Technical Note

Anterior Cruciate Ligament Reconstruction Basics: Quadriceps Tendon (All-Soft Tissue) Autograft Harvest—Part 1

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Abstract: Anterior cruciate ligament reconstruction with quadriceps tendon autograft has become increasingly popular for primary and revision anterior cruciate ligament reconstruction surgery. Although there are a variety of techniques available for performing quadriceps tendon autograft harvest for anterior cruciate ligament reconstruction, a minimally invasive, all-soft tissue harvest technique can result in a reproducible, reliable graft while minimizing donor-site morbidity. In this Technical Note, we describe our preferred technique for quadriceps tendon autograft harvest for anterior cruciate ligament reconstruction.

Anterior cruciate ligament reconstruction (ACLR) is one of the most common orthopaedic surgeries performed worldwide.[1] In comparison with other autografts, quadriceps tendon (QT) autografts have gained increasing recognition as the result of their decreased donor-site morbidity while maintaining excellent clinical outcomes.[2-4] QT is a versatile and reliably robust graft option for ACLR. It can be harvested as a partial- or full-thickness graft, either as all-soft tissue or with a patellar bone block from the superior pole of the patella. An all-soft tissue QT graft minimizes donor-site morbidity and graft-related complications associated with bone harvesting.[5] In this Technical Note, we describe a QT autograft harvest for ACLR (Video 1).

Surgical Technique

Patient Positioning

The patient is placed supine on the operating table, and general anesthesia is induced. An examination under anesthesia is performed to assess for instability and confirm the diagnosis of ACL tear. A well-padded tourniquet is then placed high on the proximal thigh, and a foot holder is oriented so that the knee can be maintained in 90° of flexion. The operative leg is prepped and draped in standard fashion. After completion of a surgical timeout, the surgical extremity is exsanguinated, and the tourniquet is inflated.

Graft Harvest

If there is any concern regarding the integrity of the injured ACL and possible candidacy for primary ACL repair, a diagnostic arthroscopy should be performed before graft harvest. Otherwise, the senior author prefers to perform the graft harvest before the arthroscopy. The operative leg is flexed to 90° to place tension on the QT. Bony landmarks, including the superior, inferior, medial, and lateral borders of the patella, as well as the tibial tubercle, are identified and marked on the skin. An approximately 2-cm longitudinal incision is made, beginning 1 to 1.5 cm proximal to the superior pole of the patella (not directly over the patella), extending proximally. A transverse incision can also be used, which may be more cosmetic. The senior author prefers a small longitudinal incision to allow for extension if needed to facilitate concomitant procedures, such as meniscus/cartilage transplantation and/or osteotomy. Excising the subcutaneous fat can be beneficial to effectively increase exposure and aid in visualization (Table 1). After dissecting down through the subcutaneous tissue, the oblique fibers of the paratenon are

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Received April 21, 2024; accepted May 25, 2024.

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2212-6287/24646
https://doi.org/10.1016/j.eats.2024.103146

incised longitudinally to expose the QT. Using a 4 × 4 gauze sponge, the QT is bluntly cleared of residual fat, and the overlying soft tissue is stripped using a Cobb elevator both proximally and distally.

Once adequate exposure is obtained, an Army-Navy retractor is placed at the apex of the incision, and the arthroscope is inserted to visualize the extent of the tendon proximally. The light from the arthroscope can be used to help mark the skin at the musculotendinous junction (Fig 1), denoting the orientation and direction for graft harvesting without having to visualize the entire tendon (thus keeping the incision small) and ensuring the harvest allows for at least 65 mm without violating the rectus femoris muscle belly (Table 1).

Next, the end of the push rod from the QuadPro tendon harvester (Arthrex, Naples, FL) is marked with a sterile marking pen (Fig 2A), which is then "stamped" onto the distal aspect of the QT, essentially on the superior pole of the patella (Fig 2B). This circular "stamp" is used to demarcate and approximate the width of the subsequent harvest incisions. The senior author prefers the 10-mm QuadPro for nearly all patients but will elect to harvest a smaller graft (no smaller than 8.5 mm) for smaller-sized patients. Next, with a fresh #15 scalpel, parallel longitudinal incisions are made on the inner medial and lateral aspects of the push rod "stamp," with a transverse cut made most distally connecting the 2 longitudinal cuts to release the distal-most aspect of the QT off the superior pole of the patella. Care is taken to release the tendon distally by staying directly on the bone to obtain the maximum amount of tendon length. Once control of the distal tendon is achieved, an Allis clamp is then placed on the distal aspect of the tendon, and the full-thickness dissection is continued for approximately 2 to 4 cm proximally with the scalpel. Care is taken to avoid widening the dissection plane, especially for a full-thickness harvest, to avoid harvesting a graft that is too thick (Table 1). Next, a FiberLoop SutureTape (Arthrex) is passed through the distal aspect of the tendon with 2 to 3 circumferential whipstitches without removing the needle (Fig 3A). For easier suture passage through the graft, rotate the SutureTape loop so that the thinnest portion is at the needle (Table 1). This suture allows for tension and control of the graft as the dissection is continued

Table 1. Pearls and Pitfalls of Quadriceps Tendon Autograft Harvest Using the QuadPro Tendon Harvester

Pearls	Pitfalls
Excise the subcutaneous fat to improve visualization during quadriceps tendon harvesting.	Failure to identify the quadriceps musculotendinous junction and direction of harvest may result in injury to the rectus femoris muscle.
Use the arthroscope light to mark the overlying skin corresponding to the musculotendinous junction.	Widening the dissection plane can result in harvesting a graft that is too thick.
An arthroscopic knot-pusher can be used to close the quadriceps tendon defect, depending on the size of the incision and the length of the harvest.	

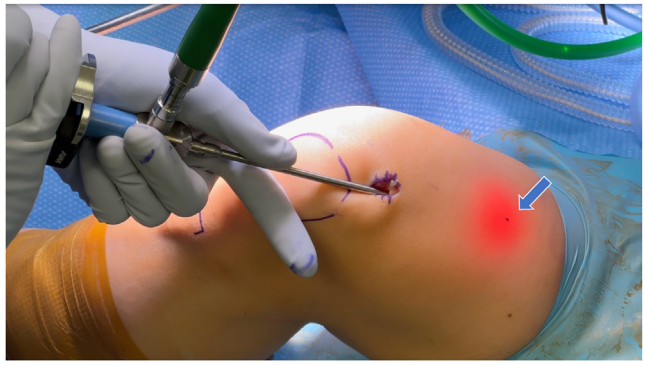

Fig 1. Intraoperative view of a left knee. The light from the arthroscope is used to mark the overlying skin corresponding with the musculotendinous junction (blue arrow). This mark designates the proximal limit of the quadriceps tendon and the direction for graft harvesting.

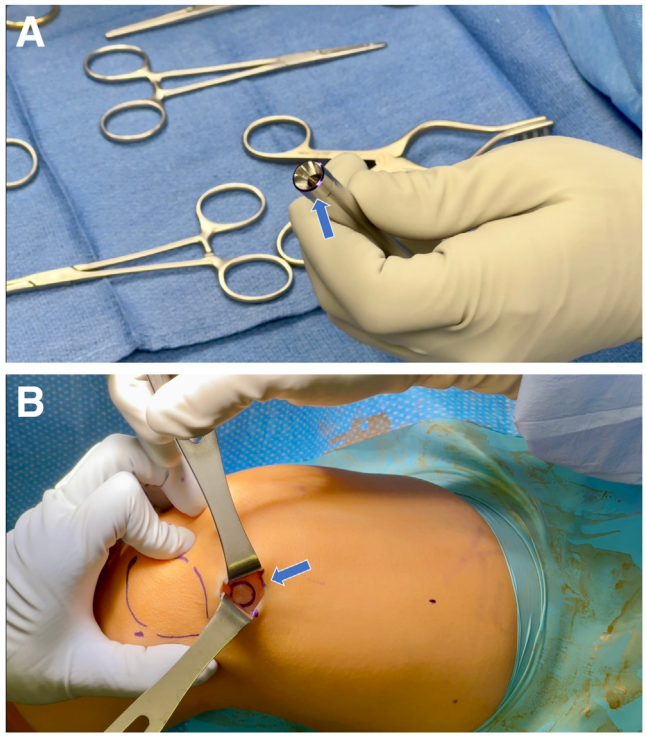

Fig 2. Intraoperative view of a left knee. (A) The end of the push rod from the QuadPro tendon harvester (blue arrow) is marked. (B) This is "stamped" into the quadriceps tendon to approximate the width of the incision for graft harvesting (blue arrow).

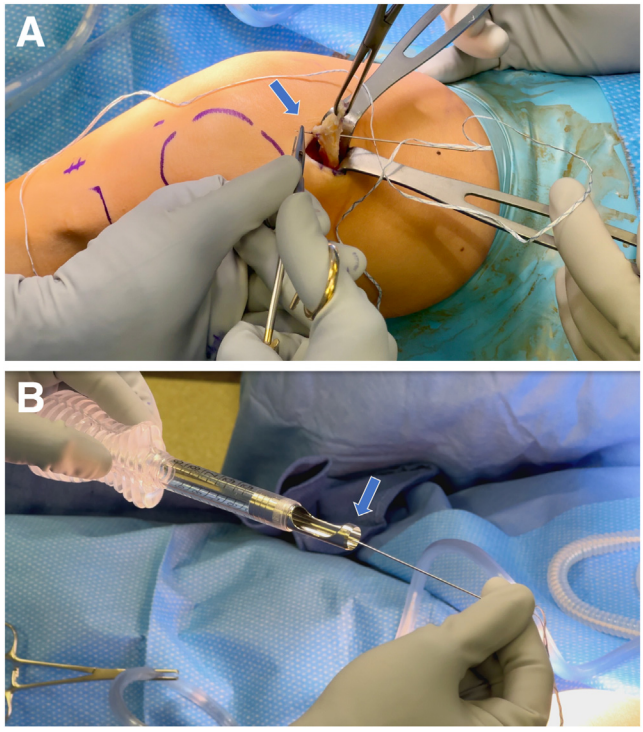

Fig 3. Intraoperative view of a left knee. (A) A FiberLoop SutureTape is passed through the distally released quadriceps tendon (blue arrow). This allows tension control for proximal graft harvesting. (B) The FiberLoop SutureTape needle is then dropped through the QuadPro tendon harvester (blue arrow). The weight of the needle pulls the FiberLoop SutureTape through to the other end of the instrument.

proximally. Making the incision slightly proximal to the superior pole of the patella allows adequate visualization to harvest approximately 3 to 4 cm of the tendon with a scalpel before the QuadPro is used to continue harvesting proximally. The FiberLoop SutureTape needle is then dropped through the sharp cylindrical tip of the QuadPro, and the sutures are pulled distally through the cannulation to the "handle end" of the harvester (Table 1; Fig 3B). The needle is then cut and passed off the field. While pulling tension on the sutures, the harvester is pushed toward the exposed end of the tendon until the tendon is inserted into the tip of the device (Fig 4). As pressure is applied, the QuadPro tendon harvester is rotated in a 360° circular fashion, using quarter turns in the same direction to advance the dissection proximally until the desired graft length is achieved. The senior author prefers to perform "all-inside" ACLR when using QT and aims for a graft length of 70 mm for most patients, up to 75 mm for patients taller than 5′10″, and as short as 65 mm for patients shorter than 5′2″. Care is taken to keep the harvester parallel to the femur to obtain a consistent graft thickness. Once the desired length is achieved, the harvester is withdrawn until the graft amputation window is

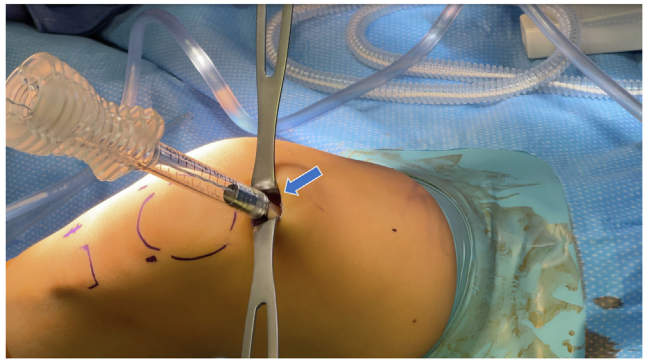

Fig 4. Intraoperative view. The QuadPro tendon harvester is pushed over the distal quadriceps tendon in the left knee (blue arrow).

accessible, and then the distal aspect of the graft is shuttled through the window using the tagging suture. The harvester is reinserted into the incision until it reaches the previously dissected measurement length. Still holding tension on the tagging suture, the push rod is inserted into the tendon harvester cannulation and driven forward to transect the proximal end of the graft. The graft is safely transferred to the back table for graft preparation.

Harvest Site Closure

Because of the full-thickness nature of the harvest, to avoid fluid extravasation during subsequent arthroscopy, the tendon harvest site is reapproximated with 0-VICRYL sutures (Ethicon, Somerville, NJ) using the Scorpion Suture Passer (Arthrex). Typically, 4 to 6 sutures are passed with the Scorpion in a simple configuration and tied in standard fashion (Fig 5 A and B). Depending on the size of the incision and the length of the harvest, an arthroscopic knot-pusher can be used (Table 1). The QT harvest defect is closed with the knee in 90° of flexion, and care is taken to avoid overtightening the tendon. A vancomycin-soaked Ray-Tec sponge is pushed into the harvest incision until final closure.

Discussion

This Technical Note describes a minimally invasive QT autograft harvest using the QuadPro tendon harvester. Although bone–patella tendon–bone (BPTB) grafts have shown improved clinical outcomes, postoperative stability, and high return-to-sport rates, these grafts are associated with harvest-related complications, particularly anterior knee pain.[6,7] QT harvesting is associated with a smaller incision, likely contributing to less graft-site pain and sensory loss compared with BPTB autografts.[7,8] BPTB grafts are also associated with an increased risk of patella fracture and patellar tendon rupture.[6] Although this is rare, an all-soft tissue QT autograft eliminates these risks.

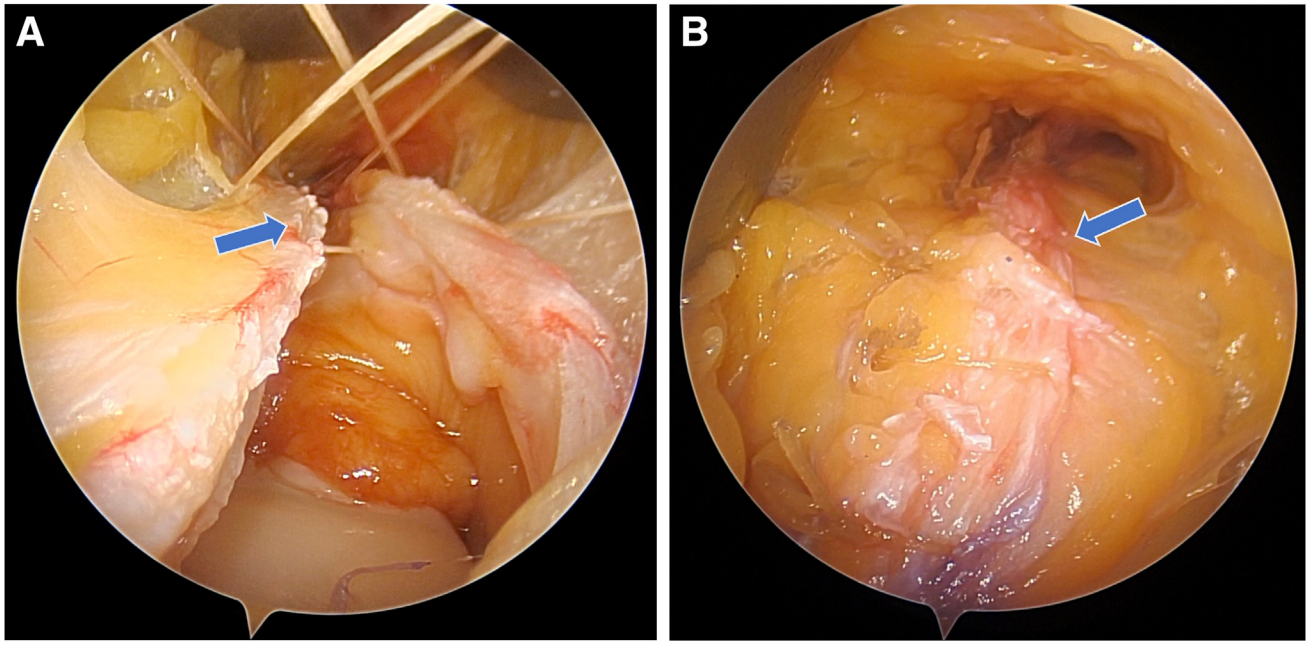

Fig 5. An arthroscopic view from the quadriceps incision of a left knee demonstrating (A) closure of the central defect of the quadriceps tendon using a Scorpion self-retrieving suture passing device and a simple interrupted suture technique, working proximal to distal (blue arrow). (B) The completed closure is shown (blue arrow).

The QT can be harvested as a full-thickness or partial-thickness graft. Full-thickness harvest consistently yields a larger and more robust tendon.[9] The theoretical advantages of a full-thickness graft include increased tensile strength, lower failure rates, and improved stability.[10] Notably, a recent systematic review of 20 studies found no significant differences in outcomes or complication rates between full-thickness and partial-thickness grafts for primary ACLR.[10] On the contrary, full-thickness harvest has conventionally required a larger incision compared with minimally invasive partial-thickness techniques, potentially leading to increased donor-site morbidity.[9] There is also an increased risk of penetrating the joint capsule or suprapatellar pouch with a full-thickness harvest, allowing fluid extravasation during arthroscopy.[11] This emphasizes the importance of taking the precautionary steps highlighted in this technique and the necessity for careful closure of the full-thickness defect after harvest. Despite the potential disadvantages, the authors feel harvesting a full-thickness QT graft is technically easier and provides a consistently thicker tendon, likely leading to a more reproducible and reliable harvest.[11]

Although a minimally invasive QT harvest can improve postoperative outcomes, it may be considered technically challenging by some, requiring a considerable learning period (Table 2). Failure to identify the musculotendinous junction and direction of harvest can result in injury to the surrounding quadriceps musculature. Overall, this Technical Note offers a minimally invasive QT autograft harvest, providing a vastly simplified, efficient, safe, and reproducible option for ACLR.

Table 2. Advantages and Disadvantages of Quadriceps Tendon Autograft Harvest Using the QuadPro Tendon Harvester

Advantages	Disadvantages
Quadriceps tendon autograft is associated with reduced donor-site morbidity	Technically challenging with learning curve
Graft length is accurately approximated under direct visualization using the QuadPro Tendon Harvester.	Risk of injury to quadriceps musculature with poor technique
Minimally invasive harvesting reduces soft-tissue trauma, decreases the risk of infection, and improves cosmesis.	

Disclosures

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: R.M.F. reports board membership for American Academy of Orthopaedic Surgeons, American Orthopaedic Society for Sports Medicine, American Shoulder and Elbow Surgeons, Arthroscopy Association of North America, International Cartilage Regeneration & Joint Preservation Society, International Society of Arthroscopy Knee Surgery and Orthopaedic Sports Medicine, *Journal of Shoulder and Elbow Surgery*, and *Orthopedics Today*;

consulting or advisory and speaking and lecture fees from AlloSource; consulting or advisory, funding grants, and speaking and lecture fees from Arthrex; consulting or advisory and speaking and lecture fees from JRF Ortho; and speaking and lecture fees from Ossur. All other authors (D.J.S., T.R.C., B.P.E., K.S., K.K.S.) declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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