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**The Use of a Simple Vaginal Speculum to Harvest Quadriceps Tendon
Autografts for Anterior Cruciate Ligament Reconstruction and Avoid any
Potential Pitfalls during Harvesting Procedure**

A technical note

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Abstract

Anterior cruciate ligament reconstruction with quadriceps tendon autograft has gained popularity in recent years, while many harvesting techniques were described with the use of different harvesting systems available on the market. There are multiple techniques varying from transverse to longitudinal skin incision, from open to minimally invasive approach. Despite the preferred technique, it seems that there is a reported learning curve as with the majority of surgical procedures. The present technical note makes an effort to present a straightforward harvesting method of quadriceps tendon autograft with the use of a simple vaginal speculum and direct visualization with the scope. Our technique is minimally invasive, easily reproducible from every surgeon despite the level of experience, with short learning curve, requiring no additional cost or technical support during the procedure, while creating a stable working space with freedom of manipulation of the surgical instruments and arthroscope.

Keywords: Anterior Cruciate Ligament; Knee; Arthroscopic Surgery; Quadriceps Muscle; Autografting.

Introduction

Quadriceps tendon (QT) is a promising alternative autograft used for anterior cruciate ligament reconstruction (ACLR).¹ Different harvesting techniques have been described using either an open or minimally invasive approach, full or partial thickness graft, with or without bone block and/or quadriceps tendon defect repair.^{1,2} The Danish Knee Ligament Reconstruction Registry, a prospective, nationwide web-based study, analyzed the data of 16,579 ACLR and demonstrated a higher revision rate of quadriceps tendon grafts compared to hamstring tendon and patellar tendon grafts. The different level of experience among multiple surgeons and the higher revision rates confirmed by low-volume clinics with lower than 100 procedures per year, might have been associated with those results.^{3,4} Additionally, previously published studies reported that QT graft harvest was a technically demanding procedure with a high learning curve when harvesting the autograft, requiring the use of different harvesting tools available on the market.^{5,6}

Surgical Indications and contraindications

The indications for ACLR with the use of QT graft appear to be similar to those for other autografts (hamstring tendon and bone patellar tendon bone grafts) and include young active patients (especially athletic demand patients aged <25 years), complex knee ligament injuries and revisions cases. However possible contraindications include, but are not limited to, patients with chronic quadriceps tendinopathy, quadriceps muscle atrophy, history of prior tendon rupture and patella fractures.^{7,8}

Advantages and disadvantages of quadriceps tendon graft

The QT autograft offers many advantages over hamstring tendon (HT) and bone patellar tendon bone (BPTB) grafts. Firstly, it is associated with a lower rate for anterior knee pain/pain with kneeling and with less sensation of numbness compared to BPTB and HT, respectively.^{5,7} Secondly, histologically, QT graft can provide approximately 20% more collagen fibers, higher fibril-interstitium ratio and higher fibroblast density per cross-sectional area compared to the BPTB graft.⁶ Thirdly, the graft thickness is more predictable than HT grafts.⁶ Also, QT graft has the advantage of preserving the hamstring strength and dynamic stability of the knee [Table 1]. This has been linked to reduced ACL injuries, while it is crucial when treating professional soccer players, who suffered an ACL tear.⁹

However, most QT graft disadvantages are associated with loss of orientation during its harvesting which may challenge an inexperienced surgeon in identifying the medial and lateral borders of the quadriceps tendon.¹⁰ Potential drawbacks of this approach may be associated with harvesting of inappropriate graft length and lateralized or medialized splitting of the donor quadriceps tendon. Skin necrosis due to excessive tension of the wound from the vaginal speculum is also possible, especially in the case of small skin incisions. That is associated with the placement of the vaginal speculum with the knee in extension, followed by the placement of the knee in 90 degrees of flexion thus raising the tension of the skin. Finally, the hematoma formation at the musculotendinous junction of quadriceps (more common with the use of full thickness graft)⁶, and the risk of patella fracture (with the use of bone block technique) are possible drawbacks of the harvesting method.¹⁰

Current harvesting techniques

A number of different techniques have been described for the ACLr with the use of QT as an autograft, including open or minimally invasive methods for harvesting, use of full or partial thickness grafts, with or without patellar bone blocks.^{1,2} Fink *et al.* performed a transverse skin incision over the superior border of the patella and exposed subcutaneously the QT using a long Langenbeck.¹¹ In contrast, Malinowski *et al.* performed a 4 to 5 cm skin incision in a sagittal plane perpendicularly to the superior pole of the patella, starting 4 to 5 cm proximally to the patella and finished distally, specifically one centimeter over the patellar dorsal surface. In their harvesting technique, authors used two Farabeuf retractors in order to visualize the quadriceps tendon and its medial and lateral border.¹⁰ Alternatively, Ollivier *et al.* moved the knee from a flexed to an extended position and exploited skin elasticity (the technique of movable window) to harvest the QT bone graft by direct vision. In order to improve visualization, they used two retractors at the proximal part of the incision to apply strong traction on the bone graft distally.⁵

Novelty of the new technique

The present technical note makes an effort to address the issue of QT harvesting (loss of orientation during the harvest procedure), while minimizing the risk of possible graft failure and revision rates in patients who undergo ACLr with QT grafts. The dry and direct endoscopic view of the quadriceps tendon, with the use of a simple vaginal speculum, facilitate the visualization

of the vastus medialis and vastus lateralis muscle bellies of quadriceps tendon, as well as the initial cutting point from proximal to distal. To our knowledge, this is the first report of the use of a simple vaginal speculum to assist the harvesting of quadriceps tendon graft and limit the possible complications during the harvesting method.

Patient positioning

The patient is placed in supine position with two posts attached to the operative table in order to facilitate access by the surgeon. The first post is lateral to the proximal thigh, while the second post is used as a foot rest to maintain the knee position in 90 of flexion. After anesthesia induction, the operative leg is prepared and draped in sterile fashion. Then a tourniquet is placed in a standardized location on the thigh and inflated to 250 to 300mm Hg.

Surgical technique

We advocate the use of a vaginal speculum [Figure 1A], in order to retract the anterior skin and thigh soft tissue, visualize the borders and measure the length of quadriceps tendon, harvest the graft and side to side defect closure. A 2-cm longitudinal skin incision is made one centimeter proximal to the superior pole of the patella and carried down through the subcutaneous tissue and deep fascia until the QT is visualized [Figure 1B]. The soft tissues can be easily released using a finger for better visualization of the tendon. Then, the simple vaginal speculum is inserted and used as a retractor of the anterior skin and subcutaneous tissue in order to enable dry arthroscopy and fully expose the borders of QT [Figure 2]. At this point, the use of a gauze pad can facilitate the removal of any remaining soft tissue, achieving a better view of the tendon. Once minimum space has been developed over the QT, dry arthroscopy is utilized, in order to visualize the whole length and borders of QT, harvest tendon graft and perform side to side defect closure [Figure 3]. It is important to note that graft is harvested applying firm tension on the distal sutures, while the quadriceps tendon stripper cutter is used to strip and cut the autograft proximally, once the desired graft length is achieved (Arthrex, Naples, FL) [Figure 4]. The simple vaginal speculum serves as a tent, while the surgeon is able to identify the proximal myotendinous junction of rectus femoris and the starting point of the graft harvesting in the proximal part of the patella, where the skin incision is made. Ultimately, the entire length of the quadriceps tendon can be visualized. Based on the available length of the tendon, the length and the width of the graft to be

harvested depends on the desired size of the tendon graft. Additionally, the skin incision serves both as viewing and working portal [Video 1]. Consent for publication was obtained from the patient.

Conclusion

The major advantage of the described technical note is the provision of a direct view of the whole borders of the QT by the surgeon during the harvesting method and the minimalization of the technical errors during harvesting. This technique can be easily performed by all surgeons, regardless of the level of experience, while it does not require a high learning curve. The required instrumentation consists of a simple vaginal speculum, a reusable instrument without additional cost for the procedure. This instrument does not rely on the availability of the product and does not require any technical support. Also, this technique can easily reproduce the harvesting method of QT graft for the ACLr by creating a stable working space and providing freedom of manipulation of the surgical instruments and arthroscope.

Authors' Contribution

NEK proposed the idea of the project; AVV and TD designed the methodology and made the investigation; AVV and TD drafted the manuscript; NEK reviewed the manuscript. All authors approved the final version of the manuscript.

Conflicts of Interest

The authors declare no conflict of interests.

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188 **Table 1:** Advantages and disadvantages of the reported harvesting technique.

Advantages
Minimally invasive with 2 cm longitudinal skin incision
There is no need for an extra assistance
Reproducible despite the level of experience
Short learning curve
Creates a stable working space providing freedom of manipulation of the surgical instruments and arthroscope
Lower rate of anterior knee pain
Predictable graft thickness
Preservation of hamstring strength
Disadvantages
Potential more time-consuming technique
Care must be taken to visualize the borders
Skin necrosis due to excessive tension of the wound (for small skin incisions)
Patella fracture (with bone block technique)
Tourniquet has to be used

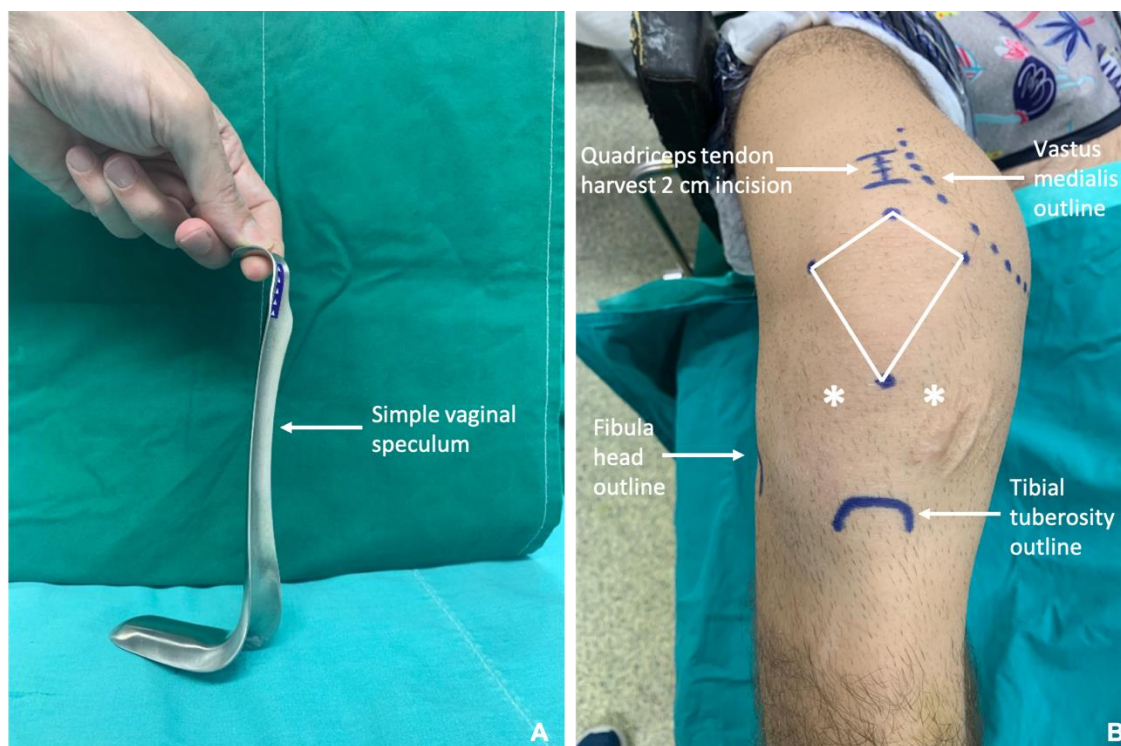


Figure 1: A simple vaginal speculum is needed in order to retract the anterior skin and soft tissue (A). Intra-operative photo (right knee) showing the location of the planned surgical skin incision for quadriceps tendon harvest. A 2-cm longitudinal skin incision will need to allow access to the quadriceps tendon, which extends proximal from the superior pole of the patella. The borders of the patella are indicated with a quadrilateral shape (marked with white) in the middle of the figure. The standard arthroscopic portals (asterisk) will be used during the anterior cruciate ligament reconstruction (B).

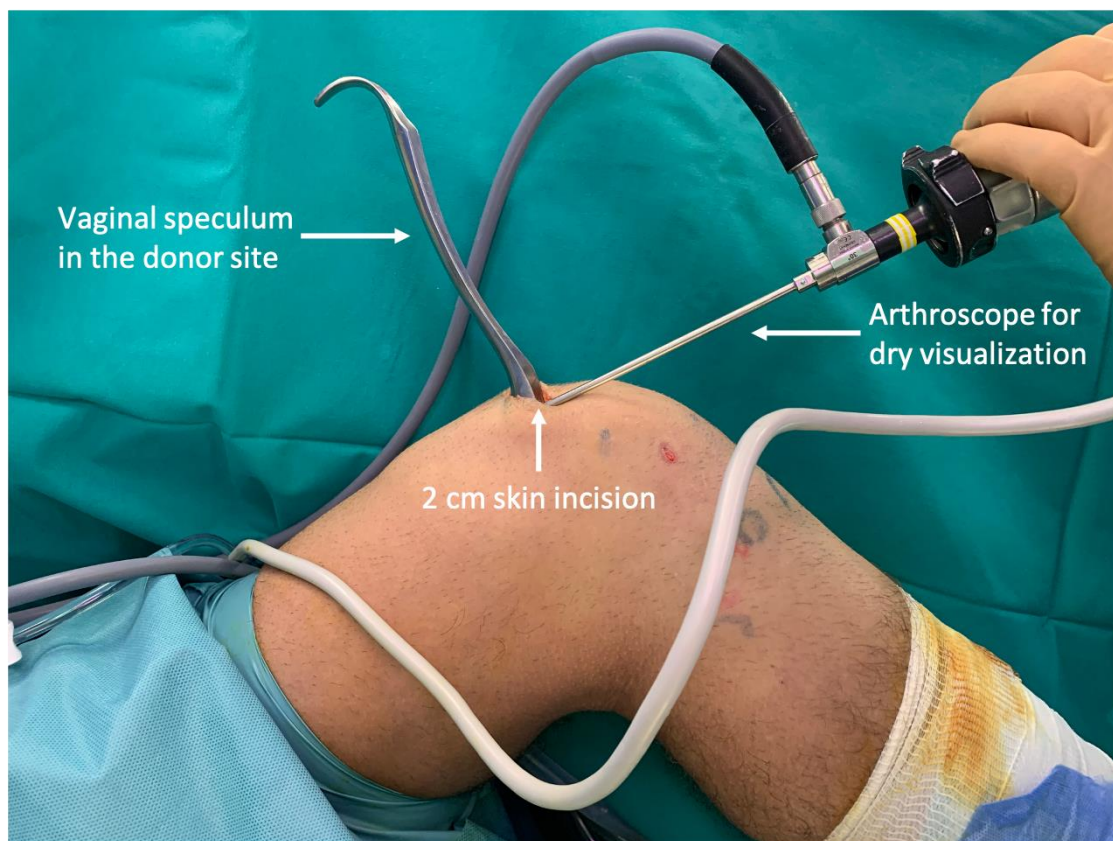


Figure 2: Visualization of the donor site with dry arthroscopic camera in a right knee.

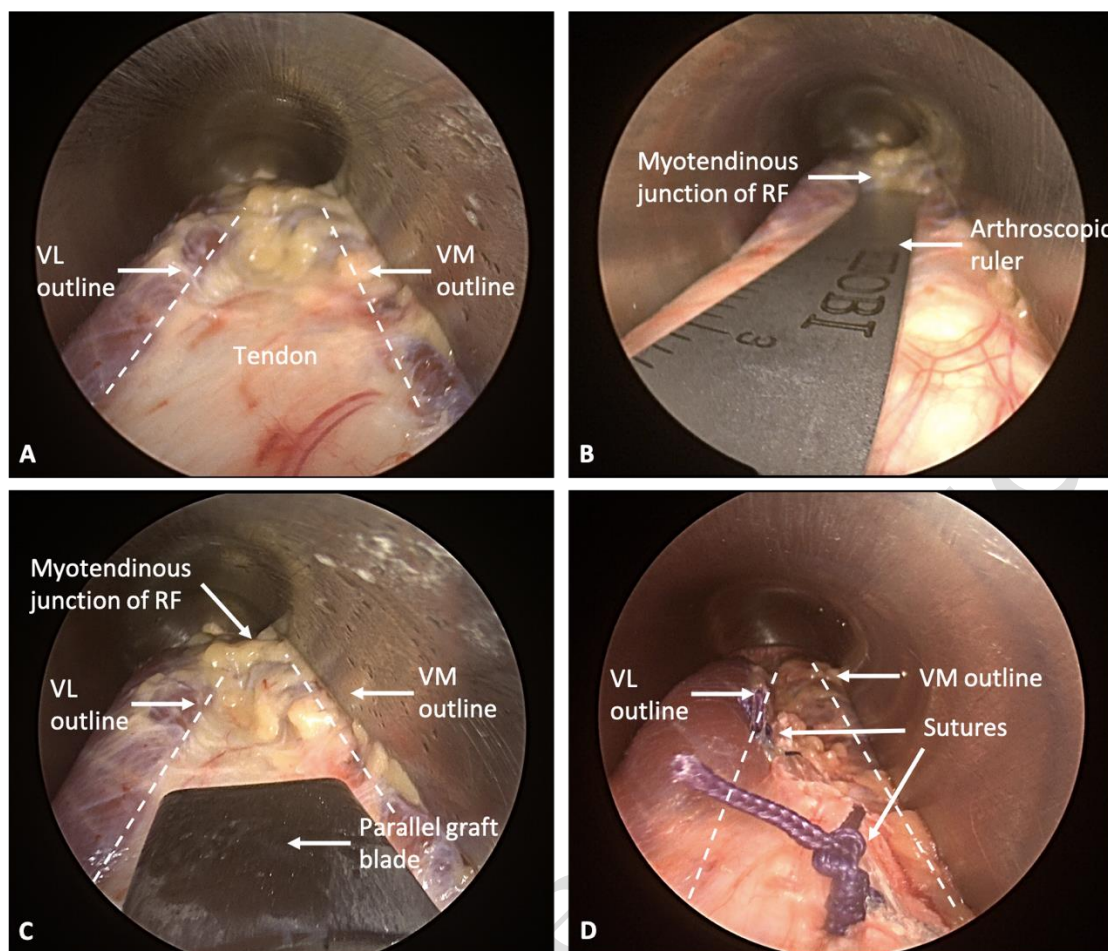


Figure 3: Arthroscopic images of direct endoscopic visualization of quadriceps tendon (VL: vastus lateralis; VM: vastus medialis; RF: rectus femoris). The arthroscope is used to visualize the whole length and borders of quadriceps tendon (A), to measure (B) and harvest the graft (C) with a parallel graft blade (Arthrex 10mm tendon stripper blade). The full-thickness tendon defect is repaired with No2 non-absorbable sutures with the use of the Scorpion Suture Passer (Arthrex, Naples, FL). The gap closure is confirmed endoscopically and the scope is introduced above the harvesting site of the graft (D).

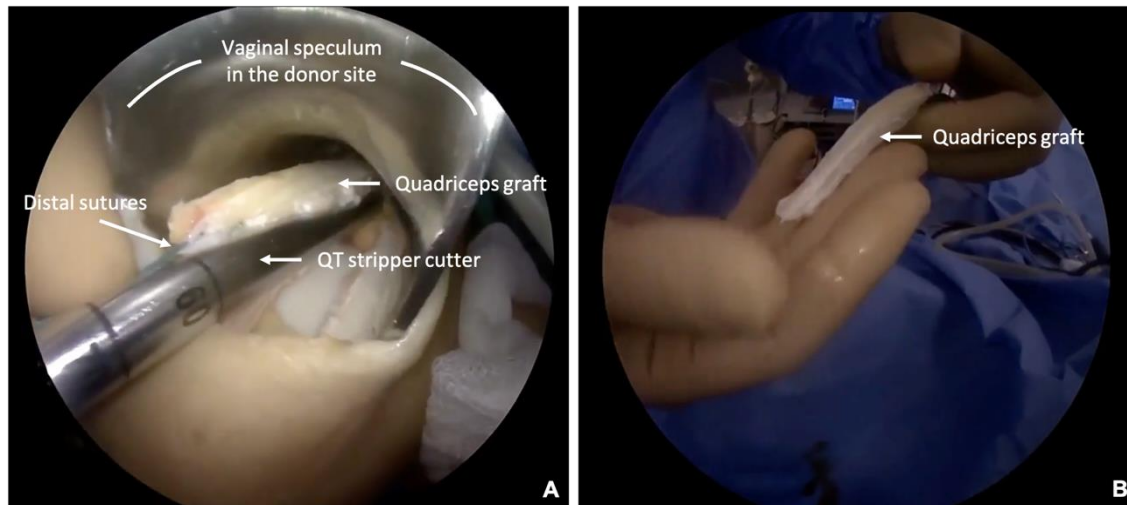


Figure 4: Tension is placed on the sutures from the distal end of the graft and the Arthrex quadriceps tendon stripper cutter is used to strip and cut the autograft proximally once the desired graft length is achieved (A). The final quadriceps graft before preparation for ACLr (B).