Full-Thickness Quadriceps Tendon Autograft for Anterior Cruciate Ligament Reconstruction

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Background: Quadriceps tendon autograft is used increasingly worldwide for primary anterior cruciate ligament (ACL) reconstruction, but remains at the third place after patellar tendon and hamstring grafts. It has shown very good results in biomechanical and clinical studies, but most of the authors describe a partial thickness tendon graft.

Indications: This presentation describes the technique for a full-thickness quadriceps tendon autograft with an original technique of fixation on the femur and provides tips and tricks to avoid pitfalls.

Technique Description: Arthroscopic preparation of the tunnel is performed before graft harvesting, to obtain the exact length of the graft needed. The femoral tunnel is drilled through the anteromedial portal, 30 to 40 mm long. For the tibial tunnel, a classic drill guide system is used, set at an inclination of 40°. The total length from the tibia to the femur is measured, which allows to position the femoral fixation on the cortex without pulling it into the soft tissue. Harvesting of the graft is done using a double-bladed scalpel, using the entire thickness of the quadriceps tendon. The bone block is detached with an oscillating saw and osteotome, and the defect in the quadriceps tendon closed in 2 layers. The graft is calibrated according to the tunnel preparation and sutured on the bony end with non-absorbable sutures tied to an endobutton. Tibial fixation is achieved by tying 2 non-absorbable sutures over a cortical screw in maximum tension with a sliding type knot, to automatically adjust the tension. Final fixation is performed with a titanium interference screw.

Results: In the senior author series over the last 20 years, there was only 1 intraoperative patella fracture, treated with osteosynthesis. In accordance with the literature, full-thickness quadriceps tendon graft is strong and allows back to play at the same level as before the injury, in most cases, with lower donor site morbidity than patellar tendon and hamstrings grafts, without a difference in muscle strength compared with partial thickness grafts.

Discussion/Conclusion: ACL reconstruction with full-thickness quadriceps tendon has shown very good clinical outcomes, with very few complications. It can be recommended for primary and revision ACL reconstruction.

Keywords: ACL reconstruction; quadriceps tendon; technique; graft preparation; arthroscopy

VIDEO TRANSCRIPT

In this video, we present the surgical technique for an anterior cruciate ligament (ACL) reconstruction with a full-thickness quadriceps tendon autograft.

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Submitted September 18, 2021; accepted October 14, 2021.

The authors declared that they have no conflicts of interest in the authorship and publication of this contribution. AOSSM checks author disclosures against the Open Payments Database (OPD). AOSSM has not conducted an independent investigation on the OPD and disclaims any liability or responsibility relating thereto.

Video Journal of Sports Medicine (VJSM®), 2(1), 26350254211058731
DOI: 10.1177/26350254211058731

None of the authors have a conflict of interest.

The goal of this video is to describe the surgical technique for an ACL reconstruction using a full-thickness quadriceps tendon with a bone block. It includes tips to avoid pitfalls, our rehabilitation protocol, and a literature review.

What are reasons why we prefer a quadriceps tendon graft in high demand patients? First, its strength. Anatomical and histologic studies have shown equivalent or superior properties to the patellar tendon, regarding volume and strength. Second, there is a predictable tissue mass, and the length is adjustable. With the quadriceps tendon, one can control the length of the graft, which is not the case with the patellar tendon, and one can also control its diameter, unlike with the hamstrings. In addition, there is no weakness in ACL agonists, better return to same level play, average higher Tegner score, less long-term muscle weakness, and low morbidity in terms of no nerve damage, and less pain than with a hamstring graft.

This clinical case illustrates our indications and technique. A 25-year-old, rugby player, presented with a noncontact knee injury, immediate swelling, and inability to continue playing. On clinical examination, he had full range of motion with a grade 3 Lachman and pivot shift. On x-ray, he had a Segond fracture, pathognomonic for an ACL tear. Magnetic resonance imaging (MRI) showed a distinctive lateral femoral bone bruise with complete rupture of the ACL and no associated meniscus or cartilage damage.

Provocative testing under anesthesia confirmed a grade 3 Lachman and pivot shift. For positioning, the leg is placed on a triangular footrest, which allows different angles of flexion with a thigh support to stabilize the leg.

Surgery starts with an arthroscopic examination. Through the anterolateral portal, no chondral or meniscal lesion is noted on the medial side. The absence of ramp lesion is confirmed by passing the scope through the intercondylar notch. Complete disruption of the ACL from the femur is seen. The lateral compartment is normal. The femoral tunnel is drilled through the antero medial portal. We aim for a point just behind the lateral intercondylar ridge and proximal to the lateral bifurcate ridge, which is the anatomical landmark separating the femoral insertions of the anteromedial and posterolateral bundles.

A marked guide wire is used to measure the exact length of the femoral tunnel. In this case, it measured 36 mm. A mark is drawn at 30 mm on the 9-mm drill bit. The drill is first advanced by hand in an anticlockwise direction to avoid damaging the posterior cruciate ligament. The drill bit is now motorized and drilled 30 mm into the femur. The tunnel is then dilated to 9.5 mm. A thinner 4.5-mm drill is used to drill through the lateral cortex of the femur to allow for the later passage of an endobutton. A double suture is placed through the guidewire and retrieved on the lateral upper leg. For the tibial tunnel, we use a classic drill guide system, set at an inclination of 40°. The tunnel will exit in the joint in an oval-shaped hole allowing the tibial drill hole to be made on the anterior aspect of the ACL footprint. The tunnel is made with a 9.5-mm drill, and the cancellous bone bits are preserved.

The suture is retrieved through the tibial tunnel. A knot is made in the suture and positioned at the entrance of the femoral tunnel. The length of the tibial tunnel and the intra-articular length of the graft is measured; here it is 65 mm. Adding this length to the femoral tunnel gives the total length from the tibia to the femur which allows, when pulling the graft into the knee, to position the femoral fixation on the cortex without pulling it into the soft tissue. Bony fragments from the femoral drilling are removed and the tunnel cleaned with a tape.

For the graft harvesting, a 6- to 7-cm skin incision is made from the upper pole of the patella proximally. The tendon portion is exposed, and a double-bladed scalpel is used to make 2 parallel incisions 9 mm apart, 65 mm long, of the entire thickness of the tendon, by following the orientation of the tendon fibers to the center of the patella. A clove hitch knot is made with fiberwire at the proximal end of the tendon before detaching it; this allows for a constant tension in all the fibers of the tendon, as well as manipulation of the graft. The patellar tendon block is cut with an oscillating saw, 20 mm long, 9 mm wide, and 9 mm thick. The depth of the cut is guided by the attachment of the posterior fibers of the tendon. The bone block is carefully detached with an osteotome. The defect is grafted with the recovered tibial bone, and the tendon is infiltrated with a long-acting local anesthetic. The defect in the quadriceps tendon is closed, in 2 layers, with continuous running absorbable suture.

The bone block is then prepared to pass through the 9.5-mm sizer for a perfect fit within the prepared femoral canal. Two Krackow-type unabsorbable sutures are placed in the tendinous end of the graft and the size determined; in this case, 10 mm. Both ends of the bone block is beveled, and a bony groove is created on the cancellous side of the block. At the bone tendon junction, a drill hole is made and at the other end, a V-shape notch. Fiberwire is passed through the drill hole and then tied with a sliding knot to an endobutton at a length that will place the bone block inside the femoral tunnel. The sliding knot and the V-shape cut prevent the bone block from swiveling inside the knee.

The graft is passed through the traction suture and passed upward from the tibia to the femur. A needle holder is placed at the previously measured total length from the femoral cortex to the tibial cortex. The graft is pulled into the joint till the placed needle holder abuts against the tibia; the endobutton is then flipped. This maneuver prevents pulling the endobutton into the soft tissue of the thigh. Isometric evaluation of the graft is now performed; the aim is to have perfect isometry, but slight tightening of the graft in extension is also acceptable. Tibial fixation is achieved by tying the 2 fiberwires over a cortical screw in maximum tension with a sliding type knot. The knee is cycled a few times, allowing the graft to bed in and the sliding knot to automatically adjust to possible anisometry. The second wire is also tensioned and knotted, and the screw tightened on the 2 traction wires.

Final tibial fixation is obtained by the use of a 9-mm titanium interference screw. The position of the screw in the tunnel is checked with a scope ensuring that it is at the correct depth and not damaging the graft. Anteroposterior stability was perfect but considering the preoperative explosive pivot shift, a lateral extra-articular tenodesis was added. A modified Lemaire technique was used where a 9-mm strip of iliotibial band is passed beneath the lateral collateral ligament and then through a 4-mm bony tunnel on the lateral flare of the femur and then back onto itself where it is sutured with nonabsorbable sutures.

Postoperative, we recommend immediate full range of motion and weight bearing with crutches for the first 4 weeks. For outdoor movements, we suggest an articulated brace allowing full flexion but preventing the last 15° of extension. The brace should be seen as a safety harness preventing accidental forced hyperextension and is recommended for 4 to 6 weeks postsurgery.

The rehabilitation protocol is given to the patient and the physiotherapist and follows the usual steps after ACL reconstruction. The one we use is inspired by the protocol used by the LaPrade team. Return to sport is envisaged from 6 months, and pivotal sports in competition from the eighth month.

Intraoperative complications are rare. Patellar fracture happened only once in our practice. The use of a small saw and, above all, good visualization of the thickness of the cut by detaching the tendon part first, can avoid this complication. The graft should always correspond to the diameter and especially to the desired length, because it is taken after the preparation of the tunnels according to the needs. The anisometry of the graft will be related to poor positioning of the tunnels. The aim is to target the ACL remnant, and the femoral tunnel should be drilled in the IDEAL zone, behind the resident ridge, near the insertion of the anteromedial bundle.

Why do we use the full thickness of the tendon? Because it is difficult to individualize the tendon layers and it is possible to damage it by making an oblique section. Furthermore, the clinical results are excellent, without slowing down or preventing muscle recovery.

Why do we use a bone block? Because it increases the length of the graft by 20 mm, useful if the tendon is very short, but above all to promote the bone-on-bone integration, which is much faster than the integration of the tendon into the bone.

Herewith a summary of our tips and tricks. Suturing the tendon before detaching it is easier and keeps the fibers evenly stretched. Infiltrating the tendon significantly reduces postoperative pain and allows the patient to contract the quadriceps quickly. The closure of the tendon in 2 planes allows to obtain a sealed joint and to avoid postoperative dehiscence. The bone block is beveled to allow it to be pulled out if it gets stuck in the joint. The 2 strands of the fiberwire are locked in small grooves and by using a sliding knot, the bone block is locked into the suture which avoid swiveling during traction. By using a suture instead of a continuous loop endobutton, the length can be accurately controlled allowing for perfect positioning of the graft in the tunnel. The tibial fixation around a cortical metal screw provides a stable and economical primary fixation, and the first wire is fixed with a slipping knot to avoid excessive tension of the graft. The tibial interference screw has blunt edges and is positioned on the suture part of the tendon to avoid dilaceration. Metallic devices are inexpensive and can be identified on an x-ray even in the long term, which is useful in case of revision.

Thank you for your attention.

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