

A Suture Anchor–Based Repair Plus Reconstruction Using Acellular Human Dermal Allograft for Recurrent Sports-Related Patellar Tendon Rupture



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Abstract: Recurrent traumatic patellar tendon rupture following early repair of a primary rupture is exceedingly rare; there is little technical literature on how to manage this potentially devastating injury. We describe here a suture anchor–based technique for revision repair augmented with an extensor reconstruction using acellular human dermal allograft.

Patellar tendon ruptures are rare, comprising the third most-common injury to the extensor mechanism. They commonly present in male patients younger than 40 years who participate in sports activities.¹ The optimal treatment is early surgical repair. Recent studies suggest suture anchor repair techniques are biomechanically superior to transosseous suture repairs.^{2,3} Regardless of the chosen technique, recurrent tears following surgical repair appear to be so rare that the actual incidence is not well defined. There is a paucity of literature to guide treatment. The severity of these injuries is well-understood; a study found that National Football League athletes who underwent patellar tendon repair fared worst with respect to return

to play rate, career length after surgery, games played, and performance at 1, 2, and 3 years postoperatively.⁴

Chronic patellar tendon ruptures are related conceptually to recurrent traumatic tear. Previous literature on chronic ruptures has described reconstructive techniques that include the use of autograft or allograft tendon, acellular human dermal allograft, and synthetic materials.⁵⁻⁷ However, there is no gold standard for these challenging cases. Acellular human dermal allograft has been used with success in reinforcing tendon repairs including distal biceps, patella, quadriceps, Achilles, and rotator cuff.⁸⁻¹¹

We describe here our technique for revision patella tendon repair plus reconstruction with suture anchors and acellular human dermal allograft. Our technique uses both knot-based and knotless fixation and maximizes suture and tape strands incorporated into the construct.

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Surgical Technique (With Video Illustration)

Video 1 shows the surgical technique. Pearls and pitfalls are presented in [Table 1](#).

Positioning, Exposure, and Preparation of Repair Margins

The procedure is performed under general anesthesia with a preoperative femoral nerve block. The patient is positioned supine on a standard surgical table with bony prominences padded. A tourniquet is applied high on the thigh, with a small bump under the ipsilateral buttock. Examination under anesthesia is performed, and a characteristic palpable defect in the extensor mechanism and patella alta is appreciated. Following sterile skin preparation and draping, the limb is

Table 1. Pearls and Pitfalls

Pearls	Pitfalls
A no. 5 FiberWire can be placed as a traction stitch over superior patella to assist with reduction of the patella. This helps minimize postoperative residual patella alta.	Under-resection of scar about previous repair may leave poor quality tissue margins for revision repair and/or make closure over the allograft reconstruction more challenging.
Use 5.5 tap for placement of 4.75 anchors in patella and tibia.	Failure to sufficiently mobilize proximal extensor mechanism may limit ability to correct patella alta.
Use of double-loaded anchor plus tape through closed eyelet provides ample suture for tendon and retinacula repair plus tape for allograft patellar tendon reconstruction fixation	Failure to oversize tap may lead to biocomposite anchor breakage.
Ensure that slack is removed from suture before proceeding with next pass for running locking stitch.	Failing to remove slack from sutures increases the risk of creep within the repair and risk development of patella alta and extensor lag after healing.
Ensure dermal allograft corners are tensioned during positioning and marking for punch holes and again when placing for the extensor reconstruction.	Relying on a limited number of suture limbs and/or repair without concurrent reconstruction may be insufficient in revision patellar tendon surgery.
On back table, use leftover anchor driver as punch to create holes for easier passage of tapes through thick graft.	

exsanguinated with an esmarch and tourniquet raised to 250 to 300 mm Hg. A midline longitudinal incision is made centered over the patella and in line with the previous incision. Full-thickness medial and lateral flaps are created to expose the medial and lateral retinacular disruptions, patella, patellar tendon remnant, and proximal tibia. Hematoma is evacuated. Meticulous debridement is performed to excise abundant scar tissue encountered about the patellar tendon remnant and retinacula. This is a key step and ensures as best possible that there are fresh tissue margins and that there is sufficient room in the soft-tissue envelope for the dermal allograft to overlay the extensor mechanism. Suture material from the previous repair is removed. We use a new no. 10 blade to freshen the margins of the patella tendon and medial and lateral retinaculum. A rongeur and curette are used to prepare the inferior margin of the patella to a bleeding bony edge, with care taken not to excessively decorticate.

Suture Anchor Placement and Repair Suture Passage

A no. 5 FiberWire (Arthrex, Naples, FL) suture is placed through the quadriceps tendon at the junction with the superior pole of the patella (Fig 1). The senior author finds this to be a useful step in all patellar tendon repairs. The traction stitch is used to tension the extensor mechanism distally while finger dissection carefully releases adhesions about the quadriceps to ensure good distal mobility. The traction suture is later incorporated into the tibial fixation.

Next, patellar suture anchor placement is performed. We drill then tap 2 holes in the inferior pole of the patella for placement of biocomposite 4.75-mm SwiveLock (Arthrex) anchors. We recommend using an oversize 5.5-mm tap to help avoid anchor breakage during insertion in the dense patella and tibia bone. Before insertion, we load the closed eyelet of each anchor with FiberTape (Arthrex) and specifically

choose this anchor for its two no. 2 high-tensile strength retention sutures. Thus, each anchor affords 2 tape strands and 4 no. 2 suture limbs for fixation, in addition to the two no. 5 limbs from the suprapatellar traction stitch (Fig 1).

To repair the patellar tendon remnant, one suture limb from each anchor is sewn in the patella tendon from proximal to distal and back in running locking fashion using a free needle. It is essential to tension the suture after each pass to remove slack, as slack may lead to creep in the overall construct. The corresponding free limbs of the passed sutures are then tensioned using a pulley effect through the anchors to tightly appose the prepared proximal patellar tendon margin to the prepared bony surface of the inferior pole of the patella. Tension on the patellar traction stitch assists in reduction of tendon to bone, and gentle cycling of the knee with tension on the repair sutures and traction suture also helps eliminate creep. The first repair suture pair is tied, with tension held on the traction suture and the second repair suture pair to maintain the apposition of patellar tendon to bone, then the second repair suture limbs are tied.

Medial and lateral retinacular repairs are next completed using the remaining no. 2 core sutures from each anchor. These sutures are passed in running whipstitch fashion from the patella to the margin of the medial or lateral retinacular tear and then back to the patella to tightly oversee the repair. The suture limbs are tied, then we cut one tail from each knot and tie the remaining core suture limb to its counterpart from the other anchor to interlink the repairs.

Allograft Preparation and Fixation

Due to the revision nature of the case and poor quality of the patellar tendon remnant, we augment our repair by incorporating an acellular human dermal allograft extensor reconstruction. A 3-mm thick ArthroFLEX (Arthrex) acellular human dermal allograft

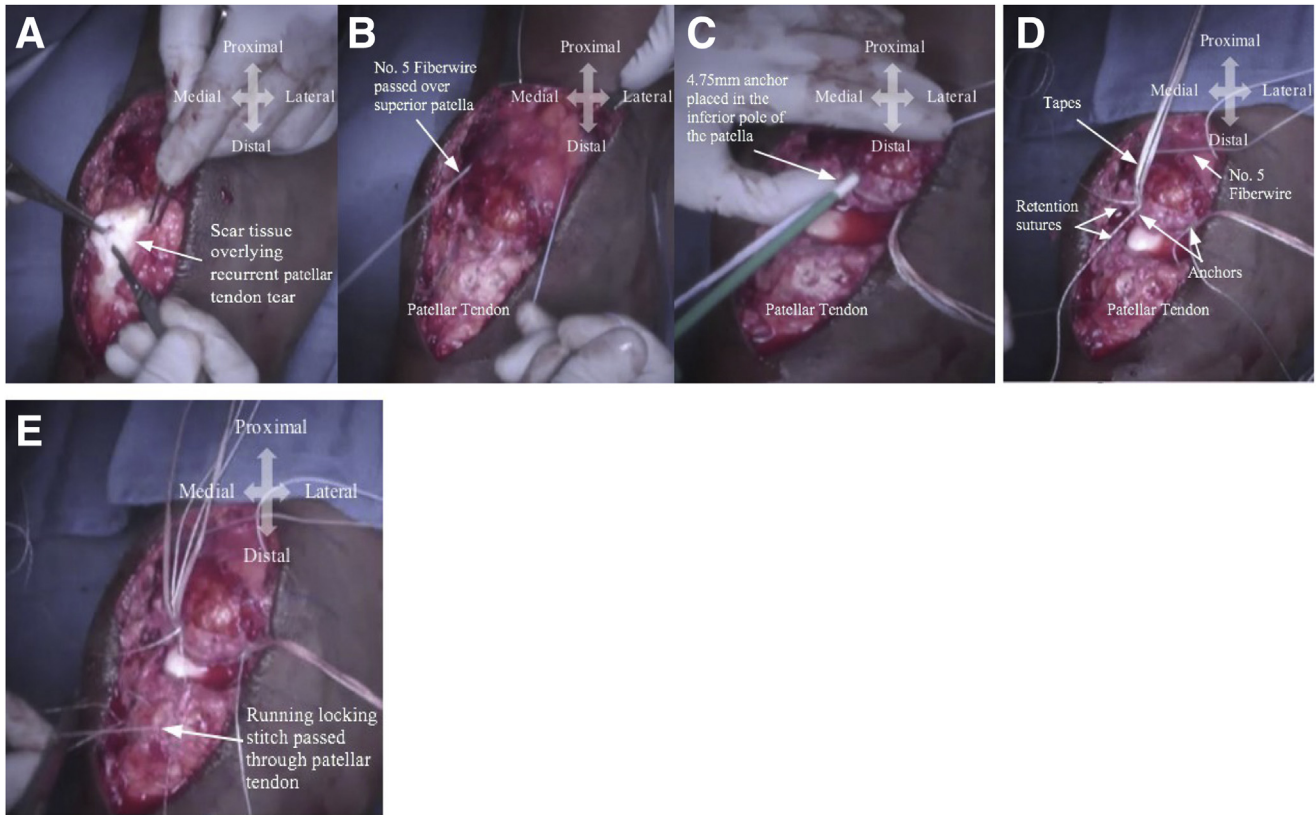


Fig 1. With the patient in the supine position, a right knee arthrotomy is made to expose the recurrent patellar tendon tear. (A) Thick, abundant scar tissue is found overlying the patellar tendon and a thorough debridement is performed. (B) We place a no. 5 FiberWire (Arthrex, Naples, FL) over the superior pole of the patella to assist with later patella reduction. (C) The inferior pole of the patella is prepared for placement of two 4.75-mm biocomposite SwiveLock anchors (Arthrex). (D) Each anchor is double loaded with TigerTape, FiberTape (Arthrex), and no. 2 core sutures. (E) We use one limb of the core sutures to perform a running locking stitch in the patella tendon. The free limb of the passed suture is then tensioned using a pulley effect through the anchors to tightly appose the prepared proximal patellar tendon margin to the bony surface of the inferior pole of the patella. Traction is applied through the no. 5 FiberWire (Arthrex) to assist with patellar tendon reduction.

is stretched out to bridge over the repair and determine position of best fit (Fig 2). The graft is positioned to span the entire length of the patellar tendon such that it will overlay the patella and central aspects of the retinaculum proximally and the proximal tibia distally. The locations of the 2 patellar suture anchors are carefully marked in the proximal portion of the dermal allograft patch for placement of punch holes to facilitate passage and overlaying of FiberTape (Arthrex) fixation. The empty driver from the SwiveLock (Arthrex) anchor makes an effective punch when placed on the dermal allograft in the desired location and struck with a mallet. Holes are then punched. The graft is placed back over the inferior pole of the patella, patellar tendon, and proximal tibia, and the FiberTapes (Arthrex) from the patellar anchors are passed through the punch holes. The distal corners of the graft are tensioned as it is laid over the repair. We then mark sites for tibial knotless suture anchors and drill and tap holes in the medial and lateral proximal tibia distal to the tensioned end of the dermal allograft. The tape limbs from the

patella and the no. 5 traction stitch limbs are tensioned. One tape from each patella anchor plus one no. 5 traction suture limb are placed in the each of the distal anchors (Fig 2). The tapes and sutures are tensioned as the knotless anchors are seated in the tibia. This step creates a box-and-cross tape configuration, similar to knotless rotator cuff repair constructs, which tightly apposes the dermal allograft to the underlying extensor tissue and additionally places multiple limbs of high strength suture and tape across the tear to reinforce the underlying repair. With sutures strongly affixed to both the patella and tibia our construct creates an effective “internal brace” to augment the soft tissue repair and allograft reconstruction.

The retention sutures from the tibial anchors can then be used to suture the distal edge of the dermal allograft to the tibia. Proximally, interrupted 1.3-mm suture tape is placed along the medial, lateral, and proximal margins of the graft to sew it into the extensor mechanism.

The repair is tested with passive range of motion confirming excellent stability. The wound is irrigated.

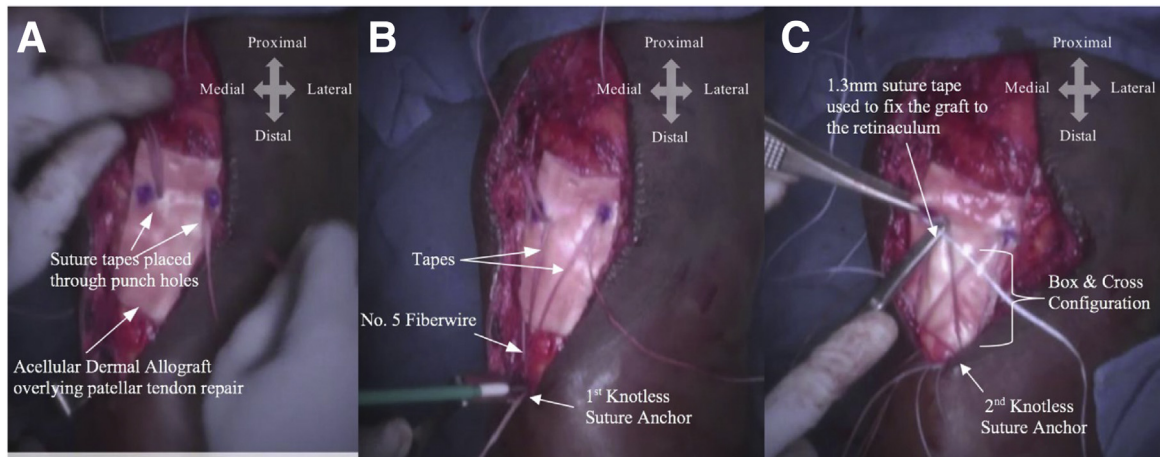


Fig 2. Right knee arthroscopy. With the patient supine, the ArthroFLEX dermal allograft (Arthrex, Naples, FL) is placed over top of the revision patellar tendon repair. (A) One tape limb from each previously placed anchor is passed through punch holes that were placed in the proximal aspect of the ArthroFLEX dermal allograft (Arthrex) on the back table. (B) Knotless anchors are loaded with tapes from each anchor and one limb of the suprapatellar no. 5 FiberWire (Arthrex) and placed in the proximal tibia distal to the allograft. (C) A resultant box-and-cross configuration is created overlying the initial patellar tendon repair. The proximal edge of the ArthroFLEX dermal allograft (Arthrex) is sutured to the retinacula with 1.3-mm suture tape (Arthrex).

The tourniquet is released and the wound is packed with saline soaked sponges to encourage hemostasis. After the sponges are removed, layered suture closure of the incision is performed. A sterile dressing is placed and the limb is placed in a hinged knee immobilizer locked in extension.

Postoperative Protocol

Our typical postoperative protocol involves early weight-bearing as tolerated in full extension with crutches and a locked hinged knee brace. Flexion range of motion is progressed to 90 over 6 weeks and the brace range of motion is gradually increased as quadriceps, core, and lower extremity motor control return. At 6+ weeks, the brace is weaned and range of motion is progressively increased to full. Beyond 12 weeks, phased strengthening and conditioning continues with exercise bike, open chain quadriceps work, progression to running, and eventually return to sport progressions (generally 24+ weeks postoperatively).

In cases of revision, we prescribe a slightly delayed rehabilitation protocol with 2 weeks of touchdown weight-bearing in extension then weight-bearing as tolerated in extension, and range of motion progressions beginning after 1 week locked in full extension.

Discussion

Acute patella tendon ruptures necessitate surgical repair. Multiple techniques exist, the most common being transosseous bone tunnels with modified Krakow suture within the patella tendon. More recently, suture anchors have been studied as an alternative to transosseous sutures. Several biomechanical studies have

demonstrated that compared with transosseous repair, suture anchor repair decreases gap formation^{2,3,12} and improves ultimate load to failure.^{2,12} Augmentation of primary repair also has been described with internal bracing and wiring, with some studies demonstrating decreased ultimate gap formation.¹³

Failure after patella tendon repair is a rare occurrence. A recent study of 68 patella tendon repairs reported a 3% failure rate, with the average time to failure occurring 4 weeks postoperatively.¹⁴ We did not find any reports describing recurrent patellar tendon tears after a healed primary repair.

In the setting of patella tendon failures after primary repair or chronic patellar tendon ruptures, reconstruction is generally preferred. Autograft, allograft, and synthetic materials have been reported as reconstruction options. Autograft reconstructions using gracilis, semitendinosus tendon, or fascia lata have been reported with good outcomes.^{11,15,16} The main disadvantages of autograft, however, include dependence on good host quality tissue, increased surgical complexity, and donor-site morbidity. Alternatively, reconstruction with allograft or synthetic materials such as allograft bone patellar bone, allograft Achilles tendon, or LARS (Ligament Augmentation and Reconstruction System) ligament have been advocated by some surgeons.^{6,7,15,17} These options avoid donor-site morbidity and may improve mechanical properties of the surgical reconstruction, permitting early mobilization and rehabilitation, but entail potential risks of tissue rejection, infection, and/or foreign-body inflammatory reaction.

Acellular human dermal allograft is an extracellular matrix that has been used successfully in the treatment

Table 2. Potential Advantages and Disadvantages of Anchor-Based Repair With Acellular Dermal Allograft Augmentation

Advantages
Avoids donor-site morbidity
Decreased operative time compared with autograft
Biomechanically strong construct with suture anchors, multiple limbs of load-sharing suture and tape
Double-loaded anchors facilitate incorporation of retinacular repair with patellar tendon repair
Low risk of foreign body postinflammatory reaction
Disadvantages
Cost of graft
Possible risks of infection and graft degradation

of chronic tears involving the pectoralis major, Achilles, distal biceps, and rotator cuff tendons.⁵⁻⁸ The dermal allograft can offer mechanical support as well as improve healing by influencing host cell infiltration.¹⁶ Clinically, there is evidence that its use is associated with a reduction in the risk of reinjury after tendon repair.^{18,19} Similar to allografts or synthetic materials, the dermal allograft obviates the need for autograft harvesting, shortening operative time, and reducing donor-site morbidity. In addition, because of its acellularity, there is low risk of tissue rejection or foreign body reaction.

Although there exist many reconstructive options in the setting of recurrent patellar tendon tears, suture anchor repair augmented with acellular dermal autograft is a reasonable option in many cases. Potential advantages and disadvantages of this technique are outlined in Table 2. We believe this is an excellent option for these challenging cases as our combined repair and reconstruction technique creates 4 levels of separate but interlinked fixation as there as separate high tensile strength anchor-based sutures/tapes for (1) revision patellar tendon repair; (2) retinacular repair; (3) patellar tendon dermal allograft reconstruction; and (4) suprapatellar fixation. We consider this technique a viable option for failed patella tendon repair with poor tissue quality and believe it also can be considered as an approach for primary tendon repairs and for reconstruction of chronic patellar tendon tears.

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