



Parkour and Chronic Quadriceps Tendon Rupture: A Novel Technique for Repair and Reconstruction of the Extensor Mechanism Utilizing Suture Anchors and Allograft Augmentation

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Abstract

The extensor mechanism of the knee is vital in providing mobility and function in the daily requirements of a person. A rupture of the quadriceps tendon will directly impact biomechanics, necessitating a surgical repair to restore function. Although uncommon, we present a case of chronic quadriceps tendon rupture in a 19 year old patient secondary to a Parkour injury. Various augmentative surgical methods have been proposed to fix chronic and retracted quadriceps tendon but have shown variable results in literature. We propose a surgical technique involving allograft augmentative weaving with application of suture anchors and Krakow sutures for fixation to aid in biomechanical superiority. Our surgical technique is easily reproducible and has shown excellent mid-term outcomes in a young patient with high physical demand.

Keywords: Chronic quadriceps tear; Tendon augmentation; Allograft reinforcement; Extensor mechanism repair; Basket weave technique; Allograft weave repair

Introduction

The 'four headed' quadriceps femoris is a critical component in the lower limb extensor mechanism and any disruption in its structure will have direct impact on knee joint biomechanics and function. In comparison to patella tendon injuries, quadriceps injuries are less frequent and occur in a relatively older, middle-aged cohort [1,2]. Acute traumatic quadriceps ruptures are usually the result of strong eccentric quadriceps contractions [3] generating forces above the tendon's inherent ultimate tensile stress. A traumatic or low energy ruptures occur in tendons with underlying microarchitecture degeneration, fatty infiltration, or cystic changes, rendering the tendon susceptible to failures at much lower stress levels [3,4]. Often these patients have concomitant endocrinopathies, renal disease, inflammatory pathologies or on long-term steroid use [3,4].

In an acute rupture, the presence of fresh tendon ends makes direct surgical repair less challenging, with standard practice performing direct apposition using non-absorbable sutures and patellar drill holes [5]. In chronic rupture where more than three weeks have passed from injury to intervention, chronic inflammatory response alters both the macro and micro architecture of the tendon with infiltration of monocytes, fibroblast, and adipose cells, resulting in tendon ends which are shortened and contracted with gaps up to 5 cm [6,7]. A durable surgical repair in this situation requires employment of additional techniques such as tendon lengthening, V-shaped tendon flap reinforcement or graft augmentation [3]. As chronic quadriceps repairs are rare, data on these techniques is limited to case reports and small series. In this case report we describe our modified technique utilizing a suture anchor repair augmented with allograft reconstruction in a young patient with neglected chronic quadriceps rupture.

Case Presentation

A 19-yrs-old male presented to our clinic with a neglected chronic 4-year history of left anterior knee pain. Prior to symptom onset, he regularly played Parkour, a sport involving frequent high impact landings in precarious positions. He subsequently was forced to stop playing the sport due to increasing knee pain and weakness but did not seek treatment. He only sought medical treatment during his mandatory national service enlistment in the army, where his knee symptoms were limiting his physical training.

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Figure 1: (A) Radiographs taken at the time of presentation. (B) Sagittal MRI left knee showing quadriceps background tendinopathy with tear of the quadriceps insertion.

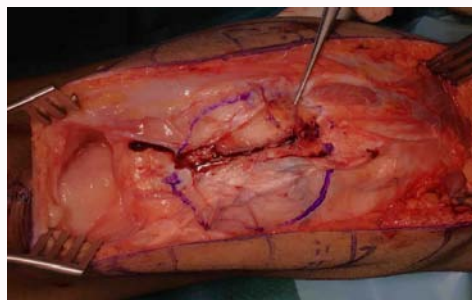


Figure 2: Intraoperative image showing unhealthy quadriceps tendon with lack of tension and patella baja.

Upon our examination, wasting of the left quadriceps muscles was noted. Pain was maximal on palpation at the quadriceps insertion at the superior pole of the patella. Although the passive range of motion was intact, knee extension power was reduced at 4/5 (MRC grade) with an extensor lag of 20 degrees.

Radiographs showed chronic intra-tendinous calcifications at the superior patella pole. MRI scan of the knee showed edema and swelling of the quadriceps insertion at the superior patella pole, with no acute tear. Overall impression was of left knee quadriceps chronic tendinopathy and the patient was started on physiotherapy.

The patient presented late with worsening pain and new onset inability to extend his knee of 6 weeks duration. The patient denied new traumatic events to the knee. Knee examination revealed a mild effusion with a palpable gap in the extensor mechanism at the quadriceps insertion to the patella. There was a “knee drop” with complete loss of extensor mechanism and the patient was unable to perform or maintain a straight leg raise. Radiographs revealed a patella baja and an urgent MRI showed high grade tear of the distal quadriceps tendon (Figure 1).

A diagnosis of chronic (>3 weeks) quadriceps rupture was made and the patient underwent surgical reconstruction. Given the chronic nature of the injury with long standing history of background tendinopathy, an allograft reconstruction using a modified basket weave technique was performed to augment the surgical repair with suture anchors.

Surgical Technique

Following a combination of general and regional anesthesia, an arthroscopic assessment of the knee joint was first undertaken. The quadriceps tendon insertion visualized intra-articularly was thinned out and unhealthy looking with evidence of fatty infiltration (Figure

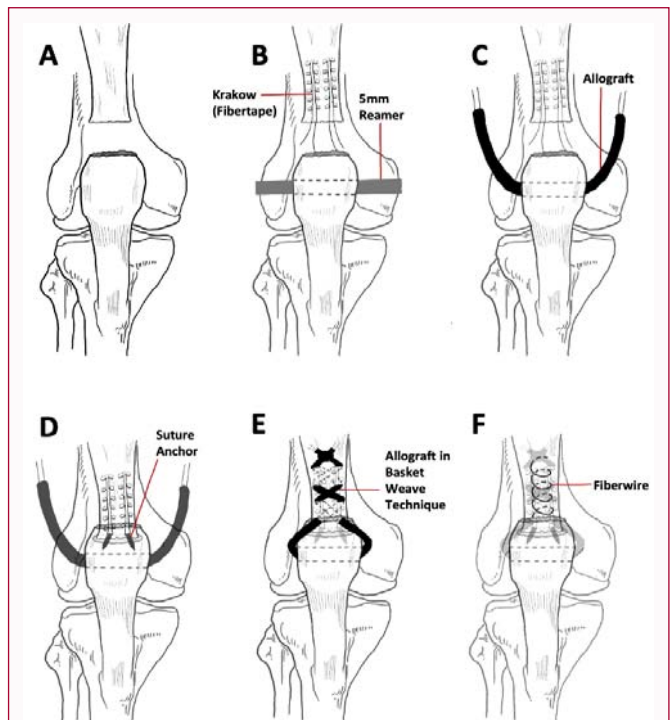


Figure 3: (A) Retracted patella tendon with removal of unhealthy tendon till healthy bleeding tissues. (B) FiberTape sutures (4 cores) in Krakow locking configuration in proximal end, 5mm reamer used to create horizontal tunnel in patella. (C) 5 mm × 280 mm peroneal tendon allograft threaded through horizontal tunnel. (D) Proximal quadriceps tendon attached to patella using suture anchors. (E) “Basket weave technique” with ends tied together. (F) Fiberwire used to reinforce weave and quadriceps.

2). The rest of the knee was unremarkable with intact cruciate ligaments, cartilage and menisci.

Next, we turned our attention to open reconstruction of the quadriceps tendon. A midline incision was utilized with exposure down to the ruptured tendon. The patella tendon was checked to be intact. Unhealthy quadriceps tendon was removed till healthy bleeding tissue (Figure 3A); the superior patella bone surface was freshened with a rongeur till healthy bleeding bone surfaces.

Next, fiber tape sutures (4 cores) were passed across the proximal quadriceps muscular tendon junction in Krakow [7] locking configuration (Figure 3B). Then, a guide wire was drilled horizontally in the superior half of the patella and over-reamed with a 5 mm reamer (Figure 3B). A 5 mm × 280 mm peroneal tendon allograft was then threaded through the bone tunnel (Figure 3C). Care was taken to place this tunnel distally enough to avoid the suture anchors

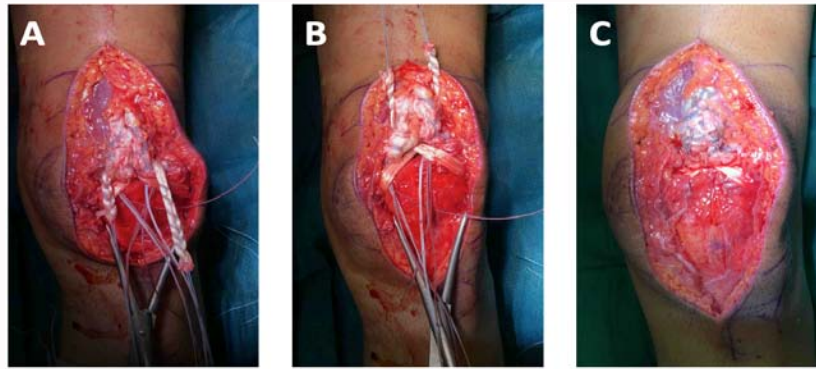


Figure 4: Using a “basket weave technique”, each end of the allograft was weaved in and out of the quadriceps with as many passes as possible with a trocar needle (A) before the ends were tied together (B). Further augmentation was performed unitizing the weave and quadriceps with fiberwire (C).



Figure 5: Lateral X-ray of the knee joint showing normal patella height and bone tunnel in patella.

required later. The tendon was then pulled down to its attachment on the patella and anchored down to bone using two PEEK Swivelock suture anchors 4.75 mm × 19.1 mm (Arthrex, Inc., Naples, FL, USA) (Figure 3D), taking care to avoid the horizontal bone tunnel and in an oblique trajectory to increase pull out strength.

Using a “basket weave technique”, each end of the allograft was weaved in and out of the quadriceps with as many passes as possible with a trocar needle before the ends were tied together (Figures 3E & 4A, 4B). Further augmentation was performed unitizing the weave and quadriceps with fiberwire (Figure 3F, 4C). Post repair and reconstruction, the quadriceps tendon tension was noted to be re-established and patella height was restored. On-table passive flexion up to 80 degrees was achieved without gaping of the construct (Figure 5).

Outcomes

Post-operatively, the knee was immobilized in extension for one month with non-weight bearing restriction in a back slab. After which, a knee brace was utilized for controlled range of motion. The range was increased at 30-degree increments at every 2 weeks. Brace was removed at 3-months post-surgery.

At 6-months post-operatively, the patient had recovered to full power in all aspects of movement and knee ROM was 0°C to 90°C (Figure 6). At 16-months post-op the patient was asymptomatic and was participating in highly activity sports with knee ROM back to



Figure 6: Image showing patient's knee in full extension with full power (6 months post-operatively).

pre-morbid status of 0°C to 140°C.

Discussion

We describe a rare presentation of a chronic quadriceps tendon rupture on background of a long history of tendinopathy in a previously young patient involved in Parkour. The patient presented with progressive knee weakness and extensor lag before subsequent loss of extensor mechanism over a protracted period of time. Such delayed presentations are rare in developed countries.

Chronic quadriceps tendon rupture is an uncommon pathology with inferior outcomes in comparison to its acute injury counterpart [3,8]. There is limited data on the outcomes of surgical management of chronic repairs. Carlos Scuderi in 1958 [6] reported a reinforcement technique for contracted tendon ends using a partial 1/3rd V-shaped tendon flap inverted on the proximal end to approximate the torn ends of the quadriceps tendon. In his series of 18 patients he reported excellent result in 11 cases with complete return to function and minimal extension lag [6]. This procedure has been traditionally supplemented [9] with Codivilla tendon lengthening technique [10] which provides further length to the repair procedure. However more recent data on these repair procedures appears less promising with Rao et al. [1,2] reporting satisfactory results in less than half of his repair cohort. Failures and inferior outcomes were also noted in cohorts studied by Rougraff et al. [11] and Rehman et al. [12].

Main drawbacks with these traditional repair approaches is the disruption of the native tendon architecture when creating flaps, which further undermines collagen integrity and impacts healing potential [4]. Modified Pulvertaft technique [13] is a more recent repair

technique which involves graft augmentation using intraosseous semitendinosus autograft passage across the patella and then weaving the graft across the quadriceps tendon. Promising outcomes were reported 3-months post op, where patient had full active knee extension. This technique retains the original fiber orientation of the quadriceps tendon as compared to traditional methods, and presence of graft directly increases the total concentration of collagen at the site of recovery, potentially increasing speed and quality of recovery of the quadriceps tendon [4].

In our technique, a modified Pulvertaft weave with allograft was utilized to augment our suture anchor repair. The use of suture anchors confers several advantages in this technique. Firstly, approximating the quadriceps tendon to the bone with good tension was efficiently and accurately done with suture anchors [14]. Secondly, the use of suture anchors obviates the need to drill full length transosseous tunnels which may increase risk of bone fracture for the repair [15]. Furthermore, short suture anchors crucially allow the separate drilling of a horizontal bone tunnel for graft passage and augmentation. This would not be feasible with full length tunnels in the usual transosseous repair of quadriceps tears [16].

The subsequent use of allograft augmentation with a bone tunnel and weave technique allows bioaugmentation and integration [17]. It substantially increases the tensile strength of the entire construct post repair and was further supplemented with fiber wire sutures. This allows the surgeon to confidently accelerate rehabilitation post-surgery.

This patient had excellent outcome post-surgery with this modified pulvertaft weave reconstruction technique with suture anchor repair. He was able to regain full range of motion, full muscle power at 6 months post op and resume high impact/velocity activities at 16 months post-op. ideally a larger series with a longer follow up will provide a more information and validate the efficacy of this surgical technique. However as mentioned, it is increasingly rare now to see neglected cases in developed countries for us to have a large case series.

Conclusion

Allograft augmented repair for chronic quad rupture, supplemented with the use of suture anchor and FiberTape has delivered excellent mid-term outcome in a young high demand patient. This report demonstrates the effectiveness of this technique as a viable treatment option for surgical management of these injuries.

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