

Chronic Quadriceps Tendon Rupture Reconstruction with Poly-Tape and Achilles' Tendon Allograft: A Case Report and Review of the Literature

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Learning Point of the Article:

The novel combination of Poly-Tape supplemented with an Achilles' tendon allograft has been proven in this case to provide a structurally competent reconstruction for chronic quadriceps tendon rupture.

Abstract

Introduction: Chronic rupture of the quadriceps tendon is an uncommon but debilitating injury, seen only in 1.37/100,000 patients per annum. The problems associated with this injury are the inability to walk due to disruption of the extensor mechanism and pain. There is limited literature on the reconstruction methods for this injury. This study aims to provide a case report and review of similar cases, using artificial tape and allograft.

Case Report: A 60-year-old male patient was operated on for chronic quadriceps tendon rupture after falling on his knee with forced flexion. The surgical management in our case consisted of mobilization of the proximal quadriceps tendon and muscle belly with a V-Y tendon plasty, advancement of the tendon, and repair using the Krakow technique through intraosseous patellar tunnels, augmented with Poly-Tape (Neoligaments©) and an Achilles' tendon allograft. This was used due to poor patient tissue quality and the extent of the defect. We also searched the literature for chronic quadriceps tendon ruptures reconstruction using poly tape or Achilles' tendon allograft.

Conclusion: Chronic quadriceps tendon rupture repairs have relatively poor outcomes, and no surgical procedure has been proven to be the gold standard treatment. We believe the novel combination of Poly-Tape supplemented with Achilles' tendon allograft produces a structurally competent reconstruction in patients with poor tissue quality and large defects and produced good results in our case report.

Keywords: Poly-Tape, quadriceps tendon rupture, Achilles' tendon allograft.

Introduction

Quadriceps tendon rupture is an uncommon but debilitating injury, seen in only 1.37/100,000 patients per annum [1]. The tendon is formed by the muscular junction of four muscles: The rectus femoris, the vastus lateralis, the vastus medialis, and the vastus intermedius. The quadriceps tendon forms one of the key components of the extensor mechanism. Without this, a patient is left unable to walk and has reduced stability of the knee. Patients generally present with the classic triad of diagnostic

signs. These include acute pain, inability to actively extend the knee joint, and a palpable suprapatellar gap [1]. Surgical management of chronic quadriceps tendons is variable, with limited methods described in the literature.

There are many risk factors for quadriceps tendon injuries, and they predominantly affect middle-aged males with a mean age of 51.1 years [1]. In addition, multiple conditions put patients at risk of quadriceps tendon injuries, such as rheumatoid arthritis, gout, chronic renal failure, and diabetes mellitus. Steroid abuse is

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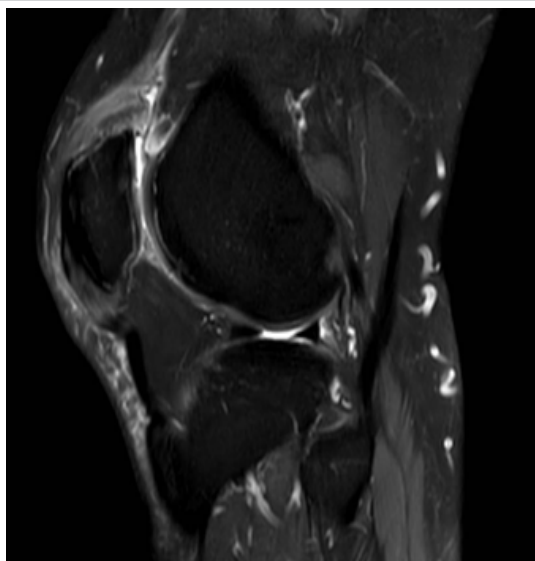


Figure 1: T2-weighted MRI image of the knee in the sagittal view; Pre-operative MRI scan confirming the chronic quadriceps tendon rupture. The scan shows the patellar tendon's thickened and edematous appearance suggesting a degree of underlying patellar tendinosis, and the scan also shows chondromalacia in the lateral patellar facet with subchondral bone changes.



Figure 2: Pre-operative X-ray of the knee in the sagittal view; pre-operative X-ray showing patella baja.

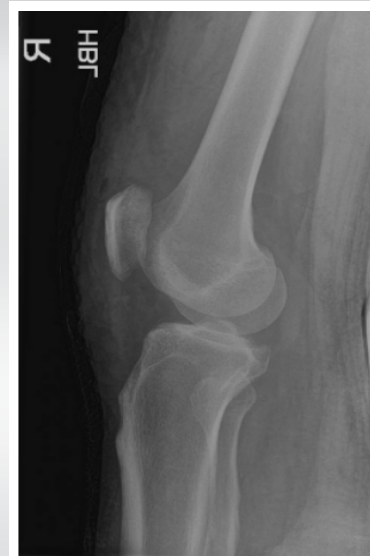


Figure 3: Post-operative X-ray of the knee in the sagittal view; post-operative X-ray showing significant improvement of the patient's patella baja.

another common predisposing condition, as corticosteroids can inhibit collagen synthesis and compromise the blood supply, weakening tendons [2]. However, trauma does occur during activity in healthy controls, usually due to eccentric loading of the knee extensor mechanism [1].

We report a case using polyethylene terephthalate tape (Poly-tape), an artificial material used to reconstruct the extensor mechanism. It is made of a woven, multifilament polyester fiber designed to be a frame for soft-tissue ingrowth and Neoligaments© formation [3]. The Poly-tape system, which has been used for ligament and tendon reconstruction, is 30 mm wide x 800 mm long and consists of an open-weave polyester mesh. The main advantages of Poly-Tape are a reduction in autograft donor site morbidity and reduced creep, compared to human tissue, which may lead to graft failure [4]. In our case, a fresh-frozen non-irradiated Achilles tendon was also used to supplement the reconstruction by augmentation.

Case Report

The authors have obtained the patient's informed consent for print and electronic publication of the case report. A 60-year-old man was seen in the clinic in May 2021 and diagnosed with a right-sided full-thickness quadriceps tendon tear. The injury occurred in January 2021 when he fell on his right knee with forced flexion. He delayed getting help, and the lockdown further compounded this during the COVID-19 pandemic. He presented in the clinic with a noticeable loss of quadriceps

muscle bulk and significant swelling. The patient could not attain a full straight leg raise or walk properly. He had a medical history of hypertension, pre-diabetes, and obesity (BMI: 32.9).

The senior surgeon subsequently sent the patient for an MRI, which confirmed the suspected quadriceps tendon rupture. Furthermore, the patellar tendon's thickened and edematous appearance suggested a possible degree of underlying patellar tendinosis. In addition, the scan showed chondromalacia in the lateral patellar facet with subchondral bone changes (Fig. 1).

The patient's quality of life decreased significantly due to the injury; he reported that he could only walk limited distances with difficulty, and he felt unsteady. He also had great difficulty getting in and out of his car. Therefore, following discussion and patient informed consent, it was decided he would benefit from surgical reconstruction of the tendon rupture.

An ultrasound was arranged as part of the preoperative planning to assess the gap between the proximal end of the quadriceps tendon and the proximal pole of the patella. This was only undertaken as the MRI scan had been performed earlier in the year; therefore, concern of further proximal quadriceps retraction was significant. There was a rupture of the medial and middle parts of the quadriceps tendon at the patellar insertion, with a proximal retraction of at least 82 mm in length. In addition, blunting of the distal margin of the quadriceps musculature was noted, and the patellar tendon was intact. Preoperative X-rays (Fig. 2) showed patella Baja, which can be seen to have been significantly improved in the postoperative X-rays (Fig. 3).



Figure 4: Intraoperative image; intraoperatively, a midline longitudinal incision was made, and the distal quadriceps tendon rupture was identified.



Figure 5: Intraoperative image; A pulvertaft weave technique was used to augment the tendon with the Neoligaments® quads tape system, allowing successful reinforcement and advancement of the tendon by 2 cm.

In July 2021, the patient underwent surgery under general anesthetic to reconstruct the right distal quadriceps tendon. A midline longitudinal incision was made, and the distal quadriceps tendon rupture was identified (Fig. 4). Unviable scar tissue was debrided from the distal edges of the tendon and the proximal pole of the patella. The quadriceps muscle belly was mobilized. This was followed by V-Y plasty to lengthen the quadriceps tendon: An inverted V was cut through the full thickness of the proximal segment of the quadriceps tendon, with both arms of the V meeting at the most proximal pole. The surgeon measured the gap at 6 cm in extension, which was reduced to 2 cm when the tendon edges were pulled distally toward the proximal pole of the patella. Modified Krackow suture with three vertical drill holes was used to try and bring the quadriceps tendon down toward the superior patella pole. A

pulvertaft weave technique was used to augment the tendon with the Neoligaments® quads tape system, whereby the proximal part of the Neoligaments® tape system is weaved through the quadriceps tendon and anchored with interrupted sutures after the adjustment to enhance strength. This allowed successful reinforcement and advancement of the tendon by 2 cm (Fig. 5). Due to the poor quality of the chronic quadriceps rupture tissue, an Achilles tendon allograft was used to supplement and reinforce the reconstruction. This was placed and secured over the superior layer of the extensor mechanism (Fig. 6). The Achilles allograft expansion was laid over the anterior patella, due to the flat, thin nature of this portion of the graft. This decision was made due to the subcutaneous nature of the patella, so no prominent excess tissue was palpable. The tubular portion of the graft was positioned over the quadriceps muscle.



Figure 6: Intraoperative image; an Achilles' tendon allograft was used on the superior layer of the extensor mechanism.

A backslab was applied to prevent flexion of his right knee. The patient was discharged the next day.

After 2 weeks, the backslab was removed and replaced by a cylinder cast. Following four further weeks in the cylinder cast, the patient was placed in a hinged knee brace. The ROM plan was to gradually increase motion to 0–30° from 6 to 8 weeks postoperatively, to 0–60° 8–10 weeks postoperatively, and to 0–90° 10–12 weeks postoperatively.

In September 2021, the patient came into the clinic presenting with a rash that originated on his left leg and spread to his groin, lower back, and the right leg. His GP had prescribed anti-fungal treatments, which did not have any effect. As a result, he was referred for an urgent dermatology review, and the rash was subsequently diagnosed as psoriasis following a biopsy. As per the dermatology review, it has not been clarified the exact cause



Figure 7: Post-operative clinical image; the straight leg was raised with a 5° extension deficit.



Figure 8: Post-operative clinical image; full flexion to 120°.

of the psoriasis. Multiple factors may contribute to the onset and exacerbation of psoriasis; hence, it is difficult to attribute or exclude directly the allogenic graft reaction or Poly-Tape hypersensitivity [5]. This did not cause any issues with knee surgery and mobilization.

The patient was seen most recently in the clinic in December 2022. He could fully extend his right knee while resting his leg on the bed. When his straight leg was raised, he had a 5° extension deficit, which resembled that of the healthy left leg, which had a 5° extension deficit (Fig. 7). He could flex to 130° (Fig. 8). He was happy with the procedure and mobilizing unaided. The patient was planning on undertaking more gym exercise, with a focus on swimming and cycling.

Discussion

Partial muscle or tendon tears that lack chronic pain and with no significant functional deficit are predominantly managed nonoperatively. However, a complete rupture can have detrimental effects on the patient's quality of life, so most surgeons would advise taking an operative route [6]. Chronic quadriceps tendon rupture repairs have relatively poor outcomes, with high re-rupture rates and levels of postoperative infection. The use of synthetic grafts, that is, Poly-tape, or allografts, could increase the success of reconstructing the extensor mechanism [7]. These injuries stand a much better chance of healing when operated on sooner. It has been recommended that surgical treatment takes place within 2–3 weeks of rupture [8]. Scuderi [9] recommended repair within 48–72 h post-injury to achieve the most successful outcome. The longer the injury is left before treatment, the higher the chance for the tendon to retract further, hindering the opportunity for successful results. However, rewarding outcomes are still possible with an extended period between

injury and treatment, proved by our case report.

There is no widely accepted treatment for chronic quadriceps tendon ruptures due to the injury's rarity and the lack of reported literature. In addition, none of the repair or reconstruction methods have been consistently successful in reinstating the function of the extensor mechanism [10]. The most common treatment options are synthetic grafts, allografts, and autografts. Synthetic grafts, made from polymers, provide excellent intrinsic strength, which allows the repaired construct to act against tensile forces [11]. There are several types of synthetic grafts, such as Marlex Mesh, Leeds-Keio Ligament, and the Neoligaments Poly-Tape system; generally used for

reconstruction of quadriceps and patellar tendons, rotator cuff muscles (Pitch-Patch device), and the anterior cruciate ligament (JewelACL system) [4]. Chen et al. [12] state that high tensile strength, abrasion resistance, and no immune reaction should all be basic properties of an ideal synthetic material used in artificial ligament manufacture. It should also allow the ingrowth of surrounding tissues. Poly-Tape possesses all these properties so are, therefore, a suitable scaffold for implantation. Literature has suggested that Poly-Tape may be superior to its counterparts. One study showed that Poly-Tape has the highest rate of cell attachment 1-day post-implant of the scaffold, with higher levels than other scaffolds such as X-repair and LARS ligament; cell attachment is required for the implanted scaffold to be incorporated into the body [13]. Artificial ligaments made from polyethylene terephthalate now act as the main apparatus in the reconstruction of the quadriceps tendon, including Poly-Tape and Leeds-Keio ligaments [12]. There are, however, some contraindications with using Poly-Tape, described by the manufacturer. The primary being where patients experience hypersensitivity to implant materials. Others include patients with any infection or pathological bone or soft-tissue condition and skeletally immature patients [4]. One limitation of Poly-Tape is that, due to being hydrophobic, it produces poor integration into the surrounding femur and patella bone tissue [14]. Yet, Li et al. [14] found a solution: a composite coating of 58S bioglass and hydroxyapatite, which can enhance the osseointegration of poly-tape in the bone tunnel. The Achilles' tendon allograft provides sufficient thickness and robustness to repair the quadriceps tendon. One of the main known limitations for allografts is the risk of infection, and although this is true for ruptures post-TKA, it has been found that after a primary procedure, the risk of infection is up to 10-fold lower than reported in the literature for post-TKA [15]. Furthermore, the

risk of infection does not represent a mechanical failure on the allografts' part [16]. The other potential issue with any allograft material used for tendon or ligament reconstruction is creep, resulting in tissue elongation over time.

Published literature has compared the outcomes of operative treatment using allografts versus synthetic ligaments. Artificial tape in reconstructing extensor mechanism ruptures is becoming more popular. To the best of our knowledge, the combination of Poly-Tape and an Achilles' tendon allograft has not been reported before in the literature. The authors believe that the combination of the two grafts could lead to a more beneficial and structurally competent reconstruction, by combining the tensile strength of the allograft, and the added strength with a smaller risk of immune reaction from the Poly-Tape. The results of this technique are commendable provided a strict postoperative rehabilitation plan is followed.

Conclusion

As far as the literature states, there is no singular procedure

yielding significantly better results. Therefore, unfortunately, there is no widely accepted treatment for chronic quadriceps tendon rupture. What has been borne out of this study, is that both the Poly-Tape and the Achilles' tendon allograft have their benefits, and combining them can lead to a more beneficial outcome for the patient.

Clinical Message

Managing chronic quadriceps tendon ruptures with poor tissue and significant defects can be challenging, due to being an uncommon injury and the lack of consensus in treatment. Surgical reconstruction with a combination of synthetic graft and allograft for chronic injuries can produce good functional outcomes.

Declaration of patient consent: The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient has given the consent for his/ her images and other clinical information to be reported in the journal. The patient understands that his/ her names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

Conflict of interest: Nil **Source of support:** None

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