of the joint line. Thus, the tibial tunnel is totally filled in its articular portion, which increases

Figure 1 A suprapatellar incision, about 5 cm long, is performed.

Figure 2 Skin flaps are raised, exposing the quadriceps tendon.

Figure 3 The central portion of the tendon is harvested with a patellar bone block.
the contact area of the graft with the cancellous bone of the tunnel and facilitates bony integration close to the articular joint line, achieving an anatomic fixation, with reduction in synovial fluid leakage.\textsuperscript{13,15}

- Femoral fixation is performed through the anteromedial portal, using a reabsorbable screw 1 mm larger than the dilated tunnel (Fig. 5).
- The bone end of the graft is secured to the anteromedial tibia, using a reabsorbable screw under arthroscopic control.
- The graft is then rechecked for tension under arthroscopy. Postoperatively, the knee is protected in a knee brace, and full weightbearing as tolerated is allowed.

**Discussion**
A technique of ACL reconstruction with QTA, using a patellar bone block, is described. This technique increases the stiffness of the graft,\textsuperscript{7} achieves a more anatomic fixation,\textsuperscript{13,15} and reduces synovial fluid leakage.\textsuperscript{13,15} QTAs are employed for primary and revision ACL reconstruction.\textsuperscript{8} Many methods of fixation for QTA have been described, including the quadriceps-tendon patellar-bone composite autograft\textsuperscript{11}; fixation of the graft, both in the femur and the tibia, using absorbable cross pins\textsuperscript{16}; and fixation of the patellar bone in the femoral tunnel, with the tendinous extremity of the graft pulled by nonabsorbable wires, remaining firmly fixed by a staple or a screw in the anterointernal cortex of the tibia.\textsuperscript{8} Despite several successful clinical reports,\textsuperscript{8,10,11} graft fixation issues remain, and the ideal technique for fixation remains controversial.\textsuperscript{7} This is a most important factor determining the outcome of ACL reconstruction.\textsuperscript{6,7,9}

A well described intraoperative complication in ACL reconstruction is a situation of graft-tunnel mismatch, particularly at the tibial tunnel.\textsuperscript{13,15} The consequences of this mismatch may be lower graft stiffness and graft micro-motion, which could potentially cause postoperative bone resorption and the “windshield-wiper” phenomenon.\textsuperscript{13,15}

A short plug within the tibial tunnel may increase lytic effects on the graft due to synovial fluid leakage into the tibial tunnel,\textsuperscript{13,15} one possible cause of tunnel widening after ACL reconstruction.\textsuperscript{13} This has led to the development of procedures to accommodate the length mismatch.\textsuperscript{13,15}

Ishibashi and colleagues\textsuperscript{15} reported that the knee becomes more lax when the tibial fixation site is moved farther from the tibial plateau. The investigators concluded that laxity, as a result of a decline in graft stiffness, increases with graft length.

The more anatomic ACL reconstruction techniques\textsuperscript{13} provide significantly higher structural properties and a less likely loss of fixation compared with nonanatomic, extracortical fixation with indirect repair on both fixation sites, resulting in the lowest structural properties.\textsuperscript{13} Different methods have been proposed to obtain anatomic graft fixation at the tibia and the femur, including use of an endobutton, interference screw, soft-tissue fixation, and bicortical screw.\textsuperscript{7,12,13,17,18}

The current investigators fix the bone plug in the tibial tunnel at the level of joint line, achieving anatomic fixation.\textsuperscript{13} In our technique, after having positioned the superior edge of the bone plug into the tibial socket at the level of the tibial plateau, the tendon end of the graft is fixed in the femoral tunnel using a reabsorbable screw that is 1 mm larger than the dilated tunnel.

Interference screw fixation provides good results in ACL reconstruction. Since Pinczewski and coworkers\textsuperscript{19} presented a new surgical technique in which a hamstring tendon graft without bone plug was fixed directly to the walls of the femoral bone tunnel with an interference screw, many investigators have reported the success of this modality of
fixation. Soft-tissue grafts without a bone plug are fixed directly to the wall of a cancellous bone tunnel, allowing return of the transition zone from ligament to fibrocartilage, to calcified fibrocartilage, to bone.

Based on these findings, to allow extensive contact between the bony wall of the tunnel and graft collagen, we drill a 4 to 5 cm femoral tunnel that is 1 mm smaller than the desired size and fix the tendon end into the femoral tunnel using a bioabsorbable interference screw.

**Conclusion**

Quadriceps tendon graft for ACL reconstruction is an alternative composite graft in ACL reconstruction. We present a technique that allows anatomic tibial graft fixation at the level of the intercondylar floor, approaching the normal physiometry of the normal ACL. Thus, we minimize graft length changes, minimize graft tension, avoid anterior to posterior sagittal windshield-wiper type graft motion, thereby producing a more stable reconstruction through full range of motion of the knee.

**Disclosure Statement**

None of the authors have a financial or proprietary interest in the subject matter or materials discussed, including, but not limited to, employment, consultancies, stock ownership, honoraria, and paid expert testimony.

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