Technical Note

Suture Anchor Repair with V-Y Plasty and Achilles Allograft Augmentation for Chronic Quadriceps Tendon Injury

Conner J. Paez, B.A., and Brian J. Rebolledo, M.D.

Abstract: Despite an overall incidence that remains low, quadriceps tendon injuries represent a common disorder of the knee extensor mechanism. Persistent pain, weakness, and loss of terminal extension can lead to poor clinical outcomes and significant functional impairment. In the acute setting, approach to management often includes primary repair of the injured tendon that can lead to excellent clinical outcomes. However, a delayed or missed diagnosis can bring forth a clinical scenario that can be difficult to manage thereafter. In the chronically injured tendon, challenges can be linked to limited tendon excursion, poor tissue quality, and increased risk of reinjury.

To successfully manage these difficult injuries, considerations should account for biomechanical and biologic impairments of the injured tendon. A comprehensive management approach to repair should aim for robust fixation without overtensioning, along with the consideration of a biologic adjunct. In this Technical Note, we present our surgical approach to manage a chronic quadriceps tendon rupture using a suture anchor repair with V-Y quadriceps plasty and Achilles allograft augmentation.

Quadriceps tendon ruptures represent a debilitating injury of the knee extensor mechanism with an incidence of 1.37 to 2.82 per 100,000 person-years.[1,2] Because of overt functional deficit, operative management is generally recommended in the acute setting, which has been coupled with successful outcomes.[3-5] In the setting of a chronic injury or reinjury, progressive impairment and permanent dysfunction can occur. Traditional repair of the quadriceps tendon has used intraosseous bone tunnels through the patella with suture fixation and tied over a bone bridge. However, contemporary techniques have promoted suture anchor repair as an excellent alternative. In addition to minimizing the surgical dissection required, equivalent biomechanical results have been linked to less gapping under cyclic load.[6]

In chronic quadriceps ruptures, the proximal musculotendinous segment can undergo retraction with segmental deficit. Chronic quadriceps tendon tears have been reported to retract >5 cm in just 2 weeks after injury.[4] The V-Y plasty or Codivilla technique is a modality used to manage a structural gap from shortened tendon stumps.[4] In addition to lengthening procedures, augmentation with allografts, autografts, or synthetic materials can also be considered.[7,8] The Achilles allograft is an adjunct that has demonstrated successful outcomes in repair of the knee extensor mechanism.[9] In addition to repair augmentation, it can provide earlier range of motion and quadriceps strength without donor site morbidity.[10,11] Furthermore, because of biologic compromise in many of these scenarios, this serves as a biologic scaffold that can help strengthen the repair. To address the injury, we present our approach for managing a chronic quadriceps tendon injury with suture anchor repair using a V-Y quadriceps plasty and Achilles allograft augment.

From the School of Medicine, University of California San Diego (C.J.P.), La Jolla, California, U.S.A.; and Department of Orthopaedic Surgery, Division of Sports Medicine, Scripps Clinic (B.J.R.), La Jolla, California, U.S.A.

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Address correspondence to Brian J. Rebolledo, M.D., Department of Orthopaedic Surgery, Division of Sports Medicine, Scripps Clinic, 10666 N. Torrey Pines Road, MS-116, La Jolla, CA, 92037, U.S.A. E-mail: rebolledo.brian@scrippshealth.org

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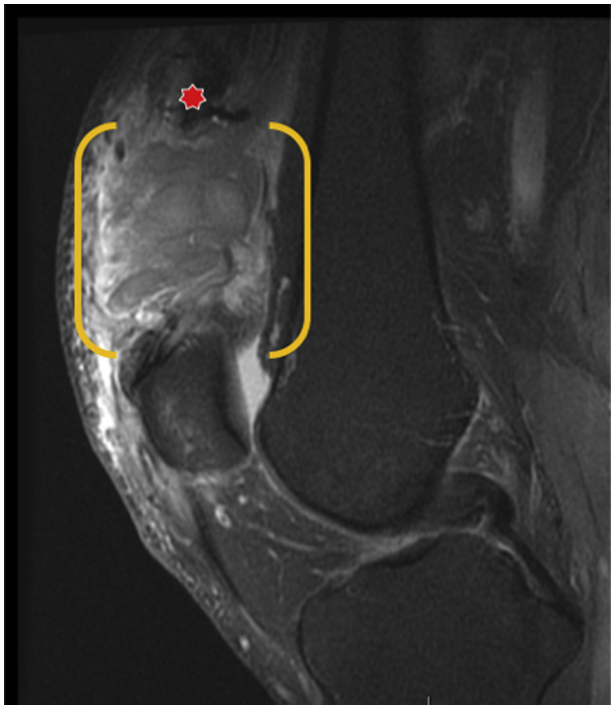

Fig 1. Preoperative Sagittal T2 magnetic resonance imaging scan showing chronic quadriceps tendon tear with proximal retraction of the tendon (star) and defect present (brackets).

Fig 2. Preoperative incision is marked out, which also incorporates an incision from a prior operation.

Surgical Technique

Patient Positioning

Regional anesthesia is performed routinely for perioperative pain management. The patient is placed in the supine position with a proximal tourniquet that can be used for hemostasis if required. A sterile bump can also be used under the knee to assist in accentuating quadriceps defect during dissection, and later be placed under the foot to bring into full extension for later repair.

Surgical Approach

Preparation before surgical intervention is critical in the setting of a retracted, chronic tear of the quadriceps tendon (Fig 1, Video 1). Incorporating the proximal extent of the previous incision, a midline incision was extended proximally for improved exposure of the retracted quadriceps tendon (Fig 2). Distal exposure was limited to the extent that the superior pole of the patella could be accessed. Adherent soft tissue was then sharply dissected off the underlying quadriceps tendon and flaps were created medially and laterally. Fibrotic scar encountered at the defect was then removed to

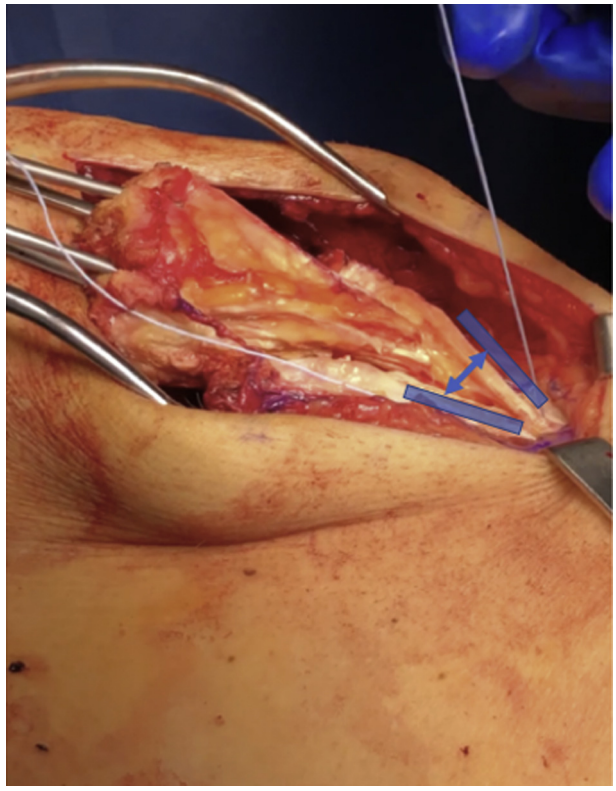

Fig 3. After initiating the V-Y quadricepsplasty, tension is held distally to achieve the appropriate amount of tendon mobility to reach the superior pole of the patella. Once acceptable excursion is obtained, the proximal Y-limb (blue bars) is sutured together (double arrows) in a side-to-side fashion to allow for distalization of the tendon.

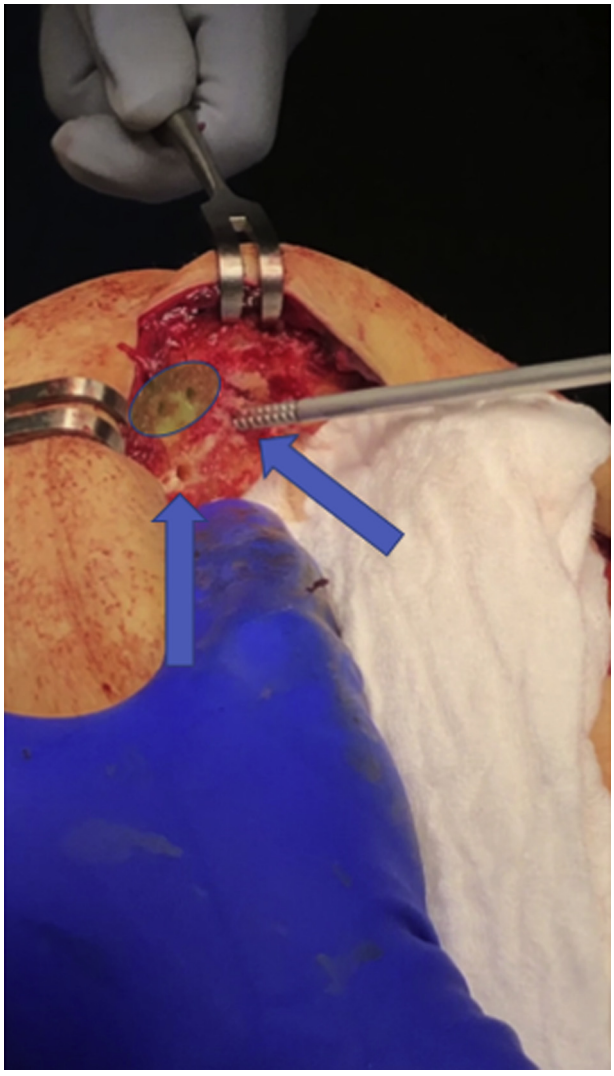

Fig 4. The superior pole of the patella is then prepared. Two drill holes are placed both medial and lateral along the midline of the patellar pole (blue arrows). Notably, the prior surgery used 2 anchors dorsal and central within the patella (circle), which does not allow for recreation of the tendon footprint over the width of the patellar pole.

adequately assess the gap distance. The degenerative tendinous portion of the distal stump was then excised until more robust quality of tendon could be appreciated.

V-Y Quadriceps Plasty

Bringing the leg into full extension, Allis clamps were placed on the distal tendon to pull traction and a final gap was measured to be 4 cm. A V-Y quadricepsplasty was then planned given the inability to reduce the distal tendon stump in full extension. Both medial and lateral arms of 8 cm were measured, thus doubling the defect length. A V-type incision was then created, with both the medial and lateral arms meeting at the middle of

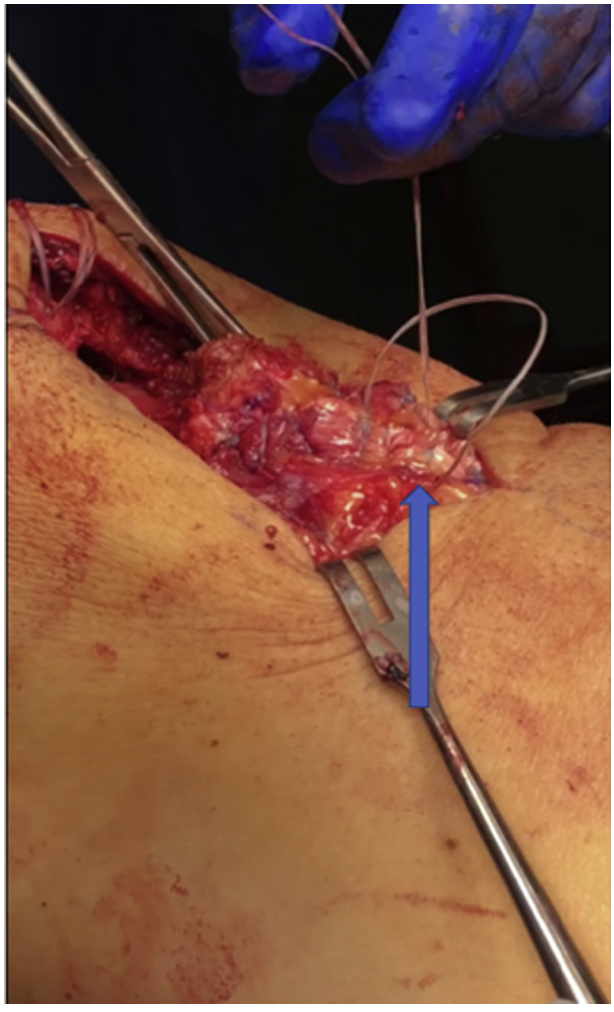

Fig 5. Following V-Y quadricepsplasty, the lengthened tendon segment (blue arrow) is repaired to the native tendon with Krackow sutures.

the intact proximal tendon. It is important that the surgeon does not completely excise the tendon at the proximal pole, but rather allow the most posterior fibers of the tendon to remain intact. This will allow for the appropriate excursion while not devitalizing the tissue. Traction was then applied which allowed for tendon excursion to the patella, and No. 2 nonabsorbable suture was used to reapproximate the tendon into a Y configuration, closing the proximal extent of the tendon in a side-to-side manner (Fig 3). Closing the Y-limb first will maximize the distalization of the tendon. At this point, the quadriceps tendon should be reexamined to ensure that the repair can be completed to the patella under limited tension. After this was completed, the medial and lateral limbs were then closed with No. 2 nonabsorbable suture, thus completing the advancement of the tendon.

Suture Anchor Repair and Biologic Augmentation

Once the V-Y quadricepsplasty was completed, the superior pole of the patella was cleared of remaining

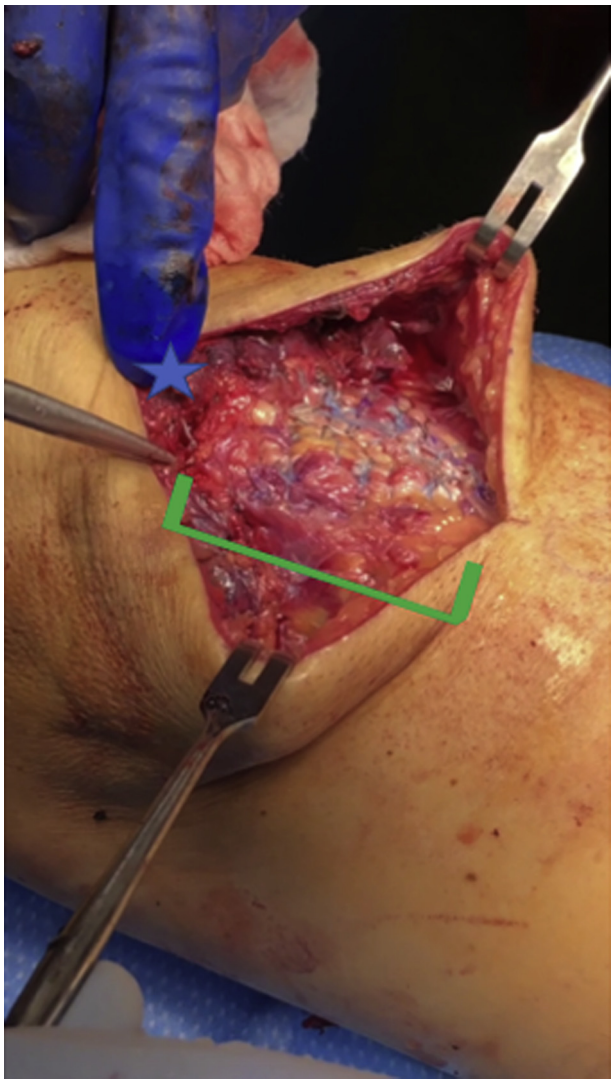

Fig 6. The completed repair of the tendon (bracket) with reapproximation to the superior pole of the patella (star).

soft tissue as well as remnants of the previous anchors from the prior surgery. The proximal pole of the patella is then debrided of soft tissue with the use of an electrocautery followed by rongeur and burr to stimulate a bleeding bony bed. A 3.5-mm drill with guide is then used to place 2 drill holes in the medial and lateral regions of the superior patellar pole. At this point, anchor placement was planned for 2 5.5-mm BioComposite Corkscrew FT anchors with 2 1.3-mm suture tapes (Arthrex, Naples, FL). Once drilled, the medial and lateral holes are tapped and the anchors placed (Fig 3) on both the medial and lateral aspects of the patella. Given the dense bone proximally, it is recommended to fully seat the tap to allow for easier placement of anchors (Fig 4). The suture tapes from both anchors are then used in a Krackow suture configuration in the distal quadriceps tendon. This should be performed so that the

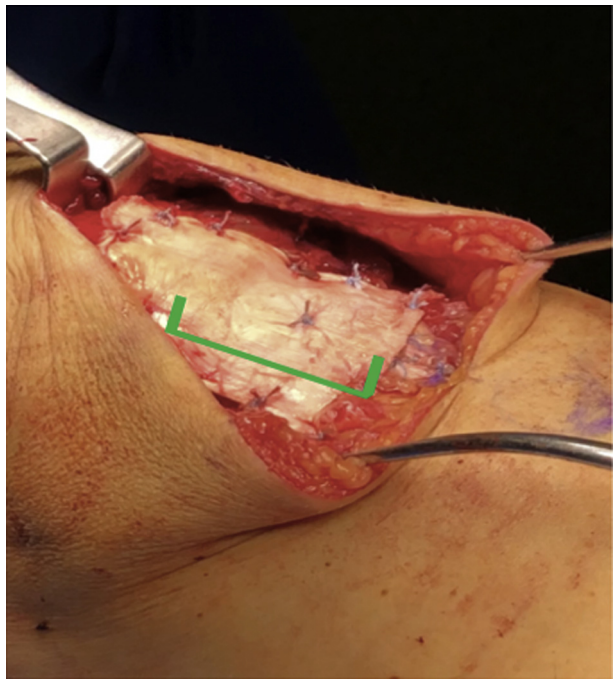

Fig 7. Biologic augmentation is included with Achilles tendon allograft (bracket) to span the quadriceps repair with V-Y plasty.

Krackow sutures bypass the proximal extent of the quadricepsplasty with incorporation of native undisturbed tendon proximally (Fig 5). This will provide improved repair strength when bypassing the recently manipulated tendinous portion (Fig 6).

Because of the compromised tendon quality in the revision setting, an Achilles allograft would be used for augmentation to enhance biologic environment. The allograft was then placed over the repair, ensuring that it spanned the periphery of the repaired tendon in all directions (Fig 7). It is important to place sutures at the periphery of the allograft to maximize surface area contact. The wound was again thoroughly irrigated and closed in layers. The extremity was then placed into a brace locked in full extension.

Postoperative Management

The patient is placed in a hinged knee brace for 8 weeks that locked in extension at all times unless participating in therapy or home exercises. Restricted weightbearing is maintained for 2 weeks with progression to full weightbearing locked in extension for 6 weeks. Range of motion is allowed with stepwise progression to 90o at 6 weeks, with unlimited motion and brace discontinuation at 8 weeks.

Discussion

Management of a chronic quadriceps tendon injury requires the consideration of both biomechanical and

Table 1. Technique Pearls and Pitfalls

Pearls	Pitfalls
• Degenerative tendon and fibrotic scar should be excised until healthy tissue is encountered • Suture anchor repair may effectively decrease the working length of the repair, allowing for less gapping at the repair site • The medial and lateral arms of the V-incision should double the length of the defect gap for appropriate excursion • Achilles allograft augment should be placed after repair, with coverage spanning the tendon repair and borders of the adjacent retinaculum	• Tears retracted >6 cm may be difficult to address with a tendon lengthening technique • Because of dense proximal bone at the superior pole of the patella, a drill along with tap can prevent anchor malfunction during placement • Krackow sutures for repair following quadricepsplasty should bypass the proximal extent of the manipulated tendon to decrease load on the tendinoplasty • Suture anchors and allograft use can increase procedure costs

biologic failures that can impact surgical success. In this technique, we use a V-Y lengthening procedure to successfully bridge a segmental tendon gap created by a chronic quadriceps tendon rupture. An Achilles allograft augment was then used as a biologic scaffold to assist in the reconstitution of the chronically torn tendon.

After injury, the injured tendon undergoes the process of healing with formation of disorganized collagen fibers and matrix, increased collagen III, and scar tissue.[12] The end result of this process is a tendon that is structurally and biologically inferior to its previous state. This puts the tendon at increased risk for repeat injury.[12,13] In addition, in the setting of a chronic injury, the muscle undergoes fibrosis and the muscle fibers lose elasticity.[4] Approximation of the tendon is therefore more challenging and presents with increased mechanical strain on the repair. For this reason, it may be necessary to augment the surgical repair with the use of a biologic scaffold. An Achilles allograft can allow for tissue enhancement of the newly lengthened tendon and with further safeguard against future injury.

This technique has the advantage of being able to effectively increase the length of the quadriceps tendon while retaining adequate tendon integrity required for repair (Table 1). No guidelines exist on the limits of V-Y plasty repair; however, Shi et al. had described a modified V-Y plasty technique with exclusion of patients with greater than 6 cm of gapping because of perceived limitations of the V-Y plasty.[14]

There are potential limitations to this technique. The most likely are those inherent to most surgical procedures and the use of allografts, including pain, infection, and graft rejection. However, this procedure does not increase the risk of these results beyond what is reasonably expected as part of standard of care. The superior pole of the patella is usually quite dense, and we recommend drill followed by fully seating the tap before anchor placement. The senior author also prefers PEEK (Arthrex) anchors over biocomposite, which can display greater resistance to breakage. In addition, our gap length deficit was 4 cm, and it unknown what the boundary extent may ultimately be for using a tendon lengthening in this scenario.

Conclusions

We have described our surgical technique for the repair of a chronic quadriceps tendon using suture anchors and a combination of V-Y quadricepsplasty with Achilles tendon allograft augment. The technique serves as an effective method to manage chronic quadriceps tendon injuries.

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