

Tendon Injuries of the Knee Extensor Mechanism: Treatment and Rehabilitation Protocol

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ABSTRACT

Background: The rupture of the extensor mechanism can have its origin at bone or tendon level. Its main cause is patellar fracture, followed by quadriceps tendon rupture, and, finally, patellar tendon rupture. These ruptures can be due to direct or indirect trauma. Tendon ruptures of the extensor mechanism are rare, developing with trauma related to the daily routine, sports, or associated systemic diseases. They represent 3% of all tendon injuries. **Materials and Methods:** We presented 22 tendon ruptures of the knee extensor mechanism, surgically treated between June 2015 and January 2019, from which eight (8) ruptures were of the quadriceps tendon (2 bilateral) and fourteen (14) of the patellar tendon (1 bilateral). The cases were evaluated using the Lysholm score, radiographs, and MRI. **Results:** The minimum follow-up was one (1) year. According to the results of those twenty-two (22) surgeries, thirteen (13) cases had excellent results, seven (7) cases were good and two (2) of them were fair. **Conclusion:** In cases of patellar tendon injury, the primary repair with transosseous suture plus figure-of-eight cerclage as augmentation provides a stable reconstruction, allowing the implementation of an early mobilization post-surgery protocol, thus achieving excellent functional outcomes with low complication levels.

Keywords: Extensor mechanism of the knee; tenorrhaphy; quadriceps; patellar.

Level of Evidence: IV

Lesiones tendinosas del aparato extensor de la rodilla: Protocolo de tratamiento y rehabilitación

RESUMEN

Introducción: La rotura del aparato extensor puede ocurrir a nivel óseo o tendinoso; la principal causa es la fractura de rótula, seguida de la rotura del tendón cuadricipital y la rotura del tendón rotuliano. Estas lesiones pueden deberse a traumas directos o indirectos. La rotura tendinosa del aparato extensor es poco frecuente: representa el 3% de todas las lesiones tendinosas. Se presenta con traumatismos relacionados con la actividad diaria, deportiva o asociada a enfermedades sistémicas. **Materiales y Métodos:** Presentamos una serie de 22 roturas tendinosas del aparato extensor de la rodilla (8 del tendón cuadricipital [2 bilaterales] y 14 del tendón rotuliano [1 bilateral]), tratadas mediante cirugía, entre junio de 2015 y enero de 2019. Todos los pacientes fueron evaluados inicialmente con radiografías y resonancia magnética. Se empleó la escala de Lysholm para la evaluación funcional posquirúrgica. **Resultados:** El seguimiento posquirúrgico fue mínimo de un año (rango 12-24); los resultados fueron excelentes en 13 casos, buenos en 7 casos y regulares en 2 casos. **Conclusión:** La reparación primaria, con sutura transósea de las roturas tendinosas del aparato extensor más cerclaje en 8 como aumento en las lesiones del tendón rotuliano brinda una reconstrucción estable, permite implementar un protocolo posquirúrgico de movilización temprana, y así lograr excelentes resultados funcionales con una tasa baja de complicaciones.

Palabras clave: Aparato extensor de la rodilla; tenorrafia; cuadricipital; rotuliano.

Nivel de Evidencia: IV

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INTRODUCTION

The rupture of the extensor mechanism may be at bone or tendon level;¹ the main cause is the fracture of the patella, secondly, the rupture of the quadriceps tendon and finally the rupture of the patellar tendon.^{2,3} These injuries may be due to direct or indirect trauma.^{4,5}

Tendon rupture of the extensor mechanism is rare, accounting for 3% of all tendon lesions. It occurs from trauma related to daily- or sports-related activity or systemic disease. Quadriceps tendon injury is observed in people >40 years, with a peak between 60 and 70 years, unlike the patellar tendon injury that is more frequent in individuals <40 years and associated with direct trauma.¹

Surgery is the gold standard for the treatment of these injuries and its objective is to restore the integrity of the extensor mechanism, reducing the complications associated with this condition, such as loss of range of motion and joint stiffness.^{1,6,7}

The aim of this article is to report the outcomes in a series of patients with tendon injuries of the extensor mechanism, treated with tenorrhaphy by transosseous tunneling.

MATERIALS AND METHODS

We present a series of patients with tendon ruptures of the knee extensor mechanism who underwent surgery between June 2015 and January 2019. The inclusion criteria were: patients >18 years of age operated with the transosseous tunneling tenorrhaphy technique. Exclusion criteria were: chronic tendon ruptures (>4 weeks), presence of another associated knee injury, and follow-up <1 year. The series consisted of 20 patients with 22 tendon ruptures of the knee extensor mechanism. Eight had a quadriceps tendon injury (2 bilateral) and 14 had a patellar tendon injury (1 bilateral). The average age of the group with quadriceps tendon rupture was 34 years (range 22-75) and that of the group with patellar tendon injury was, on average, 31 years (range 21-71). Seventeen patients were men and three were women. Thirteen had compromise on the right side and nine on the left.

In all cases, the diagnosis was based on the symptoms, physical examination and radiographs, and was confirmed by magnetic resonance imaging, assessing the discontinuity of the tendon fibers, as well as the location and type of tear (Figure 1).

The results were evaluated using the Lysholm scale,⁸ the time elapsed until the return to work was also recorded. The pain was assessed with the Lysholm scale and analog scale. Post-surgical satisfaction was assessed using the Likert scale.⁹



Figure 1. Knee radiograph and magnetic resonance of a patient with a ruptured quadriceps tendon at its insertion in the proximal end of the patella.

Surgical technique

Patellar tendon

Through a longitudinal approach, the distal end of the tear was debrided, as well as the medial and lateral, which made it possible to visualize the extension of the tear and associated retinaculum injuries. The distal end was debrided and the lower pole of the patella was curetted to optimize the healing process. Krackow stitches were placed medially and laterally in the patellar tendon with a Ti-cron™ 5 suture; then three parallel and longitudinal tunnels were created in the patella with a 3.5 mm drill bit, two of the strands were passed through the central tunnel and the other two strands through the medial and lateral, respectively, and knotted over the proximal pole of the patella (Figure 2). Subsequently, a figure-of-eight cerclage with 1.2 mm wire was performed as an augmentation technique and, finally, the retinaculum was repaired using continuous running sutures with Vicryl 1. Once the repair was finished, its resistance was verified by passive flexion up to 90 ° (Figure 3).

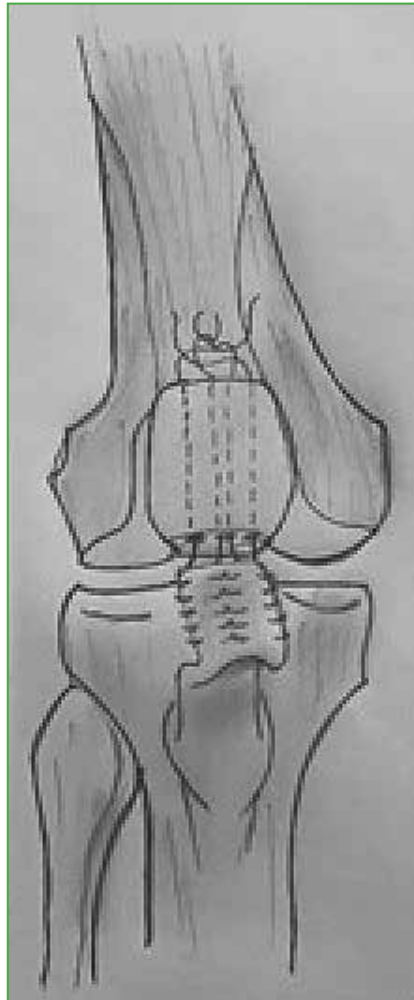


Figure 2. Patellar tendon repair using the transosseous tunnel technique in the patella. The suture (dotted line) passes through three parallel and longitudinal tunnels and is tied over the proximal end of the patella.

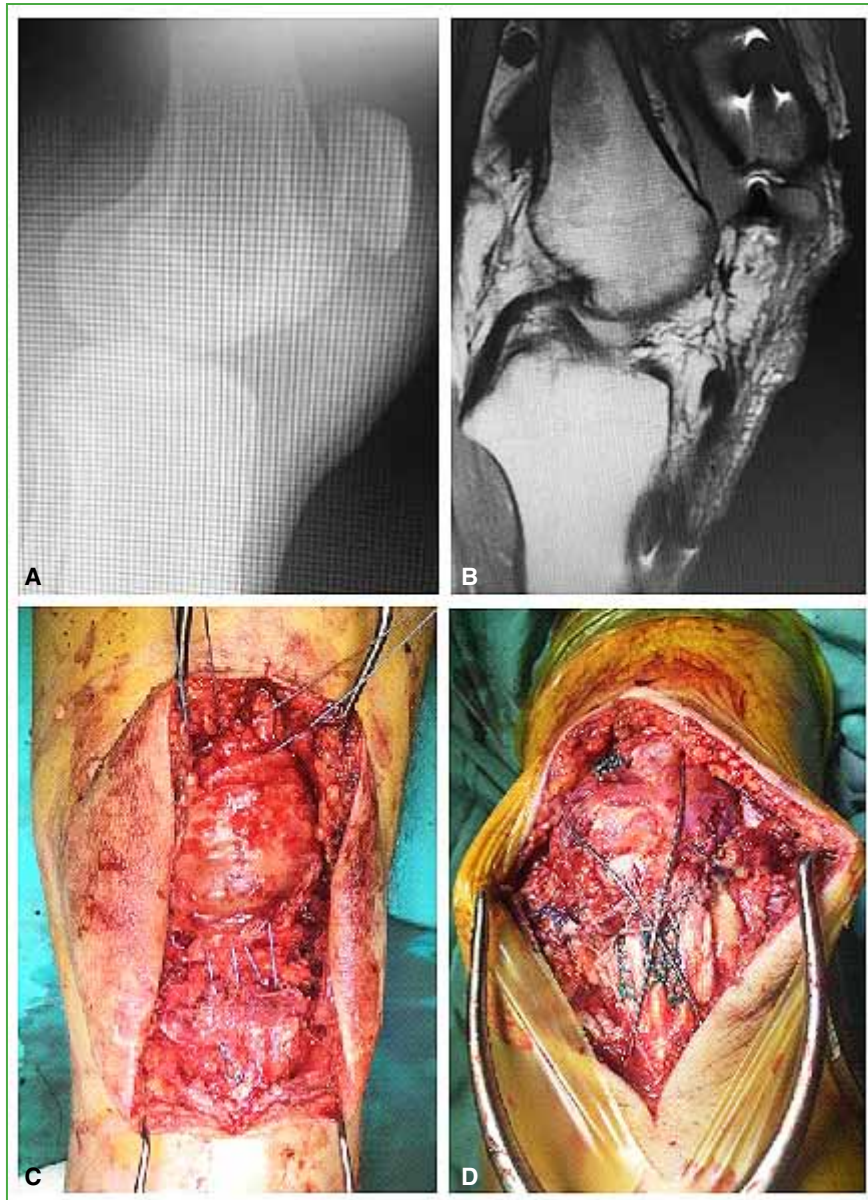


Figure 3. A 43-year-old man with a ruptured patellar tendon, who underwent repair by a transosseous suture in the patella and protection with cerclage. **A.** Lateral knee radiograph showing superior patellar displacement. **B.** Knee MRI, sagittal plane. Note the proximal rupture of the patellar tendon. **C.** Krackow stitches on the tendon and passage of the suture through bone tunnels. **D.** Final assembly with the protective figure-of-eight cerclage wire.

Quadriceps tendon

Through a longitudinal approach, the proximal end of the tear was debrided, as well as the medial and lateral, which made it possible to visualize the extension of the tear and associated retinaculum injuries. Krakow stitches were placed medially and laterally in the quadriceps tendon with a Ti-cronTM 5 suture. Next, three parallel and longitudinal tunnels were created in the patella with a 3.5 mm drill bit. Two of the strands were passed through the central tunnel and the other two strands medially and laterally, respectively, and knotted over the distal pole of the patella (Figure 4). Finally, the retinaculum was repaired using continuous running stitches with Vicryl 1. Once the repair was completed, its resistance was verified by passive flexion up to 90° (Figure 5).



Figure 4. Quadriceps tendon repair using the transosseous tunneling technique in the patella. The suture (dotted line) passes through three parallel and longitudinal tunnels and is tied over the distal end of the patella.

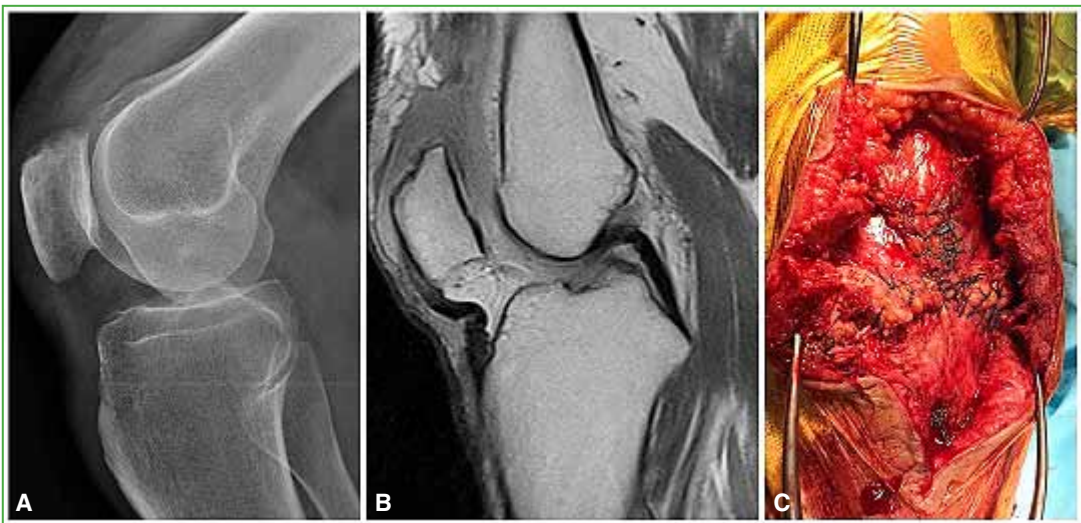


Figure 5. A 74-year-old man with a ruptured quadriceps tendon at its insertion in the patella, who underwent repair by transosseous suture. **A.** Lateral knee radiograph showing inferior patellar displacement. **B.** Knee MRI, sagittal plane. The rupture of the quadriceps tendon is observed at the level of its insertion in the patella. **C.** Immediate postoperative period.

In the immediate postoperative period, a splint was placed in extension and isometric quadriceps contraction exercises were allowed. Weight-bearing with crutches was authorized and the load in extension of the operated limb was accepted. At three weeks, the skin sutures and splint were removed, and active extension and flexion were initiated. A 45° flexion was allowed, gradually increasing to 90° for the first six weeks. In all cases, the protective cerclage was removed at eight weeks, with mobilization of the knee during the same procedure. Then, full range of motion was initiated, authorizing resistance quadriceps strengthening exercises after 12 weeks. Low-impact sports activities were allowed from the fourth month and activities that involved impact or jumping could be resumed after month 9.

FINDINGS

The minimum postoperative follow-up was 12 months (range 12-24); functional evaluation according to the Lysholm method yielded excellent results in 13 patients, good in seven cases and fair in two (Table 1).

Table 1. Outcomes according to the Lysholm method

Outcome	Quadriceps tendon rupture Number of cases	Patellar tendon rupture Number of cases
Excellent	5	8
Fair	2	5
Regular	1	1
Poor	0	0
Total	8	14

When assessing the range of motion of the operated patients, an average range of 0 to 110° was found at four months. All returned to their usual activities, on average, within 12 weeks of the injury (Table 2). Only four reported mild pain during sports activity on the analog scale for pain.

Table 2. Ranges of motion and rehabilitation time

Joint range of motion	Quadriceps tendon Number of cases	Patellar tendon Number of cases	Time
45°	8	14	4 weeks
90°	8	14	6 weeks
110°	8	14	12 weeks

One patient (5%) had a superficial infection that was cured with oral antibiotic treatment. One patient required mobilization under anesthesia six weeks after the repair of the quadriceps tendon rupture, because the range of joint motion was 0 to 50°. A flexion of 100° was achieved. 90% of the operated patients reported being satisfied with the results obtained, while 10% expressed dissatisfaction.

DISCUSSION

Tendon rupture of the knee extensor mechanism is a rare injury. The mechanism of injury varies according to age, and the most frequent is the sudden contraction of the quadriceps with the knee in semi-flexion, mainly due to direct trauma in young people and indirect trauma in the elderly. The typical clinical triad consists of pain, functional impairment, and suprapatellar or infrapatellar hiatus.^{10,11} Bilateral ruptures of these tendons are even rarer and are associated with systemic diseases—as reported by Rose and Frassica¹² in a systematic literature review—such as systemic lupus erythematosus, chronic kidney disease, rheumatoid arthritis, and primary hyperparathyroidism.

Surgery for knee extensor tendon rupture aims to achieve a stable reconstruction, allowing early rehabilitation. Different techniques have been described, such as end-to-end suture, transosseous suture, and suture with augmentation of peritendinous tissues; the first two are for acute injuries and the last is for chronic injuries.

In a study by Rasul and Fischer⁶ with tenodesis of the quadriceps tendon through transosseous points, it was concluded that this technique achieves excellent results, and that age, sex, mechanism and location of the injury do not they have an impact on the long-term outcome. Similarly, Siwek and Rao¹ compared a series of surgical techniques and concluded that tenorrhaphy through transosseous tunnels yielded better results.

It is worth mentioning that, in the national literature, there is only one study, by Costa Paz et al.¹³, where tenodesis with suture anchors is proposed for the management of these injuries. These authors point out that it is a valid and effective technique for repairing knee extensor mechanism tears. This technique was proposed by Maniscalco et al.¹⁴ and provides greater stiffness in flexion. However, in a biomechanical study of different surgical techniques for the repair of patellar tendon rupture, Schliemann et al.¹⁵ concluded that the transosseous suture plus augmentation technique, either with cable wire or suture, provides greater firmness and less elongation when subjected to cyclical loads in comparison with a suture-anchor fixation technique.

On the other hand, with regard to rehabilitation, in studies such as that of Benjamin and Kaiser, it was shown that early mobilization is beneficial for tendon healing and also to maintain a healthier joint cartilage and improve joint ranges of motion. They propose to stimulate an early passive flexion from 30 ° to 90 °, starting on the first day after surgery. Meyer and Ricci⁵ reported that early repair added to early rehabilitation was effective; the same conclusion was reached by Bhargava et al.,¹⁶ who stated that a primary repair plus cerclage and early mobilization provide excellent results in isolated ruptures of the patellar tendon.

We consider that the strengths of our study are the number of patients and the presentation of a surgical technique that has not been published in our country. However, its weaknesses are its retrospective nature and not having a control group undergoing a different surgical repair technique.

CONCLUSION

For the treatment of patellar tendon injuries, the primary repair with transosseous suture of the tendon ruptures of the extensor mechanism and a figure-of-eight cerclage as augmentation provides a stable reconstruction and allow the implementation of an early postoperative mobilization protocol, thus achieving very good functional outcomes with a low rate of complications.

Conflict of interests: The authors declare they do not have any conflict of interests.

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