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CASE REPORT

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Patellar tendon reconstruction using a medial gastrocnemius flap: review of the literature and an illustrative case report, including some technical Tipps

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ABSTRACT

Patients with chronic patellar tendon ruptures, failed primary repair, injuries with significant loss of tendon tissue or skin coverage require a complex reconstruction. Several reconstructive options are available, but in the case of a revision surgery with an associated infection, most of them seems contraindicated. The use of a vascularized gastrocnemius tendon graft to reconstruct the knee extensor apparatus, is in our opinion, the most appropriate treatment option. We will report a complex case of chronical patellar tendon rupture (after failed allograft reconstruction) in the context of an infection with soft tissue defect. This 65-year-old patient was successfully treated with the reconstruction of the patellar tendon and a soft tissue coverage using a medial gastrocnemius flap. We followed her up for three years and the clinical outcome was recorded including several clinical scores and isokinetic strength measurements, showing an excellent result, with full patient satisfaction and without any limitation in daily activities. In addition, we will review the literature about patellar tendon reconstruction using a medial gastrocnemius flap, presenting the indications and advantages of this technique, sharing our personal experience and some technical aspects of the technique. Finally, we discuss why this flap, is our first choice in such cases.

SHORT ABSTRACT

A complex case of chronic patellar tendon rupture with infection and soft tissue defect in a 65-year-old patient was successfully treated using a medial gastrocnemius flap for tendon reconstruction and soft tissue coverage. The patient achieved excellent clinical outcomes. The case highlights the advantages of this technique for complex reconstructions.

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Introduction

The patellar tendon, in combination with the quadriceps tendon and the patella bone, composes the extensor mechanism of the lower leg. Extensor mechanism ruptures are rare, but result in loss of active knee extension, causing significant disability.

In cases of acute patellar tendon trauma where there is sufficient viable tendon tissue remaining, it is possible to repair the tendon ends directly with a suture or to re-insert the tendon ends at the insertion of the patellar or tibial tuberosity. Typically, the primary repair is reinforced with a patellotibial cerclage wire [1–4].

Patients with chronic patellar tendon ruptures, failed primary repair, injuries with significant loss of tendon tissue or skin coverage will require a more complex reconstruction. The degree of secondary retraction, the extent of the defect, and the vitality of the tissues will determine the need for tendon transfer or muscle flap augmentation [2,3,5]. Several reconstructive options are available, including the use of allograft [6–8], synthetic graft [9] or autologous graft [10]. Each approach has its own advantages and disadvantages [6–10].

In 1994, the use of a vascularized gastrocnemius tendon graft to reconstruct the knee extensor apparatus was independently reported in two cases by Babu

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et al. [11] and in four cases by Leung et al. [12] When there is a significant soft tissue defect around the knee in addition to the injured extensor mechanism, the use of a medial gastrocnemius flap has the advantage of addressing both issues in a single surgical procedure. Since then, a few other case reports and small case series have described similar techniques [2,3,13], but the literature on this surgical procedure is still limited despite its potential importance.

In this article, we will report a complex case of chronical patellar tendon rupture in the context of an infection with soft tissue defect and his reconstruction using a medial gastrocnemius flap, we also review the literature and discussed the potential indications and advantages of this technique. In addition, we share our experience about some technical aspects to adapt the technique to different situation that we found useful during reconstruction.

Case presentation

We retrospectively reviewed the medical records of a patient who required a patellar tendon reconstruction using a medial gastrocnemius flap, with a history of multiple surgeries around the knee, who had sustained a deep infection, and had failed primary repair of the patellar tendon. She presented with a skin coverage defect in addition to the chronic patellar tendon deficiency.

Approval was waived by the ethics committee.

This female patient, aged 65, was involved in a traffic accident abroad. She sustained a severe open fracture-dislocation of her right knee, classified as Gustillo-Anderson type 3C, Schenk type five. This involved a superficial femoral artery injury and loss of soft tissue coverage over the patella and medial aspect of the knee, proximal leg and distal femur. The knee joint presented with a bicruciate ligament rupture, medial collateral ligament avulsion, popliteofibular ligament avulsion, and lateral collateral ligament rupture. In addition, there was a traumatic bone loss of the posterior third of the medial femoral condyle and a midsubstance lesion of the patellar tendon.

Emergency surgery was performed abroad to realign and stabilize the knee with an external fixator, fasciotomies to all four compartments of the leg, and reconstruction of the superficial femoral artery with a contralateral saphenous vein graft. The fasciotomy incisions aided in soft tissue closure over the medial aspect of the knee.

The patient was admitted to our hospital after five weeks with knee arthrofibrosis, extensor mechanism deficit, and ligament instability. The fasciotomy wounds were first covered with a partial-thickness skin graft and the external fixator was removed. The goal was then to restore range of motion and extensor mechanism function prior to ligament reconstruction. This included artholysis, quadriceps plasty as described by Judet, and reconstruction of the patellar tendon with an Achilles tendon allograft protected by a patellotibial cerclage performed at three months post trauma. This reconstruction was complicated by scar dehiscence in the infrapatellar area and Streptococcus mitis infection of the allograft. The infection was successfully treated with debridement, removal of the cerclage and allograft, followed by intravenous antibiotics. However, at 6 months post-trauma, there was a residual infrapatellar soft-tissue defect (prior to debridement) of two cm2 with extensor mechanism deficit but full passive range of motion.

It was then decided to cover the soft tissue defect and reconstruct the patellar tendon with a medial gastrocnemius flap.

Surgical procedure

Using an anterior approach to the knee, the patellar tendon rupture site and the skin margins should be thoroughly debrided [2,3,12]. Fibrous remnants should be carefully removed toward the tibial tuberosity and distal patellar pole with preservation of the Hoffa fad pad.

Following this debridement, the indication for this reconstruction technique is confirmed when (1) there is a defect in the tendon that does not allow direct end-to-end suturing while maintaining patellar height to achieve symmetry with the contralateral side, and (2) there is insufficient anterior soft tissue coverage [13], especially in the presence of a history of previous infection [2,9,11–13]. In our case a soft tissue defect of 4×6 cm resulted from this debridement.

A second incision is performed two fingerbreadths posterior to the medial border of the tibia to elevate the gastrocnemius muscle flap. It is crucial to leave a sufficient broad skin bridge in between both incisions, to assure the vascularity of it. The sural nerve and the small saphenous vein serve as useful landmarks for locating the median interval of the gastrocnemius muscle body. The dissection of the medial gastrocnemius muscle proceeds from distal to proximal [3,14,15], preserving the arterial supply on the proximal side and including the desired length of the partial thickness Achilles tendon on the distal side. It is continued proximally until reaching the neuro-vascular pedicle at the popliteal crease. Efforts should be made to preserve the innervation of the flap to maintain muscle trophicity [13–15]. In cases where a longer flap is

required, it may be necessary to detach a portion or even all of gastrocnemius insertion at the posterior aspect of the femoral condyle [16,17]. Scoring of the posterior muscle fascia will also provide additional length to reach suprapatellar defects if needed.

The patellar height is adjusted and stabilized with a temporary patellotibial cerclage wire under lateral fluoroscopy at 60 degrees of knee flexion. The muscle flap is transferred anteriorly under an appropriately released skin bridge and positioned obliquely to cover the anterior skin defect, similar to the technique used by Babu et al. [11]. The area of the patellar tendon gap is covered by the aponeurotic portion of the gastrocnemius flap (Figure 1). This robust aponeurosis is partially detached from the actual muscle flap, mobilized, and then rotated to match the direction of the patellar tendon fibers. It is folded over if additional thickness is required [3,11]. It is then tensioned and sutured to both sides of the defect in the extensor mechanism using non-absorbable sutures, such as 2–0 Orthocord (DePuy Mitek, Raynham, MA, USA) with the knee in full extension.

If the medial and lateral retinacula are still intact, they can be used for reinforcement and closure of the anterior knee joint capsule. The graft may be anchored to the periosteum surrounding the tibial tubercle if no tendinous portion of the distal insertion of the patellar ligament can be salvaged [13]. Alternatively, a longer segment of the Achilles tendon can be included in the flap, along with the inclusion of a fragment of the bony insertion into the calcaneum [12]. This bone fragment can then be secured to the tibial tubercle with a fully threaded 3.5-mm bicortical screw [12] or a bone anchor. The muscular part of the gastrocnemius flap is left intact and serves as a superficial soft tissue cover, which is further covered with a split-thickness skin graft from the ipsilateral thigh. The cerclage wire is removed before closure.

After the procedure, the knee is immobilized in an articulated brace in full extension for two weeks, followed by 2 weeks limited at 0–30° of flexion and 2 weeks at 0–60°. Full range of motion is then allowed, but the brace should be worn until 4 months postoperatively. If there is no other skeletal injury requiring reduced weight bearing, this may be started immediately. Patients can begin active straight leg raises and static quadriceps exercises the day after surgery under the supervision of a physical therapist. After six weeks, quadriceps and gastro-soleus strengthening exercises are permitted.

In our case this surgery was followed by twelve months of rehabilitation. Finally, the knee instability was addressed. Anterior cruciate ligament reconstruction was performed with a contralateral hamstring autograft along with the medial collateral ligament by Achilles tendon allograft.

Clinical outcomes

At three-year follow-up, the patient had a crutch-free and limp-free gait and full satisfaction.

She had an acceptable final aesthetic result (Figure 2) and regained active range of motion of Flexion/Extension of 90–0–0 degrees with a stable knee (Figure 3(A,B)). Early post-traumatic osteoarthritis was observed in the medial tibiofemoral compartment but remained asymptomatic. This allowed for good function as confirmed by

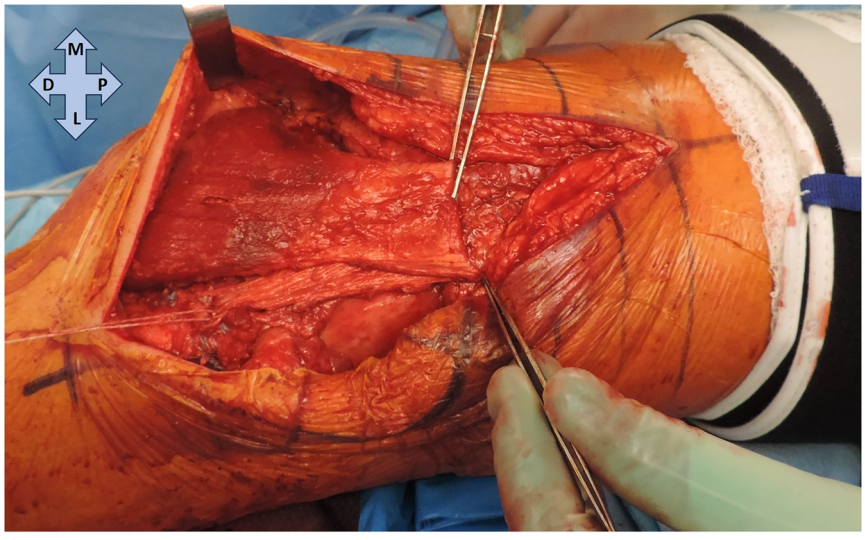

Figure 1. Intraoperative image showing the medial gastrocnemius flap fixated distally and hold in place proximally by two forceps, just before tensioning and proximal fixation.

Figure 2. Esthetical result at the 3 years follow-up.

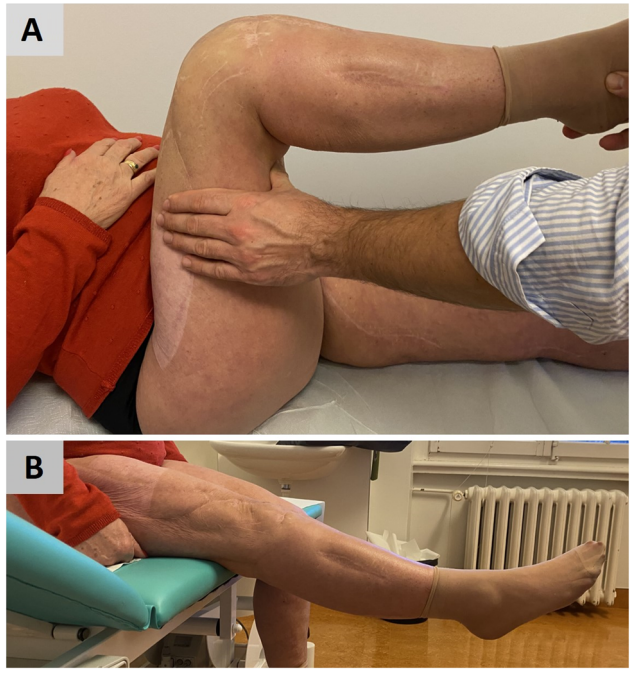

Figure 3. (A) Limitation of knee flexion at 90°; (B) full extension of the knee against gravity at the 3 years follow-up.

patient-reported outcome measures including IKDC [18], KOOS [19], SF-12 v.2 (physical and mental health) [20], and patellofemoral Kujala scores [21]. These results are summarized in Table 1.

In addition, an isokinetic strength test showed that the extensor mechanism of the involved knee had a leg symmetry index of 55% (at 180°/sec) in concentric and 53% in eccentric activity (details in Table 2). The MRI showed a reconstructed tendon in full continuity with a vital muscle (Figure 4).

Discussion

We described the surgical technique of the reconstruction of the patellar tendon, using a medial gastrocnemius flap. We illustrated this technique with an example of a patient with chronic patellar tendon deficiency associated with a defect in soft tissue coverage and a history of multiple surgeries (including a failed extensor mechanism allograft (EMA)) and a deep infection. Our case stands out due to the complexity of the surgical circumstances, which precludes most other options from achieving a successful outcome.

This complex injury was successfully treated with a medial gastrocnemius muscle flap with good function outcome at a follow-up of three years, with a fully satisfied patient, achieving painless and crutch-free ambulation.

The rotational pedicled gastrocnemius flap has emerged as one of the most commonly employed flaps for providing soft tissue coverage around the knee joint, the distal thigh, upper third of the leg, and popliteal area [14,15,22]. This flap is not only valuable for extensive defects resulting from posttraumatic injuries or tumor resections in native knees, but it has also become the preferred method for soft tissue reconstruction [14,17,23]; following severe complications like soft tissue necrosis or infections associated with TKA or high tibial osteotomy [14,23–25]. The medial gastrocnemius flap is favored for numerous reasons, including its reliable anatomy, substantial size, and mobility, making it an exceptional and versatile choice for reconstructing medium to large defects [14–16,26], without requiring microvascular anastomosis [27,28]. Studies on the donor site morbidity of single [29–31] and even a double gastrocnemius flap [14] have revealed reasonable functional donor site morbidity, particularly when considering the gravity of the underlying patient conditions [14,30].

The gastrocnemius muscle features a substantial aponeurosis on the deep aspect of the middle third of

Table 1. Shows the summarized scores before the reconstruction of the extensor apparatus and at different time points during the follow-up.

	IKDC	Kujala	KOOS symptoms	KOOS pain	KOOS activities of daily living	KOOS sport	KOOS quality of life	SF 12-PCS	SF 12-MCS
After initial treatment	46	50	68	92	100	25	19	30	64
After Judet reconstruction	41	35	64	86	85	60	19	40	61
1 Year after extensor reconstruction with gastrocnemius flap	55	56	61	100	93	30	6	56	57
Two months post ligament reconstruction	54	50	57	86	93	30	19	46	54
6 Months post-op	60	66	75	100	99	90	56	55	58
1-Year post-op	68	64	75	100	100	100	38	55	58
2-Years post-op	72	65	100	100	100	100	100	58	57

IKDC: International Knee Documentation Committee Score; Kujala: Kujala score; KOOS: Knee Injury and Osteoarthritis Outcome Score; SF 12: 12-Item Short Form Survey; PCS: physical score; MCS: mental score.

Table 2. Isokinetic evaluation.

Concentric	Affected knee Nm	Nm/kg	Contralateral knee Nm	Nm/kg	% of Contralateral
60°/sec	45	0.69	91	1.4	49.45
180°/sec	34	0.52	62	0.95	54.84
endurance 180°/sec	609		1235		49.31
Excentric					
90°/sec	57	0.88	107	1.65	53.27

Shows the Isokinetic Evaluation of the Quadriceps muscle at the two years follow-up visit. Nm: Newton meter; Nm/kg: Newton meter per kilogram body weight.

Figure 4. Knee MRI at 3 years follow-up showing a reconstructed extensor apparatus. Note the dark neo-patellar ligament (arrow) and the vital gastrocnemius muscle flap (star).

the musculotendinous unit [2,32]. When this flap is transposed to cover the knee's anterior surface, this aponeurotic portion overlays the joint and offers an ideal option for reconstructing extensor apparatus defects, simultaneously with soft tissue coverage [2,11–13]. By including the superficial part of the Achilles tendon and eventually a bony flake of their insertion into the calcaneus, a broad variety of extensor apparatus defects can be reconstructed [12]. Including those involving the quadriceps and patellar tendon or even cases with a short distal stump, non-suitable as anchor point for a repair [12].

The available literature on the use of the gastrocnemius flap in extensor mechanism reconstruction is scarce, primarily consisting of small case series and case reports [3,11–13].

Our patient is older as most cases described and has a longer follow up (FU) as most reports. It stands out due to an excellent result without flexion contractions in spite of a very complex case with multiple prior surgeries and an infection. No case so far has been evaluated with scores or isokinetic strength assessment.

In 1994, Babu et al. [11] and Leung et al. [12] reported for the first instances of employing the medial gastrocnemius flap in this type of reconstruction. Babu's series included two patients who underwent simultaneous quadriceps tendon reconstruction and soft tissue coverage for isolated injuries, achieving excellent results. In Leung's four reconstructions [12], their patients had more severe trauma. In two patients they used the medial gastrocnemius, in one the lateral gastrocnemius, and in one both gastrocnemii [12]. Two of these patients required crutches to walk, likely due to the underlying injury's severity, such as severe intraarticular fractures and knee instability [12]. While in Leung series the length of FU is unclear [12], in Babu's series it was 1.5 years [11].

Jepegnanam et al. [13] had the largest series, included eight young patients (mean age 32 years) with severe high-velocity injuries and intraarticular fractures of the knee, combined with infection and contamination [13]. All patients were treated in an acute setting and required multiple surgeries to control infection and achieve stable fracture fixation [13]. Three of them needed a reconstruction using both gastrocnemii [13]. Rhomberg et al. [2] summarized the results of five patients. They modified the surgical

technique slightly to enhance the reconstruction's strength by folding the aponeurosis [2]. All patients were able to walk without crutches and climb stairs [2].

Our patient underwent revision surgery to reconstruct the extensor apparatus after an initial attempt using a nonvascularized graft (Achilles tendon allograft). An EMA reconstruction, as used in our first attempt, has the advantage to avoid any autograft harvesting [7] and is an adapted option for the first line reconstruction of a chronic extensor mechanism disruption, however, it can lead to high failure rates, up to 38% [33–37], due to infection, allograft patellar tendon rupture or patellar fracture, and graft attenuation with extensor lag [5,35]. Patients may develop persistent knee instability and difficulty ambulating over time [38], and only a few treatment options exist after failed EMA reconstruction.

To repeat an EMA in this setting of a revision surgery exhibit even more frustrating with failure rates as high as 70–75% [8,39]. Hence, in our opinion it's contra-indicated as well as in the setting of an infection. The gastrocnemius graft on the other hand, presents a valuable option in revision surgeries. A vascularized graft can enhance a physiologic healing with well-vascularized tissue, reducing common problems associated with nonvascularized grafts (allografts, synthetic grafts, autologous grafts), such as infection rate, delayed healing, graft attenuation or rerupture [2,40]. This facilitates earlier rehabilitation and quicker recovery [2].

Successful performance of these surgeries necessitates a dedicated orthoplastic team or strong collaboration between various surgical disciplines, especially given the importance of timing and the potential influence of underlying articular problems on the final outcome [41].

We presented a typical and distinct example of when the gastrocnemius flap can be used for extensor apparatus reconstruction alongside soft tissue defect coverage. This technique can also be used in older patients with multiple prior surgeries and in the setting of a deep soft tissue infection. The main strength of our case is, that we had a long FU and a precise clinical assessment with a mid-term FU.

In conclusion, the gastrocnemius flap appears to be a viable option for addressing soft tissue defects with extensor mechanism loss, consistently delivering positive outcomes across a wide range of presentations also in older patients. This muscle flap is especially robust in cases involving infection and revision surgeries, offering efficient extensor mechanism reconstruction with minimal donor site morbidity in non-athletic patients.

Ethical approval

The ethical approval is waived for single case reports from the responsible local entities

Disclosure statement

No potential conflict of interest was reported by the author(s).

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