

Anterior Cruciate Ligament Reconstruction with Quadriceps Tendon Autograft

A Minimally Invasive Harvest Technique

Harris S. Slone, MD, and John W. Xerogeanes, MD

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Introduction

We describe a minimally invasive surgical technique for harvest of a quadriceps tendon autograft that reliably produces a graft suitable for anterior cruciate ligament (ACL) reconstruction while minimizing morbidity and complications classically associated with alternative autograft choices.

Recently there has been a surge of interest, biomechanical research, and reports of clinical outcomes regarding the quadriceps tendon and its utility as a graft option for ACL reconstruction. Advantages of quadriceps tendon autografts include excellent clinical results with low donor-site morbidity¹⁻⁹, ease of harvest, and excellent biomechanical properties¹⁰⁻¹². The quadriceps tendon is a versatile autograft choice that can be harvested with or without a bone block^{3,4,7,8,13-16}; can be used for single or double-bundle reconstructions^{3,9,17,18}; and can be employed for anatomic¹⁸, transtibial^{3,16}, or all-inside reconstructions¹⁹.

Traditionally, quadriceps tendon harvests have been performed through larger incisions, which allow visualization of the entire tendon. Our described technique is reproducible and consistently yields all-soft-tissue grafts of 9 to 10 mm in width, 6 to 7 mm deep, and 7 to 8 cm in length; longer grafts can be obtained with a patellar bone-block harvest. We demonstrate how this harvest is performed through a small (1.5-cm) incision.

Step 1: Positioning

Position the patient supine on the operating room table.

- Position the patient supine on the operating room table, and perform an examination after successful general anesthesia has been administered.
- If you wish to use a tourniquet, apply it to the involved extremity (but do not inflate it) and place

the extremity into a circumferential arthroscopic leg-holder with the knee resting at 90° of flexion. Use of the tourniquet is optional but is recommended as it will assist with visualization through the small incision. Confirm the ability to hyperflex the knee to >120°.

- Place the contralateral leg into a well-padded lithotomy leg-holder.
- Prepare and drape the involved extremity in a sterile manner.
- Perform a diagnostic arthroscopy either prior to or after quadriceps tendon graft harvest, depending on your preference.

Step 2: Marking of Landmarks

Palpate and mark soft-tissue and osseous landmarks on the involved extremity.

- With the knee at 90° of flexion, mark the superior pole of the patella.
- Mark the medial border of the vastus medialis obliquus and the lateral border of the patellar tendon above the patella.
- Then mark a longitudinal incision starting 0.5 cm above the patella at a point slightly lateral to the midpoint between the vastus medialis obliquus and the lateral quadriceps tendon extending proximally 1 to 2 cm (Fig. 1 and Video 1).

Step 3: Subcutaneous Dissection

Perform the incision and subcutaneous dissection.

- If you wish to use a tourniquet, exsanguinate the extremity and inflate the tourniquet at this time.
- Inject the planned incision site and subcutaneous tissue with local anesthetic with epinephrine solution.

- Make a 1.5-cm longitudinal incision and ellipse out the subcutaneous fat beneath the skin. This is key to allow for adequate visualization through the small incision (Figs. 2-A and 2-B).
- Identify the fascia over the quadriceps tendon and excise it with Metzenbaum scissors or a scalpel.
- Use a gauze sponge over a Key elevator to dissect bluntly over the anterior portion of the tendon both proximally and distally over the patella (Video 2).
- Use a finger to ensure that all adhesions have been released proximally and distally.
- Place an Army-Navy retractor into the proximal apex of the incision, and use the arthroscope (with the water off, and looking down at the tendon) to locate the vastus medialis obliquus, lateral tendon border, and proximal-most visualized portion of the rectus femoris tendon.
- Rotate the arthroscope so that the light is pointing anteriorly (away from the tendon), and mark this point of light seen through the skin (Fig. 3).
- Measure this mark from the superior pole of the patella (Fig. 4 and Video 3). If an 8-cm graft is needed, this mark should be 8 cm from the superior pole.

Step 4: Graft Harvest

Harvest the graft.

- While using two Senn retractors to protect the skin, insert a double-bladed knife and incise the tendon longitudinally, using the previously made rectus femoris tendon marking for directional reference. Additionally, the length of the graft can be measured off of the knife handle (Video 4).
- Continue the incision distally until the superior pole of the patella is encountered.
- Slightly extend the knee and dissect the distal part of the quadriceps tendon off of the patella, taking care to taper the distal end of the tendon slightly to minimize the need for subsequent graft trimming, as 1 mm of thickness will be gained with later suture addition (Fig. 5).
- We prefer to harvest a partial-thickness graft, although a full-thickness graft can be taken if needed. To harvest a partial-thickness graft, use a knife and/or Metzenbaum scissors to dissect proximally (Video 5).
- If fat is encountered, do not dissect deeper as there is a risk of violating the capsule. Alternatively, if bone is desired use a saw to remove a bone block from the superior pole of the patella, taking care to avoid overpenetration into the articular surface.

- Once 3 cm of graft is freed distally, use a whipstitch or FiberLoop (Arthrex, Naples, Florida) to gain control of the distal part of the tendon, starting about 1.5 to 2 cm proximal to the distal extent of the graft. Grasping the distal tip of the tendon with an Allis clamp can aid with suture placement (Fig. 6 and Video 6).
- While applying tension to the sutures, carry out additional dissection proximally with Metzenbaum scissors if necessary.
- Use a closed-ended Arthrex graft gun to strip proximally until the desired length of graft is freed. The graft length is measured off of the graft gun.
- Push the graft gun proximally and close the handle, cutting the graft proximally (Fig. 7 and Video 7)
- After the graft is delivered from the wound, bring it to the back table for preparation (Fig. 8).

Step 5: Graft Preparation

Prepare the graft.

- There are several methods of fixation for both the femoral and the tibial side.
- For the femoral side, we prefer a cortical button, which is sewn to the graft with FiberWire (Arthrex) suture. Sew a second whipstitch or FiberLoop (Arthrex) to the other side of the graft.
- We prefer to tie the tibial side over a screw and washer.

Step 6: Closure

If a partial-thickness graft is harvested, no deep closure is needed.

- The arthroscope can be reintroduced into the wound to ensure that a partial-thickness graft was harvested (Video 8). If a full-thickness graft was harvested, either intentionally or unintentionally, close the capsular layer with absorbable suture to prevent fluid extravasation.
- After irrigation, close the skin with absorbable suture and skin glue.

Results

Since September of 2011, the quadriceps tendon has been our autograft of choice for ACL reconstruction. We have prospectively collected data on 201 quadriceps tendon autograft ACL reconstructions (unpublished data), including primary (n = 181) and revision (n = 20) reconstructions and ACL reconstructions in elite athletes (Video 9).

We have seen no early failures with this surgical technique. Four patients have required revision reconstruction. All reinjuries requiring reconstruction were a result of sports or trauma. The only failure before six months occurred in a college athlete at five months postoperatively, after he jumped off several steps while running to catch a bus.

What to Watch For

Indications

- Primary ACL reconstruction.
- Revision ACL reconstruction.
- ACL reconstruction in a skeletally immature patient.

Contraindications

- History of quadriceps tendon injury or surgery.
- Preexisting quadriceps weakness or neuromuscular deficit.

Pitfalls & Challenges

- Inadvertent capsular violation or full-thickness harvest.

Harris S. Slone, MD

John W. Xerogeanes, MD

Department of Orthopaedic Surgery, Emory University, 59 Executive Park, Suite 1000, Atlanta, GA 30329

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- If a large portion of the capsule is excised, deep closure can be challenging.
- Failure to taper the graft end, necessitating graft trimming or a larger tunnel.

Clinical Comments

- We prefer to use a free-tendon, all-soft-tissue graft because sufficient graft length can be reliably harvested without bone, and complications and morbidity with this technique are minimized with all-soft-tissue harvest. Additionally, harvesting the graft without bone is faster and technically easier than harvesting it with bone.
- In our experience after a short learning curve, the quadriceps tendon harvest via this technique has been substantially faster than our bone-patellar tendon-bone or hamstring harvests.
- We found no early failures related to suspensory fixation and all-soft-tissue grafts in our clinical follow-up.

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Figures

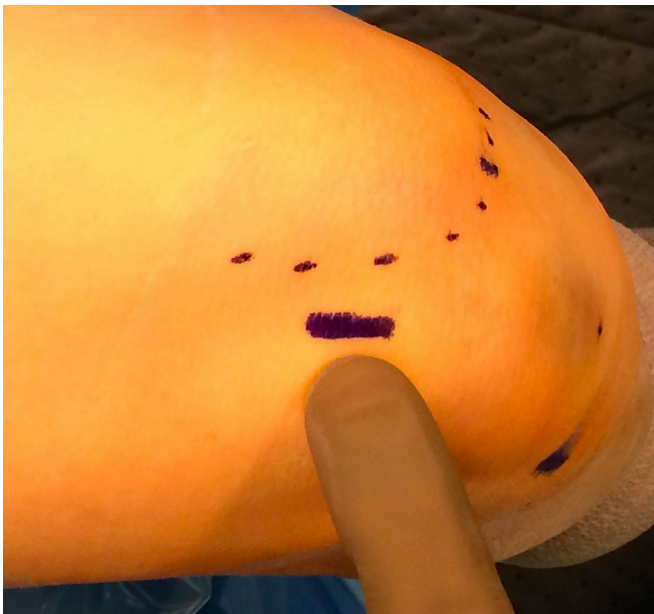


Fig. 1
Preoperative marking of the vastus medialis obliquus and the planned incision 0.5 cm above the superior pole of the patella.



Figs. 2-A



Figs. 2-B

Figs. 2-A and 2-B Ellipse and excision of subcutaneous fat is critical for visualization. **Fig. 2-A** Before fat is excised. **Fig. 2-B** After fat is excised.

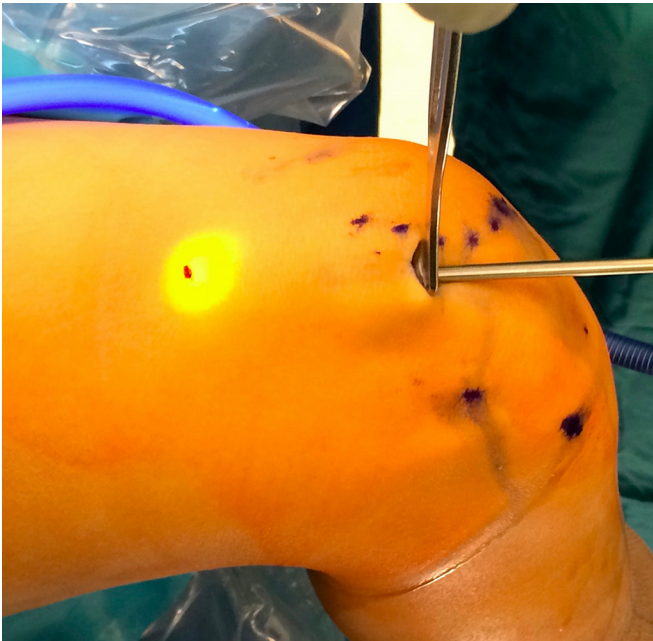


Fig. 3
The arthroscope is used to visualize the proximal rectus musculotendinous junction. The arthroscope is turned to look away from the tendon, and a mark is placed on the skin at the point of transillumination.



Fig. 4
A second mark is made in line with this point and the superior pole of the patella at the length of planned graft harvest.

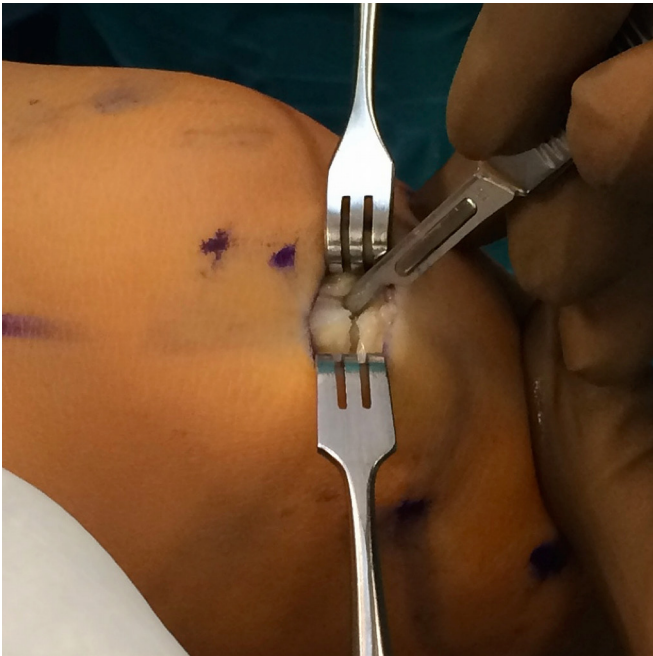


Fig. 5
The quadriceps tendon is dissected off the superior pole of the patella.

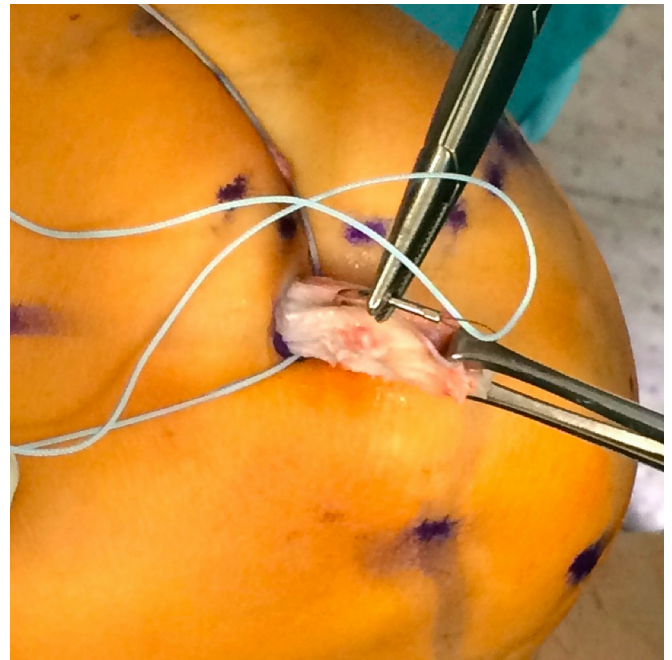


Fig. 6
Once 3 cm of graft has been dissected, the distal tip is grabbed with an Allis clamp, and a FiberLoop or whipstitch is used to gain control of the tendon.



Fig. 7
The Arthrex graft gun with a combined tendon stripper and built-in tendon cutter. Markings on the shaft allow measurement of graft length prior to cutting.



Fig. 8
Harvested graft after preparation.