Technical Note

Minimally Invasive Quadriceps Tendon Harvest for Anterior Cruciate Ligament Reconstruction Using the Quadriceps Tendon Harvest Guide (QUADTRAC) System and Repair Augmentation With a Bioinductive Implant

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Abstract: Quadriceps tendon autografts are an increasingly popular choice for anterior cruciate ligament (ACL) reconstruction, with decreased donor-site morbidity alongside good patient outcomes. Although harvesting of the tendon can be done in a minimally invasive fashion, this introduces some difficulty with visualization and consistency of graft sizing. The purpose of this Technical Note and video is to provide a method of quadriceps tendon autograft harvesting using the Quadriceps Tendon Harvest Guide System (QUADTRAC) in a single-bundle ACL reconstruction.

Anterior cruciate ligament (ACL) ruptures are an increasingly common orthopaedic sports injury. In young, athletic patients, reconstruction is considered the gold standard treatment. Numerous graft choices, alongside fixation techniques, are available. Autografts are a popular option, owing to not only their availability and cost but also biological benefits such as decreased incorporation time and lower rates of graft failure.

The bone–patellar tendon–bone (BPTB) autograft is one of the most commonly used graft sources, owing to its extensive history of use, good stability and function, and a low rate of retear. However, harvesting of BPTB autografts is known to produce significant donor-site morbidity, including anterior knee pain and, less frequently, patella fracture or patellar tendon rupture.[1] Quadriceps tendon (QT) autografts have recently gained popularity due to several advantages, including diminished donor-site morbidity, predictable size, and the ability to harvest the tendon in a minimally invasive fashion.[2,3] Further, these advantages do not result in inferior outcomes when compared with reconstruction using BPTB or hamstring autografts.[4,5]

Harvesting of the QT autograft in a minimally invasive nature allows for a reduction in soft-tissue trauma, postoperative pain, and healing time compared with larger open techniques. However, these benefits necessitate a more limited surgical view, which may increase the risk of injury to nearby structures, such as

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the rectus femoris muscle belly or the suprapatellar bursa. The purpose of this Technical Note and video is to provide a method of quadriceps tendon autograft harvesting using the Quadriceps Tendon Harvest Guide System (QUADTRAC; Smith & Nephew, Andover, MA) in a single-bundle ACL reconstruction. This technique offers several advantages over other methods (Table 1).

Table 1. Pearls and Pitfalls of using the QUADTRAC System for Quadriceps Autograft Harvest and Repair of Harvest Site with Bioinductive Implant

Pearls
Minimally invasive technique and improved visualization with the Q-VIEW Retractor
Consistent longitudinal cut depth of graft using the TRAC-Cutter
Graft length estimator on both the Guide-TRAC Handle and QUAD-Cutter allow for controlled, reproducible proximal tendon truncation
Decreased incidence of patellar tendonitis and anterior knee pain compared to patellar tendon grafts
Bioaugmented repair of quadriceps harvest-site defect
Pitfalls
Patients may have decreased knee extensor strength compared with the contralateral side.
Risk of injury to surrounding structures, including suprapatellar bursa and rectus femoris
Potential for altered knee proprioception.

QUADTRAC, Quadriceps Tendon Harvest Guide System.

Surgical Technique (With Video Illustration)

Patient Preparation

The patient is placed in a supine position with the surgical limb secured in an arthroscopic leg holder and the contralateral leg in a foam well-leg holder. After the induction of general anesthesia, an examination with the patient under anesthesia is performed to assess knee stability and range of motion. A nonsterile tourniquet is placed proximally on the leg and set to 250 mm Hg.

Graft Harvest With QUADTRAC System

With the operative leg flexed at 90°, anatomical landmarks are identified. The harvest site incision is marked as a 3-cm vertical line at the superior pole of the patella. A 3-cm vertical incision is made at the superior pole of the patella (Video 1). Excision of the prepatellar bursa and fat pad is completed using the Bovie (Fig 1A). Blunt dissection and release of adhesions is performed using the Guide-TRAC handle. The Q-VIEW Retractor is then attached onto the Guide-TRAC and introduced into the incision until the flange is flush with the skin. Adjustments of the retractor are made as necessary to best visualize the tendon. The arthroscope is used through the Q-VIEW Retractor to ensure that the resection is centralized on the tendon and not violating the muscle belly (Fig 2A). The head of the Guide-TRAC is used to measure the graft width, and an appropriately sized TRAC-Cutter is selected. Semicircular blades are attached to either side of the TRAC-Cutter, allowing for a consistent 6-mm cut depth. The TRAC-Cutter is placed onto the Guide-TRAC Handle and longitudinal cuts are made on the tendon (Fig 1B). All instrumentation is removed, and a surgical knife is used to continue longitudinal cuts to the patella and strip the distal end of the graft, dissecting to the desired graft thickness. Next, a tag stitch using a looped suture tape is placed onto the distal end of the graft (Fig 1C). While lifting the graft, the leading edge of the QUAD-Cutter is inserted to finalize the inferior cut and remove any remaining soft-tissue bridges. After ensuring the safety lock is engaged, the tag stitch and graft are loaded through the eye of the QUAD-Cutter (Fig 1D). While pulling tension on the graft via the tag stitch, the distal end of the graft is aligned with the graft length estimation line on the QUAD-Cutter to confirm graft length. The safety lock is depressed, and actuation of the QUAD-Cutter truncates the graft.

With the graft removed, the harvest site is examined with the arthroscope to ensure there are no defects in the capsule (Fig 2B). If defects are found, they are approximated with 0 VICRYL suture (Ethicon, Somerville, NJ). A bioinductive implant is then introduced and placed over the harvest site. The graft is initially secured with a soft-tissue staple, moisturized with scope fluid, and then final fixation is completed with several soft-tissue staples before closing the skin incision (Fig 2C).

Graft Preparation

On a separate table, the tibial end of the harvested graft is attached to the tissue clamp on the Graft Preparation System. A marker is used to denote 20 mm from the tibial end of the graft, and the end is bulletized before stitching. The femoral end of the graft is held with an Allis clamp (Fig 3A). The needle for the ULTRABUTTON QUAD Adjustable Fixation Device is passed through the 20-mm mark and pulled until the titanium button is close to the surface of the graft. A luggage tag is made by passing the suture card and graft through the cobraid sutures, pulling the titanium button to cinch the sutures around the graft (Fig 3B). The needle is again passed top-down just proximal to the luggage tag to lock into place (Fig 3C). The suture management card is moved towards the clamp tent and 2 standard whipstitches are placed at the tibial end of the graft (Fig 3 D and E). A locking knot is then placed at the tip of the graft and the needle is removed (Fig 3F). The graft is sized, and an appropriately sized ULTRABUTTON TIB Adjustable Fixation Device is selected, and a similar stitching technique is performed

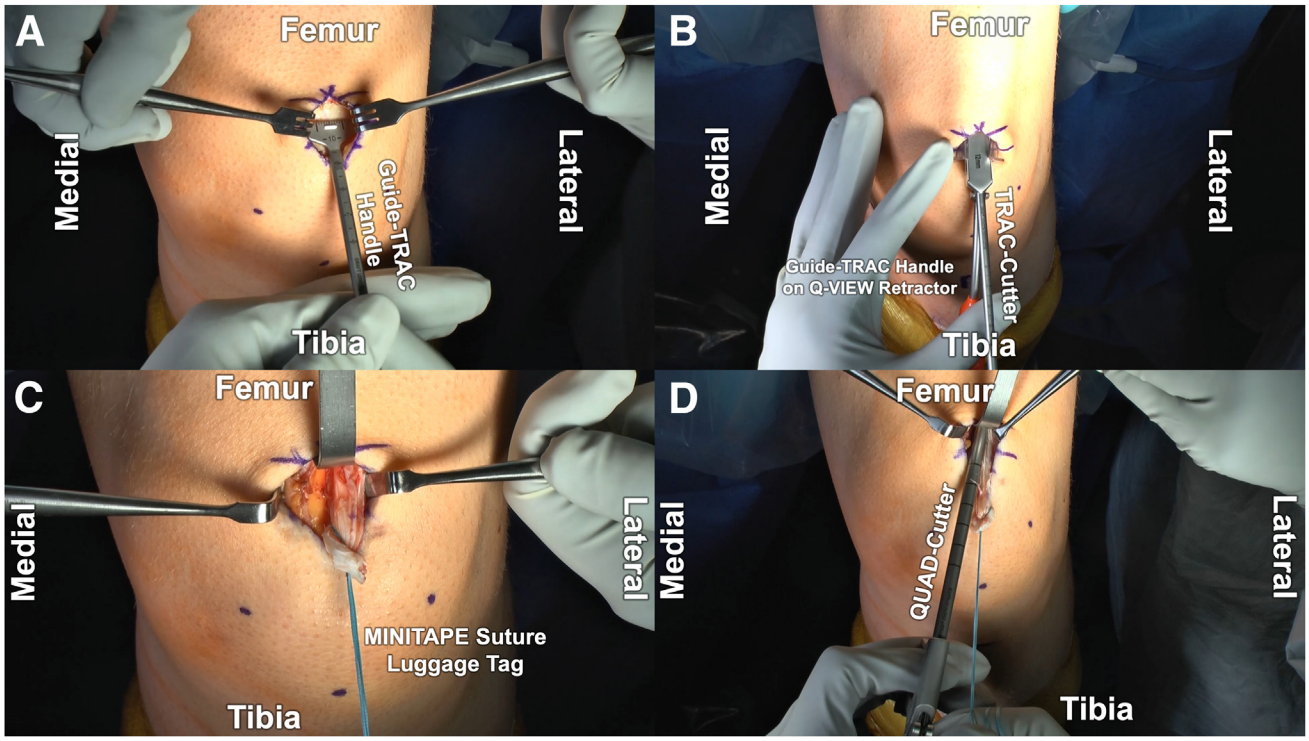

Fig 1. The patient is placed supine with left knee in flexion. (A) After the quadriceps tendon is exposed, the Guide-TRAC handle is used for blunt dissection and freeing of the soft tissue overlying the tendon. (B) After centering on the tendon with the Q-VIEW Retractor, the TRAC-Cutter is introduced to perform longitudinal cuts. A no. 15 blade is then used to elevate the distal portion of the quadriceps tendon. (C) A looped suture tape is used to create a tag stitch on the distal end of the tendon, and both the suture and tendon are inserted into the eye of the QUAD-Cutter. (D) While maintaining tension on the tag stitch, the actuation of the cutter truncates the graft to the desired length.

on the tibial end of the graft (Fig 4A). The graft is then distracted using the tensioner.

We then proceed with a suspensory based ACL reconstruction using a previously described technique.[6]

Repeated sizing (Fig 4B) is then done to confirm tibial socket and femoral tunnel diameters, and the graft is left on tension during arthroscopic tunnel preparation (Fig 4C).

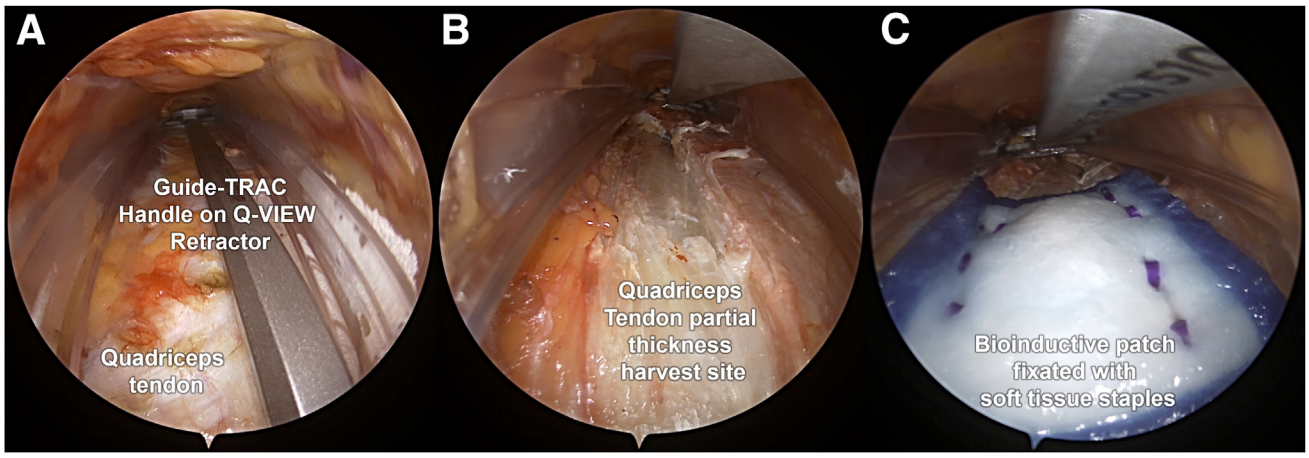

Fig 2. (A) Initial arthroscopic visualization is performed to ensure longitudinal cuts are made centrally on the tendon, without any violation of the muscle belly. (B) After truncation of the graft, second-look arthroscopy is performed to ensure there are no defects to the capsule. (C) A bioinductive patch is placed overlying the graft harvest site, moisturized with scope fluid, and fixated with soft-tissue staples.

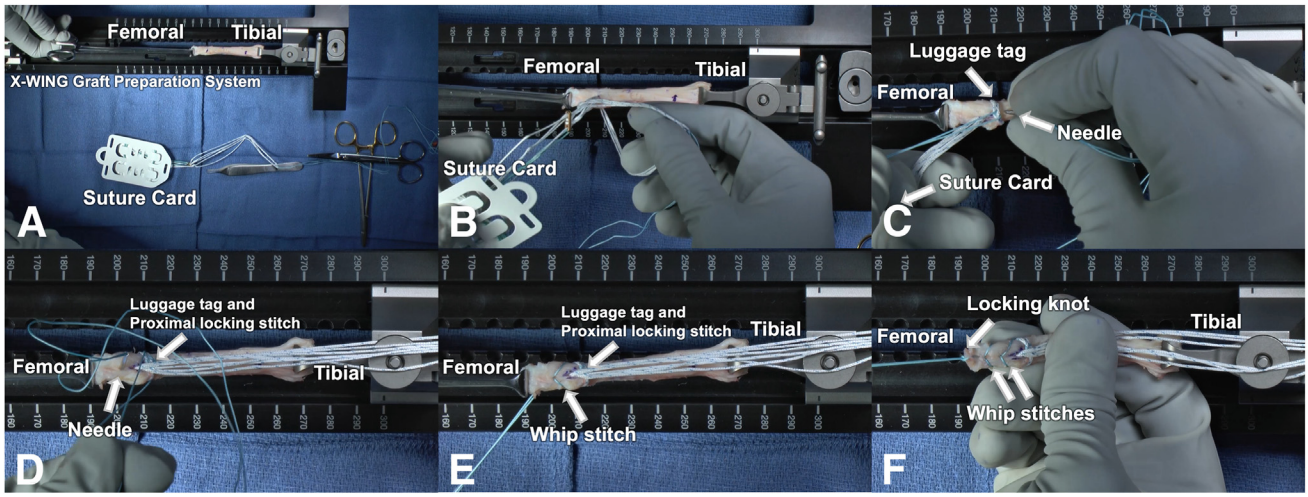

Fig 3. (A) On the back table, the tibial end of the graft is clamped onto the X-WING Graft Preparation System. (B) The needle for the adjustable fixation device is passed through the 20-mm mark on the femoral end and pulled through until the titanium button is close to the surface of the graft. A luggage tag is formed by passing the suture card and graft. (C) The needle is again passed just proximal to the luggage tag to lock into place. (D) A whip stitch is placed distal to the luggage tag. (E) At least 2 whip stitches are placed. (F) Finally, a locking knot is placed at the tip of the graft and the needle is removed.

Discussion

This Technical Note is a detailed surgical technique of minimally invasive quadriceps tendon autograft harvest and preparation using the QUADTRAC Quadriceps Tendon Harvest Guide System in a single-bundle ACL reconstruction. Advantages of this technique include improved visualization and reliable acquisition of a QT graft with the desired length and cross-sectional area. In addition, QT harvest can be done with or without a patella bone plug.

The use of quadriceps tendons in ACL reconstruction is becoming an increasingly popular option, offering

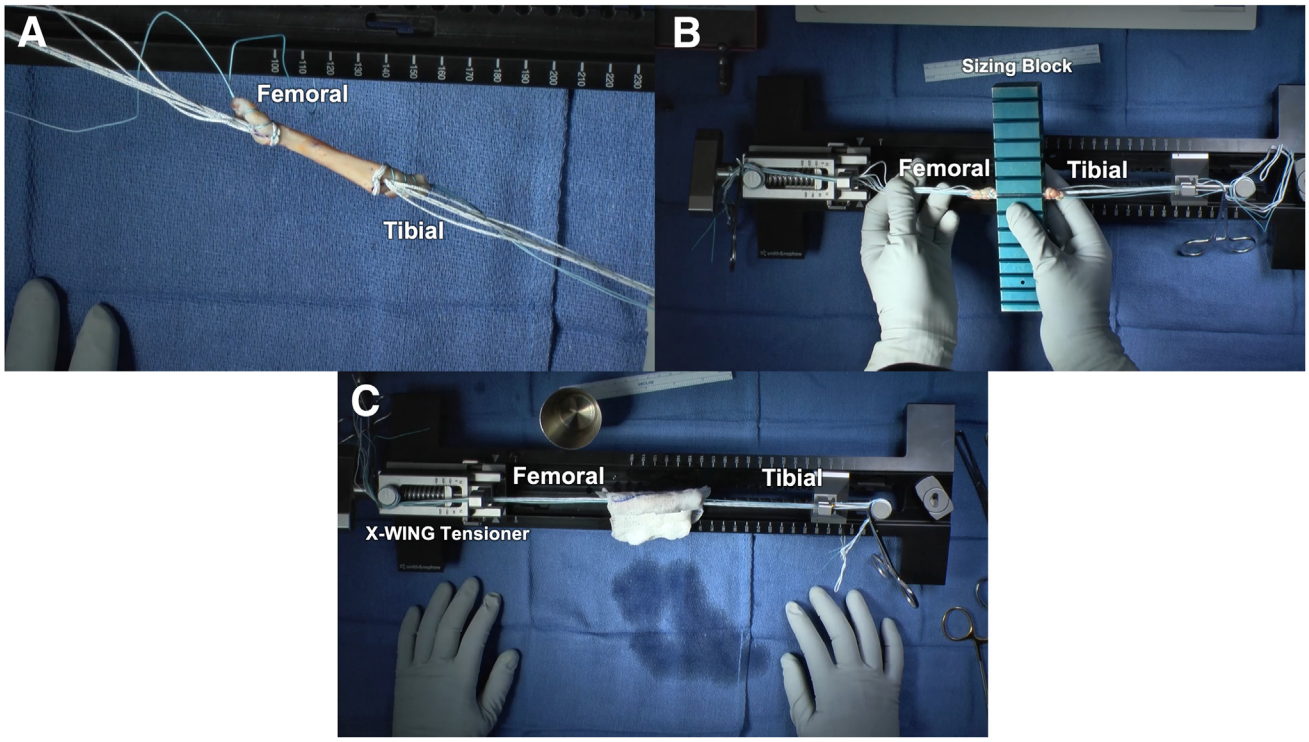

Fig 4. (A) The same suturing technique is performed on the femoral end of the graft. (B) After once again sizing the graft to ensure appropriate tunnel size, (C) the graft is covered with a vancomycin-soaked lap sponge and left under tension during arthroscopic tunnel preparation.

decreased graft harvest-site morbidity compared with the historical gold standard of BPTB while maintaining similar outcomes and graft survivorship.[1] Opponents to implantation of QT grafts pointed out the nonuniformity in harvesting and greater failure rates as cause for concern. However, the increased revision rates were found to be associated with low surgical routine,[7] and advancements in surgical technique have enabled surgeons to perform minimally invasive graft acquisition with greater intersurgeon reliability.[2] Cadaveric and biomechanical studies also have demonstrated that the QT has a predictable morphology with increased cross-sectional area and load to failure compared with BPTB.[5,8]

This technique is not without limitations. Lee et al.[9] found that at up to 7 years following QT ACL reconstruction, patients had persistent quadriceps weakness compared with the contralateral knee. Guney-Deniz et al.[10] demonstrated the presence of proprioceptive deficits in knee position near-terminal extension. Cases of patellar fractures have also been reported.[11] It is critical that, regardless of a surgeon's selection of graft or ACL reconstruction technique, an interdisciplinary approach with therapists and trainers is used to optimize patient recovery and return to preinjury levels of activity.

Existing literature has shown equivalent postoperative clinical outcomes in the use of QT autografts for ACL reconstruction, but there is understood to be a learning curve with selected surgical techniques. The QUADTRAC system offers an instrument set that allows for QT harvest with consistent, reproducible measurements. Further studies are needed to evaluate outcomes with the use of the QUADTRAC system for QT ACL reconstruction.

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