Knotless Tape Suture Fixation of Quadriceps Tendon Rupture: A Novel Technique

Publish date: January 26, 2018
Authors: James M. Paci, MD Amanda Pawlak, MD
Author Affiliation | Disclosures

Authors’ Disclosure Statement: Dr. Paci reports that he receives research support and is an educational consultant for Arthrex, Rotation Medical, and Zimmer Biomet. Dr. Pawlak reports no actual or potential conflict of interest in relation to this article.

Dr. Paci is a Team Physician for Stony Brook University and an Associate Professor, and Dr. Pawlak is a Resident, Department of Orthopaedic Surgery, Stony Brook University School of Medicine, Stony Brook, New York.

Address correspondence to: James M. Paci, MD, Department of Orthopaedic Surgery, Stony Brook University School of Medicine, 101 Nicolls Road, Stony Brook, NY 11794 (tel, 631-444-1496; email, james_paci@yahoo.com).

Take-Home Points

- Knotless tape suture fixation of the quadriceps tendon is biomechanically superior to traditional fixation techniques.
- When passing locking Krackow stitches, be sure to take all slack out with each pass.
- Consider double tapping the patella pilot holes prior to placing anchors, as the bone is very hard.
- Palpate the articular surface of the patella when drilling pilot holes for safe placement.
- Perform an adequate retinacular repair to complete the repair.

Quadriceps tendon rupture is an uncommon yet potentially devastating knee injury with an estimated incidence of 1.37 in 100,000. It most often occurs in male, middle-aged or older patients with degenerative tendon changes and serious systemic diseases, such as chronic renal failure, diabetes mellitus, rheumatoid arthritis, and disorders requiring long-term steroid use (tissue quality is often compromised by patient age and comorbidities). Whereas partial tears with an intact extensor mechanism may be managed nonoperatively, prompt operative intervention is indicated in cases of complete tear or an incompetent extensor mechanism to facilitate early range of motion (ROM) and return of knee function.

The standard of care is repair with a nonabsorbable suture passed through transosseous patellar tunnels, often with several weeks of postoperative immobilization to protect the repair. Reported complications of this method include significant extension lag, decreased strength, and ROM compared with the contralateral knee, chronic pain, and iatrogenic patellar fracture. Repair techniques using suture anchors have been proposed as viable alternatives, but biomechanical studies comparing them with standard transosseous repair have reported mixed results. Two studies found improved biomechanical characteristics with suture anchors, but others found the characteristics of suture anchor fixation equal to or worse than those of transosseous fixation.
In light of the controversy regarding strength and clinical outcomes of suture anchor repair compared with transosseous repair, new and potentially superior surgical interventions should be considered.

We recently completed a cadaveric study comparing the biomechanical properties of a novel quadriceps tendon repair technique using 4.75-mm biocomposite knotless suture anchors with suture tape and the properties of conventional techniques using either transosseous or suture anchor repair alone. In the cadaveric model, compared with transosseous and fully threaded suture anchor techniques, repair of quadriceps tendon ruptures with this knotless suture anchor with suture tape technique was biomechanically superior in cyclic displacement, construct stiffness, and ultimate load to failure. Additionally, this method allows for less extensive dissection, shorter operative times, and the potential for earlier and more aggressive rehabilitation protocols. We propose this technique, presented in this article, as a superior alternative to traditional quadriceps tendon repair techniques.

**Technique**

The patient is placed in supine position with a tourniquet placed on the proximal thigh. A midline incision is made from the proximal pole of the patella, proximally by 5 cm. A combination of sharp and blunt dissection is performed through skin and subcutaneous tissues down to the extensor mechanism, exposing the proximal pole of the patella and the torn quadriceps tendon.

The distal aspect of the quadriceps tendon is then débrided of any devitalized tissue and secured with an Allis clamp. A long tape suture (FiberTape; Arthrex) is then used to place a locking Krackow stitch in a distal-to-proximal and then proximal-to-distal direction for 5 throws in each direction within the quadriceps tendon, with the tails exiting distally at the tear site. Care is taken with each pass to ensure that there is no slack within the system.

The proximal pole of the patella is then prepared by débriding any remaining soft tissue back to an area of exposed subcortical bone, which is débrided to a bleeding bony bed. Holes are drilled in the medial and lateral thirds of the patella at the proximal pole using the drill for 4.75-mm biocomposite knotless suture anchors (SwiveLock; Arthrex). The tap for the 4.75-mm anchors is then passed at each guide hole. In hard bone, double-tapping is recommended.

Next, the medial strand of tape suture is loaded within a 4.75-mm biocomposite knotless suture anchor eyelet and reduced to the patella. The medial anchor is malleted and screwed into place, while tension is kept on the lateral strand with the knee in full extension. The lateral strand is then placed into its 4.75-mm biocomposite knotless suture anchor, reduced to the patella, and then malleted and screwed into place in the lateral hole, thereby completing the core portion of the repair (Figures A-D). The core strands from the 4.75-mm biocomposite knotless suture anchors are then back-passed in mattress fashion and tied, and medial and lateral retinacular repairs are then performed using supersuture tape (SutureTape or FiberWire; Arthrex).

After surgery, the patient is placed in a knee brace locked in full extension and allowed to weight-bear as tolerated using crutches. During the first week, knee ROM is allowed up to 30°. During weeks 2 to 6 passive ROM is gradually increased to 90°, and use of crutches is tapered. At week 6 the brace is unlocked for ambulation; it may be discontinued after 7 to 8 weeks or when determined safe. Light activity is permitted from month 4 to month 6. A patient who achieves satisfactory strength, is clinically examined, and progresses through rehabilitation is allowed to return to fully unrestricted sport.
Discussion

Quadriceps tendon rupture is an uncommon clinical entity that requires early surgical management.\textsuperscript{1,5,12,17,19} The standard of care is passage of nonabsorbable sutures through transosseous patellar bone tunnels, but repair with suture anchors has been studied as an alternative that allows for less tissue trauma, decreased operative time, safe early initiation of rehabilitation protocols, and reduced risk of patella fracture or damage.\textsuperscript{3,7,10-12,18-20,21,23} Despite these potential advantages, biomechanical studies have yielded inconsistent results regarding the superiority of suture anchor repair over repair with transosseous tunnels.\textsuperscript{7,10-12,18-20} We propose quadriceps tendon repair using the 4.75-mm biocomposite knotless suture anchor with tape suture technique as a biomechanically superior alternative to either transosseous tunnels or suture anchor repair alone, with significant advantages both in and out of the operating room.

Results of biomechanical studies comparing transosseous tunnel repair and standard suture anchor repair have been mixed, though the heterogeneity of their study methods and endpoints makes direct comparisons difficult.\textsuperscript{7,10-12,18-20} Petri and colleagues\textsuperscript{10} and Sherman and colleagues\textsuperscript{21} reported statistically significant higher load to failure\textsuperscript{10} and reduced gapping during cyclic loading\textsuperscript{10,21} with suture anchor repair relative to transosseous repair. However, Hart and colleagues\textsuperscript{12} found that repair with suture anchors had lower ultimate tensile load, and they concluded that transosseous repair is superior. Lighthart and colleagues\textsuperscript{11} found no significant difference in displacement between the 2 repairs.

In our cadaveric biomechanical study, a novel 4.75-mm biocomposite knotless suture anchor with suture tape repair was compared with traditional 3-tunnel transosseous repair and with standard 2-anchor suture anchor repair.\textsuperscript{22} Statistically significant superiority was found across multiple parameters, including initial tendon displacement, stiffness, and ultimate load to failure (vs 5.5-mm biocomposite fully threaded suture anchor repair), as well as initial and late tendon displacement, stiffness, and ultimate load to failure (vs transosseous repair).\textsuperscript{22} Although definitive conclusions are difficult to draw on the basis of prior cadaveric studies comparing standard suture anchor repair and transosseous repair, our results decidedly favor the biomechanical characteristics of this 4.75-mm biocomposite knotless suture anchor with suture tape repair and make it a potentially superior repair technique based on biomechanics alone.\textsuperscript{22}

Similarly to standard repair with suture anchors, repair using a 4.75-mm biocomposite knotless suture anchor with tape suture eliminates the need to expose the distal pole of the patella.\textsuperscript{7,10-12,21} This allows for a smaller surgical incision, less extensive dissection, and prevents possible interference with the patellar tendon.\textsuperscript{7,10-12,21} Additionally, it eliminates the risk of iatrogenic patellar fracture and damage to the articular surface from drilling the transpatellar tunnels.\textsuperscript{17,18} Both our own review of cases repaired with our 4.75-mm biocomposite knotless suture anchor with suture tape technique as well as studies of suture anchor repair have consistently found operative times of <1 hour.\textsuperscript{21} Shorter operative times and smaller surgical wounds are advantageous given that many of these patients have medical comorbidities that predispose them to intraoperative and wound-healing complications.\textsuperscript{12,19-22}

Optimal rehabilitation protocols for quadriceps tendon repair are a matter of controversy. Multiple studies of repair with transosseous patellar tunnels describe immobilization for 6 weeks after surgery, but there has been a recent push toward early motion.\textsuperscript{7,13,23,24} Reported complications of extended immobilization include limited flexion, pain, weakness, decreased patellar mobility, and patella baja.\textsuperscript{14} Studies have suggested that, while excessive loading can cause gap formation and weaken the repair, some controlled motion is necessary to heal the tendon\textsuperscript{23,25} and reduce the risks of stiffness and atrophy.\textsuperscript{14} The improved biomechanical characteristics of the 4.75-mm biocomposite knotless suture anchor with tape suture technique allow for safe early initiation of ROM.
exercises and accelerated rehabilitation protocols.

In our early experience with this technique, functional outcomes have been excellent. A formal 2-year outcome study of patients who have undergone quadriceps tendon repair with this 4.75-mm biocomposite knotless suture anchor with tape suture technique is under way.

**Key Info**

**Figures/Tables**

Figures / Tables:

[Figures/Tables: paci-0118-f1.png]

**References**


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**Multimedia**

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**Product Guide**

**Product Guide**

- BioComposite SwiveLock Anchor
- BioComposite SwiveLock C, with White/Black TigerTape™ Loop
- BioComposite SwiveLock Anchor, With Blue FiberTape Loop
- Knotless SutureTak® Anchor
Citation

Publish date: January 26, 2018

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