Technical Note

Surgical Treatment for Chronic Rupture of the Patellar Tendon Performed in 2 Stages

José Leonardo Rocha de Faria, M.D., Matheus de Barros Carvalho, M.D., André Cavalcante Marques, M.D., Naasson Trindade Cavanellas, M.D., M.Sc., Eduardo Branco de Sousa, M.D., M.Sc., Ph.D., João Mauricio Barretto, M.D., M.Sc., Ph.D., and Alan de Paula Mozella, M.D., M.Sc.

Abstract: Patellar tendon rupture is an uncommon but disabling lesion. It usually occurs in men younger than 40 years, through direct or indirect trauma. Obtaining satisfactory results with treatment of chronic injuries and re-ruptures in which the patella retracts owing to quadriceps contraction is a challenge. This is of major concern especially in cases in which the patella cannot be positioned in its anatomic position when distal traction is performed. In these cases, V-Y stretching of the quadriceps can be performed in an attempt to perform reconstruction in 1 stage. Instead, a 2-stage procedure can be chosen, in which the first stage relies on patellar trans-skeletal traction to achieve distalization of the patella. In 1981, a technique for the treatment of chronic injuries of the patellar tendon in 2 stages was described. In that procedure, the first stage consisted of transpatellar traction and the second stage was tendon-tendon suturing with fascia lata reinforcement. We describe a surgical technique performed in 2 stages; in the first stage, trans-skeletal traction is performed, and in the second stage, the technique of Kelikian et al. with our modification is performed. This technique is used in patients with chronic rupture of the patellar tendon associated with a high patella with nonreducible quadriceps shortening.

The extensor mechanism of the knee is composed primarily of the quadriceps muscle and tendon, the patella, and the patellar tendon. In addition, it has stabilizing ligaments such as the medial and lateral patellofemoral ligaments, patellar reticular fibers, the Hoffa fat pad, and the prepatellar bursa.[1,2] Because of its complex anatomy, the extensor mechanism has been the focus of numerous articles trying to better elucidate its structure and function.[3-6]

From the Knee Surgery Center (J.L.R.d.F., A.C.M., N.T.C., E.B.d.S., J.M.B., A.d.P.M.) and Department of Orthopedics and Traumatology (M.d.B.C.), National Institute of Traumatology and Orthopedics of Brazil, Rio de Janeiro, Brazil.

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Address correspondence to José Leonardo Rocha de Faria, M.D., Instituto Nacional de Traumatologia e Ortopedia Jamil Haddad, Av Brasil, 500, Rio de Janeiro, CEP 20940-070, Brazil. E-mail: drjoseleonardorocha@gmail.com

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The extensor mechanism is largely responsible for knee extension and stability of the patellofemoral joint. Structural or functional changes in this mechanism, whether congenital or traumatic, may lead to failure of such stabilization.[7,8] Rupture of the quadriceps tendon, patellar fracture, and patellar tendon injury are the most common traumatic changes that may occur.[9]

Rupture of the patellar tendon is an uncommon but disabling lesion, usually occurring in men younger than 40 years, through direct or indirect trauma to the knee.[10] When indirect, it is the result of a strong eccentric contraction of the quadriceps with the knee flexed around 60° in a fixed position. It is believed that such lesions occur in tendons with previous micro-lesions in the midsubstance.[11,12] Bilateral ruptures are rare but are usually associated with diseases such as chronic renal failure, primary hyperparathyroidism, systemic lupus erythematosus, and rheumatoid arthritis.[13-15]

Rupture is generally followed by severe pain, an inability to stand up without help, and hemarthrosis. On physical examination, patients present with a palpable gap in tendon topography and difficulty in reaching or maintaining knee extension against gravity.

On radiographs of the affected knee, we can observe the presence of patella alta.[5,11,16]

A great variety of techniques have been described for the treatment of acute lesions, presenting good clinical results.[13,17] Treatment of chronic lesions and re-ruptures, in which the patella retracts owing to quadriceps contraction, when the patella cannot be positioned in its anatomic position, represents a challenge in terms of obtaining satisfactory results.[18] In these cases, V-Y stretching of the quadriceps can be performed in an attempt to allow reconstruction in 1 stage. An alternative is a 2-stage surgical procedure using patellar trans-skeletal traction in the first stage to achieve distalization of the patella.[5]

In 1981, Siwek and Rao[5] described a technique for the treatment of chronic patellar tendon injuries in 2 stages, with the first stage consisting of transpatellar traction and the second stage involving tendon-tendon suturing and strengthening with fascia lata; good clinical results were obtained in their series. Garg et al.[19] published a study in 2012 using 3 methods of surgical treatment for patellar pseudarthrosis associated with proximal retraction of the quadriceps. The best results were found in the group in which patellar trans-skeletal traction was used.

The surgical technique using quadriceps V-Y elongation presents the possibility of loss of the final degrees of knee extension, yielding unsatisfactory clinical results. Moreover, the use of only the fascia lata may not be sufficient for the treatment of chronic lesions and patellar tendon re-ruptures. Thus, we describe a 2-stage surgical technique for the treatment of chronic patellar tendon injuries. This technique is indicated for patients with proximal quadriceps retraction who present with a Caton-Deschamps index, measured on knee radiographs, greater than 2 and in whom the patella does not reduce to its physiological height with digital distal traction (Fig 1). The first surgical stage consists of patellar trans-skeletal traction, and in the second stage, the technique of Kelikian et al.[20] with our modification is performed.

Surgical Technique

First Stage

The patient lies in the dorsal decubitus position while under anesthesia. Asepsis is performed with chlorhexidine detergent, and antisepsis, with alcoholic chlorhexidine.

The knee is flexed at 30° with the aid of an image intensifier; a 3.5-mm Steinmann pin with a central thread is passed transversely in the proximal one-third of the patella, from medial to lateral, percutaneously. A stirrup is installed at the 2 ends of the pin, and a trans-skeletal traction device is installed, with 3 kg of traction initially (Fig 2).

The patient remains hospitalized with the traction device in the patella, increasing the weight by 0.5 kg/d. Sequential radiologic images with a lateral view of the knee in extension are obtained to estimate distalization of the patella (Fig 3). When we observe that the distance between the anterior tibial tuberosity (ATT) and the distal pole of the patella equals the longest length of the patella, the second surgical stage is performed with reconstruction of the patellar tendon using the technique of Kelikian et al.[20] with our modification.

Second Stage

The patient lies in the dorsal decubitus position while under anesthesia and a femoral nerve block. Asepsis is performed with chlorhexidine detergent, and antisepsis, with alcoholic chlorhexidine.

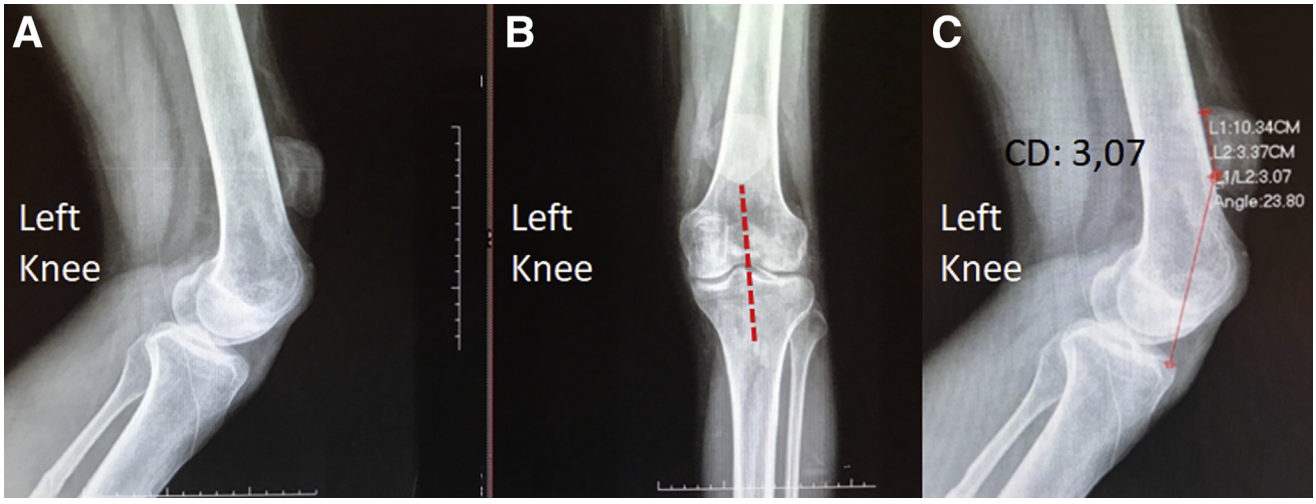

Fig 1. (A) Lateral view of left knee with chronic patellar tendon rupture, with great amount of retraction of quadriceps tendon. (B) Anteroposterior view of left knee showing high patella. Dashed red line depicts distance between anterior tibial tuberosity and lower pole of the patella. (C) The Caton-Deschamps index (CD) is 3.07. L1 = patella articular surface. L2 = distance between the lower pole of the patella and upper limit of the tibia.

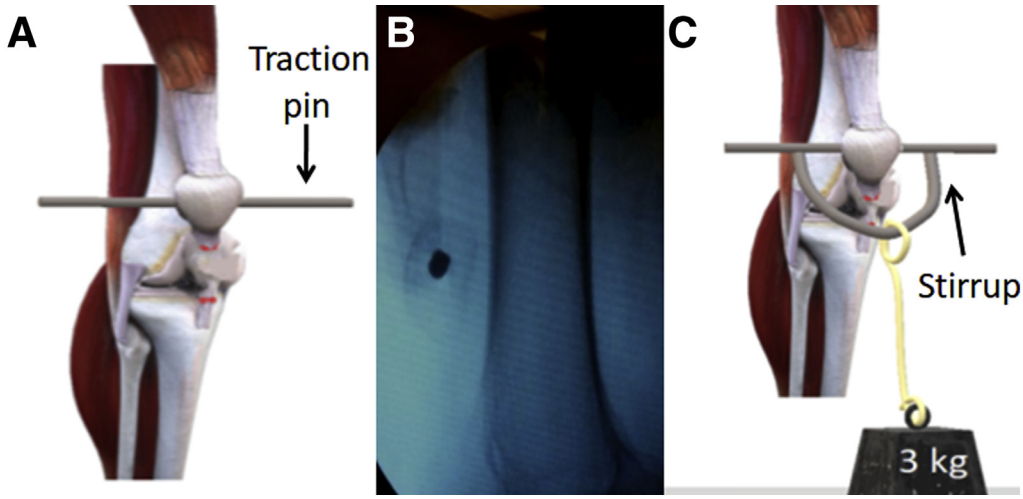

Fig 2. (A) Traction pin inserted into proximal third of patella. (B) Intraoperative fluoroscopic image evidencing traction pin inside proximal one-third of patella. (C) Stirrup with traction cable and 3-kg initial weight installed.

The Steinmann pin is maintained to facilitate distalization of the patella. We establish longitudinal anterior-medial access, about 10 to 15 cm in length, with extensive exposure of the patellar tendon, patella, and quadriceps tendon.

Initially, the semitendinosus and gracilis tendons are identified, and proximal detachment of the tendons with an open stripper (Arthrex, Naples, FL) is performed. The injured patellar tendon is identified and tagged using a Krackow-type suture with 2 threads of Ethibond (No. 5; Ethicon, Somerville, NJ) in its central portion, leaving 4 equal-length threads. A 4.5-mm cortical tunnel is constructed with a transverse cannula drill, from medial to lateral, in the distal portion of the patella, parallel to the Steinmann pin used for traction. With the 4.5-mm drill bit still inside the patella, 3 parallel longitudinal tunnels are made with Beath pins, leaving a repair wire on the carrying handle at the distal end of each longitudinal drill hole of the patella (Fig 4).

A horizontal bone tunnel in the tibia at the ATT is made with a 6.0-mm cannulated drill. The semitendinosus tendon is transported through the tibial tunnel, ascending to proximal and being passed from lateral to medial in the patellar tunnel, undergoing distalization, and being reinserted into its tibial origin.

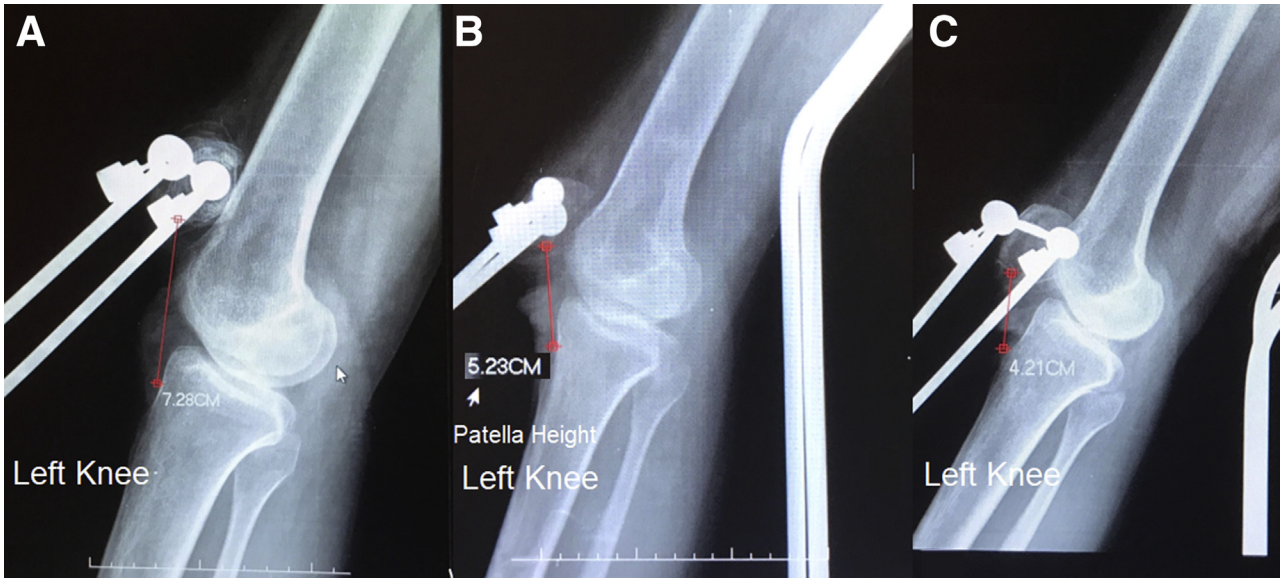

Fig 3. (A) Lateral view of left knee on first day of traction. The initial distance between the anterior tibial tuberosity and the inferior pole of the patella (red line) is 7.28 cm. (B) Day 7 of traction. The distance between the anterior tibial tuberosity and the inferior pole of the patella (red line) is 5.23 cm. (C) Day 13 of traction with patella in its physiological position. Red line depicts the distance between the lower pole of the patella and the anterior tibial tuberosity.

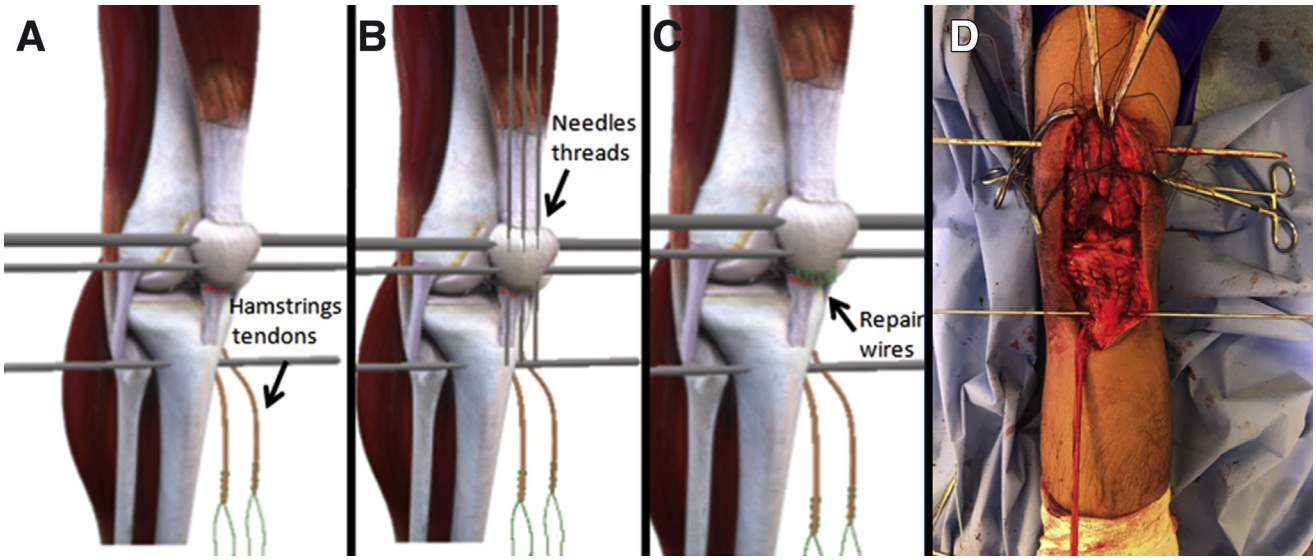

Fig 4. (A) Second surgical stage with semitendinosus and gracilis tendons with proximal detachment. A 4.5-mm-thick transverse cannula drill is inserted into the patella, parallel to the Steinmann pin used for traction. A bone tunnel is made with a 6.0-mm cannulated drill inserted horizontally in the tibia at the anterior tuberosity of the tibia. (B) Three parallel longitudinal tunnels are made on the patella with 3 needle threads, keeping the 4.5-mm drill and traction pin inserted on the patella. (C) Three Ethibond (No. 5) repair wires are retained with the carrying handle at the distal end of each longitudinal drill hole of the patella. (D) Intraoperative image of second surgical stage.

Simultaneously, the gracilis tendon is elevated to proximal, is passed from medial to lateral in the patellar tunnel, undergoes distalization, is transported in the tibial tunnel from lateral to medial, and is reinserted together with the semitendinosus tendon at its origin. In fact, we perform the passage of the tendons through the same holes (tibial and patellar) but in opposite directions (Fig 5). To increase fixation and decrease the violin-cord effect of the flexor tendons (in which the tendons become palpable and prominent in the subcutaneous area), medial and lateral fixation with 2 Agrafe 10-mm clamps (Arthrex) is performed. The 4 strands of Ethibond (No. 5) are transported to the proximal pole of the patella and sutured (Fig 6). After

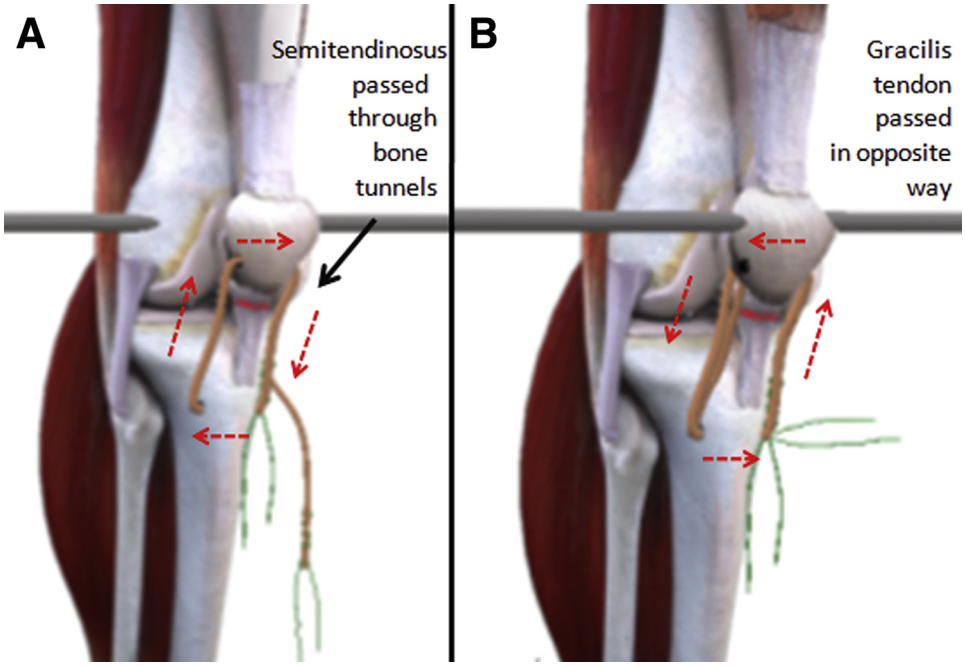

Fig 5. (A) The semitendinosus tendon is transported through the tibial tunnel, ascending to proximal and being passed from lateral to medial in the patellar tunnel, undergoing distalization, and being reinserted into its tibial origin (red dashed lines). (B) Simultaneously, the gracilis tendon is raised to proximal, is passed from medial to lateral in the patellar tunnel, undergoes distalization, and is transported in the tibial tunnel from lateral to medial, being reinserted together with the semitendinosus tendon at its origin (red dashed lines).

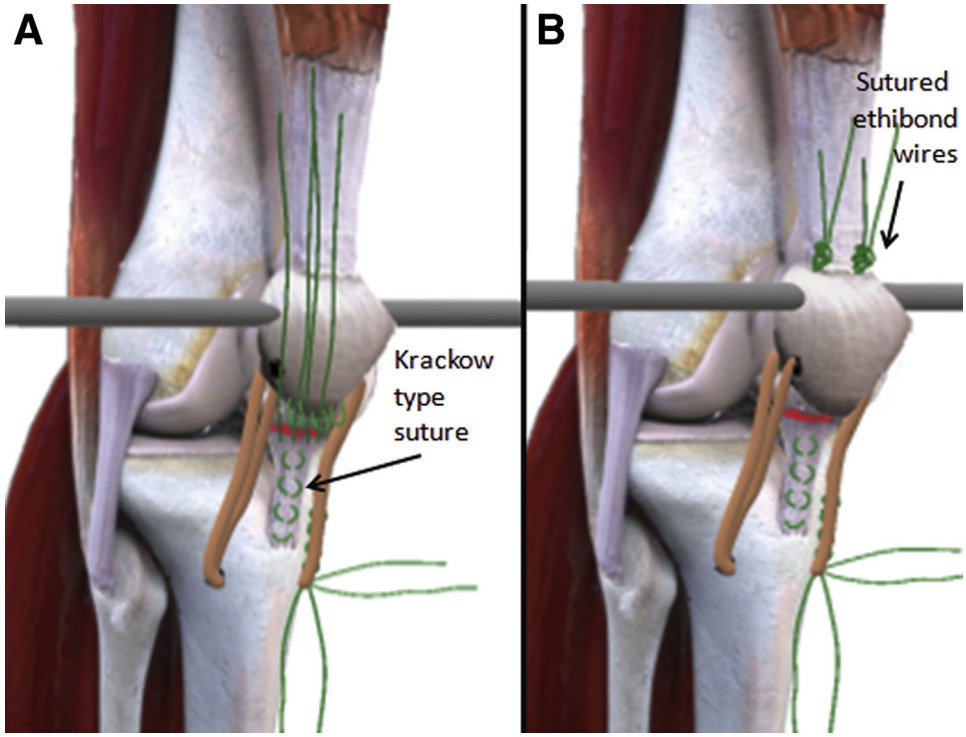

Fig 6. The 4 strands of Ethibond (No. 5) sutured in the patellar tendon are transported to the proximal pole of the patella (A) and sutured (B).

this stage, a 1.2-mm cerclage wire is passed posterior to the quadriceps tendon.[21] The 2 ends of the wire criss-cross over the patella and are tensioned. Two twists are then made, and the system with the 2 strands is brought together with the ATT. In this region, a 4.5-mm cortical screw with a washer is introduced, in a perpendicular or oblique direction from distal to proximal to the ATT, and is fixed to the posterior tibial cortex but is left with the neck still protruding. The knee is flexed at 30°, the length of the knee is marked on the wires up to the screw, and 2 more twists are made (Fig 7). The ends of the cerclage wire are enclosed

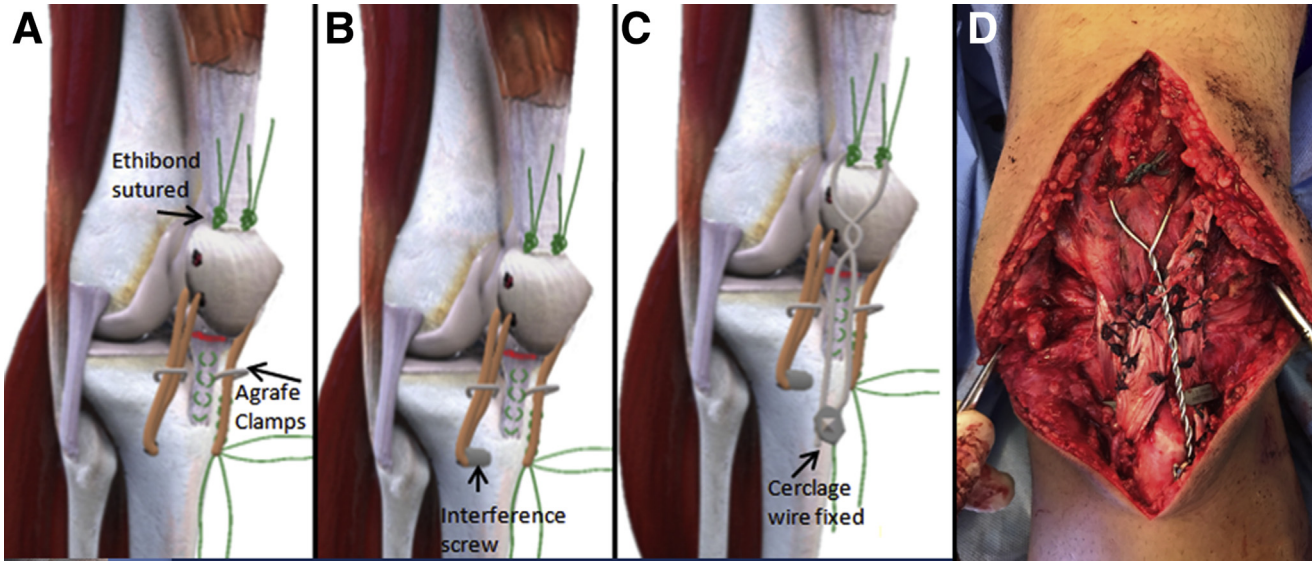

Fig 7. (A) The semitendinosus and gracilis tendons, already transported to the bone tunnels, are fixed with 2 Agrafe clamps. The 4 strands of Ethibond (No. 5) have been transported to the proximal pole of the patella and sutured. (B) An interference screw can be used in the tibial tunnel, although this is not mandatory. (C) The cerclage wire is passed posterior to the quadriceps tendon, 2 twists are made, and the distal extremities of the cerclage wire are fixed at the level of the anterior tibial tuberosity with a 4.5-mm cortical screw with a washer. (D) Final aspect of surgical procedure.

Table 1. Pearls and Pitfalls or Complications

Pearls	Pitfalls or Complications and How to Avoid Them
Fluoroscopy should always be used to insert the traction pin at the lateral aspect of the patella. A small surgical incision (1 cm) must always be performed for insertion of the traction pin.	The surgical incision in which the traction pin presents should always be covered with sterile dressing to avoid infection in the pin track.
In the preoperative period, it should be assessed whether distalization of the patella to the physiological position occurs with distal traction, realized with the examiner's own finger; a lateral radiograph should be obtained with the knee in extension in association with digital distal traction for evaluation.	The traction pin and 4.5-mm drill should be inserted in the proximal one-third and distal one-third, respectively, and the mid patella in the anterior plane to avoid an anterior cortical fracture or articular fracture of the patella.
An interference screw can be used in the tibial tunnel to increase tendon fixation.	Care should be taken when using an interference screw in this region of the tibia because it could cut the graft at the moment of insertion; if used, it must be inserted carefully.

around the neck of the screw, and the attachment is completed with the final twists while the final introduction of the screw is performed so that it does not protrude under the skin. The cerclage wire and the screw with a washer are retained during the postoperative period for at least 3 months and are removed only if the patient has discomfort. The traction pin is then removed; exhaustive irrigation and hemostasis revision are realized; and finally, suturing by planes is performed (Video 1).

Postoperative Rehabilitation

The patient leaves the operating room using a hard brace. Quadriceps isometry exercises start on the second postoperative day. Use of the hard brace allows the patient to perform full weight bearing. Abductor and adductor isometry exercises are initiated in the second postoperative week. After the third week, we remove the brace, and the passive gain of knee flexion begins, focusing on range of motion between 0° and 45°. After the sixth week, active flexion of the knee is allowed, and the patient can flex the knee up to 90°. After the eighth week, full knee flexion is allowed.

Discussion

Rupture of the patellar tendon when not treated acutely can evolve with proximal retraction of the patella, generating a complication in the treatment of this injury. In a review article on extensor mechanism injuries, Pengas et al.[2] reported unfavorable results for chronic injuries of the patellar tendon, especially those in which the patella would be retracted by the quadriceps to proximal.

In a study evaluating the current evidence on the techniques and results of patellar tendon reconstruction, published in 2015, the authors indicated that for the treatment of chronic lesions, autologous grafts are preferred.[22] To treat chronic patellar tendon injuries associated with significant proximal retraction of the quadriceps, Siwek and Rao[5] described a 2-stage surgical technique using surgical trans-skeletal patellar traction in the first stage to achieve distalization of the patella to its physiological level; the second stage consisted of reconstruction of the patellar tendon using the reinsertion of the patellar tendon as reinforcement and using autologous fascia lata graft, acting as an autologous biological reinforcement of the patellar tendon. In their study, Siwek and Rao described 6 cases of patients who remained in traction for between 4 days and 2 weeks. The results were excellent in 2 patients, good in 3 patients, and insufficient in 1 patient who continued to have an insufficient range of motion and quadriceps atrophy. Isiklar et al.[23] used an Ilizarov external fixator for 4 to 6 weeks to achieve distalization of the patella in a case report of 2 patients and reported good results.

Other authors have defended the treatment of chronic lesions of the patellar tendon in only 1 surgical stage using quadriceps elongation. Mandelbaum et al.[24] described a technique using stretching of the quadriceps tendon and Z-shortening of the patellar tendon, performing reconstruction with reinforcement of the gracilis and semitendinosus tendons.

Temponi et al.[25] reported a cases series of 7 patients in whom a modified Dejour technique was performed using the central third of the contralateral quadriceps tendon. Improvements in the International Knee Documentation Committee score and Lysholm score from 45 to 64.5 and from 45.4 to 79, respectively, were obtained, both of which were statistically significant; none of the patients had a preoperative Caton-Deschamps index greater than 2. In 2018, Samagh et al.[26] published a case report describing a technique for reconstruction of the patellar tendon in patients with chronic injuries. In the patient described, the self-reported Caton-Deschamps index was greater than 1.2 and the injury had occurred 5 months earlier. The authors did not report a large amount of proximal

Table 2. Advantages and Disadvantages

	Advantages	Disadvantages
Preoperative traction period	It is possible to achieve distalization of the patella without performing quadricepsplasty or V-Y stretching of the quadriceps tendon.	A longer hospitalization time is required. Two surgical procedures are necessary.
Modified technique of Kelikian et al.[20]	Better fixation of the tendon grafts can be achieved. The traction pin maintained in the second surgical stage assists in reducing the patella.	There is a risk of patellar fracture.

retraction of the patella, and they were able to achieve distalization of the patella without quadriceps stretching, describing a reconstruction technique using autologous semitendinosus tendon associated with suture tape (FiberTape; Arthrex). Another group of knee surgeons published a surgical technique also advocating the use of suture tape as reinforcement in the reconstruction of the patellar tendon, suggesting better results with the tape.[27]

Reconstruction of the patellar tendon using adjustable suspensory fixation has been reported for the treatment of chronic lesions.[28] The authors of this technique advocated the use of autologous semitendinosus and gracilis grafts. The grafts are bent multiple times, with the final graft measuring 10 to 12 cm long and 8.5 to 10 mm thick. A 2-cm longitudinal tibial bone tunnel is made at the center of the ATT, and a 2-cm longitudinal bone tunnel is made at the distal pole of the patella; the graft is then centrally positioned on the topography of the patellar tendon, being fixed and tensioned with suspension fixation devices.

Harato et al.[29] described a surgical technique in which they use cannulated screws and polyethylene tape, using a device that, when rotating on itself, shortens the polyethylene tape and thus achieves distalization of the patella; at the same time, they reconstruct the patellar tendon with a Leeds-Keio artificial ligament. According to the authors, the technique should be used in cases in which the patella does not show a great amount of retraction. If a patient presents with chronic and coarse proximal retraction, Harato et al. recommend the use of trans-skeletal traction before performing their technique.

In 2019, we published the case report of a patient with patellar pseudarthrosis with 9 years of evolution, presenting a distance between the fragments of the patella of 9 cm.[30] We performed patellar trans-skeletal traction, decreasing this distance to 1.2 cm, and performed patellar osteosynthesis in a conventional manner, presenting an excellent functional clinical result with an active range of motion of 0° to 90°.

The use of our 2-stage technique ensures distalization of the patella with less need for release, quadricepsplasty, or subperiosteal detachment, facilitating the second surgical stage. Pearls and pitfalls of this surgical technique are listed in Table 1, and advantages and disadvantages are shown in Table 2.

Reconstruction of the patellar tendon using the gracilis and semitendinosus passing through the same tunnel in the patella and tibia (at the level of the ATT), associated with reinforcement with cerclage wire, allows early rehabilitation, with a more rapid movement gain. The technique presented for chronic lesions of the patellar tendon in 2 stages using trans-skeletal patellar traction and reconstruction using the technique of Kelikian et al.[20] with our modification is simple, is reproducible, and presents satisfactory clinical results.

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