Review Article

Bilateral ruptures of the extensor mechanism of the knee: A systematic review

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ABSTRACT

Introduction: We conduct a systematic and qualitative review of the current literature to evaluate studies that described bilateral ruptures of the extensor mechanism of the knee.

Methods: A comprehensive literature search was performed to evaluate all studies included in the literature until September 2016.

Results: Fourteen studies with a total of 44 patients met the inclusion criteria. There were 14 patients with CRF (61%), 6 patients were affected by diabetes mellitus (14%) while other 6 patients were obese patients (14%).

Conclusion: CRF represents the most frequent comorbidity in patients with bilateral quadriceps/patellar tendon ruptures.

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1. Introduction

Patellar and quadriceps tendon ruptures represent a rare injury requiring prompt diagnosis and treatment in order to avoid loss of knee function. It can occasionally occur bilaterally, presenting a significant diagnostic pitfall.

Quadriceps tendon ruptures usually occur in subjects relatively old (over 60 years old) following a fall or a trauma. Tears are generally located at the osteotendinous junction and in presence of degenerative tendon changes. Patellar tendon ruptures occur in athletic patients aged below 40, much more following sports injuries.¹ Generally, the preferred location of tendon ruptures is the lower pole of the patella, at the bone–tendon junction. Several case reports have linked tendon ruptures to anabolic steroid usage and local corticosteroid injections. Further, bilateral extensor mechanism (BMR) ruptures are generally associated with several systemic diseases, such as chronic renal disease (CRD), hyperparathyroidism, rheumatoid arthritis, systemic lupus erythematosus, and connective tissue diseases.² In these cases, spontaneous tears without an evident trauma have been reported to be frequent, creating diagnostic problems. Because bilateral

ruptures are rare entities, more than 50% of cases are missed on initial presentation.^{3–5} For this reason, detecting associated comorbidity could help surgeons to avoid misdiagnosis. In fact, a delay in diagnosis of an average of 65 days has been reported to be common, and the consequence of missing an extensor mechanism rupture may affect the outcome of tendon repair, prolonging disability of the individual patient.³

The aim of our study was to conduct systematic and qualitative reviews of the current literature to summarize and evaluate the clinical studies that described bilateral ruptures of the extensor mechanism of the knee. These data are then used to evaluate associated systemic diseases, outcomes, and complications of patients that underwent surgical treatment for tendon repair.

2. Materials and methods

A systematic review was conducted according to the guidelines presented in the PRISMA Statement (Preferred Reporting Items for Systematic Reviews and Meta-Analyses).⁶ A systematic review of the literature on bilateral ruptures of the extensor mechanism of the knee was performed using the Cochrane Database of Systematic Reviews, PubMed, Medline, Embase, and Google Scholar. The search was conducted including all studies published until September 2016. Unpublished material was not used for this review. The following MeSH entries were used for research articles: quadriceps patellar tendon rupture, bilateral quadriceps

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lesion, bilateral quadriceps tear, bilateral patellar tendon lesion, bilateral patellar tear, bilateral quadriceps repair, bilateral patellar tendon repair, bilateral patellar tendon rupture and bilateral quadriceps tendon rupture. To reduce and minimize the number of missed studies, no filters were applied to the search strategies. Only papers published in English were considered for inclusion. Not included were animal in vivo and human in vitro studies, case reports, cadaveric studies, biomechanical studies, histological studies, immunological studies, technical notes, studies dealing with radiological classifications and studies on revision surgery. An exclusion criteria was also case reports that have included and described just one clinical case. References within included studies were reviewed and manually cross-referenced to identify potential inclusion if omitted from the initial search. Two reviewers (A.D. and S.M.) independently examined the titles and abstracts from all identified articles to assess their appropriateness to the research question. Full-text articles were obtained if necessary to allow the application of inclusion and exclusion criteria. In cases of disagreement of studies inclusion/exclusion, a consensus was reached through discussion. Further, if an agreement was not achieved, the senior author (L.C.) was consulted for the final decision.

Two authors (L.C., F.B.) extracted and recorded relevant data from each included study, according to the following standardized protocol: authors and year of publication, study type, numbers of patients, patient demographics (age, gender, type of lesion) type of trauma, tear description, duration of follow-up and treatment (surgical technique details). In addition, information on comorbidities was noted and recorded. Finally, re-ruptures and

complications were extracted and analysed from each study that met the inclusion criteria. The extracted data were then cross-checked for accuracy and checked by a third author. The flow chart illustrates the number of studies that have been identified, included, and excluded and the reasons for exclusion (Fig. 1).⁷ Two investigators (S.M., A.D.) assessed the methodological quality of the selected studies according to the Modified Coleman Methodology Score (CMS), after agreement between two investigators.⁸ Meta-analysis and statistical analysis were not feasible due to substantial heterogeneity between studies, varying methodology and lack of direct comparative results.⁹

3. Results

A total of 705 articles were identified by the initial literature search. Among these, 32 full-text articles were identified. Fourteen studies met inclusion and exclusion criteria and were included in the present review (Table 1).^{3,10–20} The articles included were published between 1977 and 2015. The evaluation of the quality of the included articles revealed that there were two retrospective studies and twelve case reports (Table 1).^{15,18} Only patients that presented a BEM rupture were considered and included in this review.¹⁸ The average modified CMS was 37,6 (range from 13 to 53) (Table 1).^{10,18}

3.1. Demographic data

The total amount of patients included in this review that presented a BEM rupture was 44 (male 74% – female 26%) (Table 2).

Fig. 1. Flow diagram that describe the number of studies identified, included, and excluded as well as the reasons for exclusion.

Table 1
Characteristics of included studies.

Authors	Published year	Journal	Country	Study Type	Number of Patients	Modified Coleman methodology score
Pierides et al. ¹⁰	1977	Clinical Nephrology	United Kingdom	Case Report	3	13
Mac Eachern et al. ¹¹	1984	Journal of Bone and Joint Surgery (British)	United Kingdom	Case Report – review	5	34
Bhole et al. ¹²	1985	Clinical Orthopaedic and Related Research	United States	Case Report	2	42
Dhar S. ¹³	1988	Injury	United Kingdom	Case Report	3	34
Keogh et al. ¹⁴	1988	Clinical Orthopaedic and Related Research	Republic of Ireland	Case report-review	4	41
Spencer et al. ¹⁵	1988	Injury	United Kingdom	Retrospective Study	2	15
Hannon et al. ¹⁶	1989	The Ulster Medical Journal	United Kingdom	Case report	2	37
Provelegios et al. ¹⁷	1991	Archives D'Anatomie Et De Cytologie Pathologiques	Greece	Case Report	5	39
Neubauer et al. ³	2007	Knee Surgery Sports Traumatology Arthroscopy	Austria	Case Report	3	41
Kara et al. ²²	2013	Acta Orthopaedica et Traumatologica Turcica	Turkey	Case Report	2	49
Popov et al. ¹⁸	2013	Medicinski Pregled	Serbia	Retrospective Study	4	53
Chang et al. ¹⁹	2014	The Physician and Sportmedicine	United States	Case Report	5	52
Goldstein et al. ²⁰	2015	Orthopedics	United States	Case Report	2	34
Seng et al. ²¹	2015	Journal of Orthopaedic Surgery	Singapore	Case Report	2	43

The follow-up across all studies ranged from 4 to 60 months, with a mean of 18,2 months (Table 3). The average age at the time of tendon ruptures was of 53,6 years, with a youngest and eldest patient of 17 and 84 –years old, respectively.^{10,11} Among 44 patients, only 15 patients reported a trauma (34%). In all other patients, a spontaneous rupture occurred (71%). Thirty-seven patients presented a bilateral quadriceps tendon (BQT) rupture (84%), 6 patients presented a bilateral patellar tendon (BPT) rupture (14%), while only one patient presented a simultaneous quadriceps and contralateral patellar tendon (BQPT) rupture (2%).²¹ Types and descriptions of tendon tears are reported in Table 2. No significant differences were noted between sex (male vs female) and types of tendon ruptures (BQT rupture vs BPT rupture vs BQPT rupture).

3.2. Patient's comorbidity

Only 27 patients of 44 presented a well-documented comorbidity. There were 14 patients with renal disease (61%), 6 patients were affected by diabetes mellitus (14%) while other 6 patients were obese patients (14%). Two patients reported BPT ruptures following total knee replacement (TKR). All comorbidities of patients included in this study are detailed in Table 3. No differences were noted between comorbidity and type of tears.

3.3. Surgical techniques and outcomes

The two most common surgical techniques used for QTR repair were simple direct sutures and patellar drill holes. Direct sutures were used in 22.5% of patients. The technique of patella drill holes was applied in 50% of patients. Reinforcement was reported in 11 patients and in 4 studies.^{11,14,17,21} Specifically, wire reinforcement technique was reported in 4 patients,^{10,14,21} while soft-tissue reinforcement, such as Codivilla's technique was described in 7 patients (Table 4).^{12,17} Outcomes were poorly described and standardized in terms of their assessment. Objective outcome scores were utilised in only 2 studies.^{18,19} However, only one study reported detailed postoperative IKDC scores (5 patients with

bilateral quadriceps rupture) with the mean postoperative scores ranged from 34,38 to 91,6 (Table 3).¹⁹

3.4. Complications and tendon re-ruptures

Concerning complications, only 3 patients among 44 presented a re-rupture of the previously repaired tendons.^{10,14,20} Specifically, re-ruptures occurred among quadriceps tendons repaired in two patients, while one patient presented a re-rupture of the patellar tendon (Table 5). Further, 10 patients out of 44 (23%) had a delayed diagnosis. However, no association was noted between missed diagnosis, delayed surgical repair and tendons re-rupture.

4. Discussion

The most important finding of this systematic review was that in case of bilateral extensor mechanism ruptures, spontaneous tears occur two-times more frequently than with trauma. Further, BQT are five times more common than BPT ruptures. Specifically, among the 44 patients included in 14 studies selected in this review, 84% had a BQT ruptures, 14% had BPT ruptures, while 2% had simultaneous quadriceps and contralateral patellar tendon ruptures.

Bilateral disruptions of the knee extensor mechanism are rare and difficult to diagnose. Patients typically present sharp pain around the patella, knee flexed with the impossibility to stand without assistance. Clinically, alteration of the normal anatomic profile and swelling of both knees could be observed. In case of quadriceps ruptures, a gap above the patella (Sulcus Sign) could often be observed. In cases of patellar tendon ruptures, a patellar floating could be highlighted, especially if medial and lateral knee retinaculum are interested. In both conditions, patients have a full passive range of motion on flexion and extension. However, because of complete extensor mechanism discontinuity, patients are unable to actively extend the knees from any flexed position and perform a straight leg raise in both knees. In addition, a simple straight leg raise may be possible from the ileotibial band function and in presence of intact patellar retinaculum. With this variable

Table 2
Demographic data.

Authors	Female	Male	Trauma	Bilateral Quadriceps Tendon	Bilateral Patellar tendon rupture	Bilateral Quadriceps and Patellar Tendon	Tear Description
Pierides et al. ¹⁰	1 (17 years)	1 (29 years) 1 (29 years)	1	3	2	–	rupture above the patella not reported not reported
Mac Eachern et al. ¹¹	–	1 (68 years) 1 (84 years) 1 (54 years) 1 (80 years) 1 (74 years)	2	5	–	–	not reported (complete tendons rupture) not reported not reported not reported not reported
Bhole et al. ¹²	1 (38 years)	1 (30 years)	–	2	–	–	both tendons rupture occurred at the tendon-osseous junction both tendons rupture occurred at the tendons (one inch above the patella)
Dhar S. ¹³	–	1 (75 years) 1 (61 years) 1 (82 years)	2	3	–	–	rupture at the musculotendinous junction not reported not reported
Keogh et al. ¹⁴	1 (71 years)	1 (70 years) 1 (62 years) 1 (74 years)	1	4	–	–	not reported not reported not reported not reported
Spencer et al. ¹⁵	sex non mentioned 1 (32 years) 1 (48 years)		–	2	–	–	not reported not reported
Hannon et al. ¹⁶	–	1 (50 years) 1 (66 years)	–	–	2	–	rupture through the mid-zone of the tendon bodies rupture through the mid-zone of the tendon bodies
Provelegios et al. ¹⁷	1 (46 years) 1 (35 years) 1 (50 years)	1 (33 years) 1 (36 years)	1	4	1	–	complete avulsion of the insertion of both of the patellar tendons complete avulsion of the insertion of both of the quadriceps tendons complete tears above insertion site of both quadriceps tendons tears with shortening of quadriceps tendon and with frayed edges not reported
Neubauer et al. ³	–	1 (55 years) 1 (52 years) 1 (30 years)	2	3	–	–	both tendons avulsed from the cranial pole of the patella both tendons avulsed from the cranial pole of the patella both tendons avulsed from the cranial pole of the patella
Kara et al. ²²	1 (34 years)	1 (43 years)	–	2			both tendons avulsed from the cranial pole of the patella not reported
Popov et al. ¹⁸	sex non mentioned (average 54 years)		N/A	4	–	–	not reported not reported not reported

Table 2 (Continued)

Authors	Female	Male	Trauma	Bilateral Quadriceps Tendon	Bilateral Patellar tendon rupture	Bilateral Quadriceps and Patellar Tendon	Tear Description
							not reported
Chang et al. ¹⁹	–	1 (68 years) 1 (84 years) 1 (54 years) 1 (80 years) 1 (74 years)	5	5	–	–	not reported not reported not reported not reported not reported
Goldstein et al. ²⁰	1 (72 years) 1 (49 years)	–	1	–	2	–	not reported not reported
Seng et al. ²¹	1 (29 years)	1 (27 years)	–	–	1	1	midsubstance tear tear near the insertion site at the tibial tubercle

clinical presentation, it is necessary to have a high index of suspicion, especially in patients that reported bilateral knee dysfunction, and with a history of systemic disease. In fact, several case reports published in the past two decades suggested an association between extensor mechanism rupture and specific systemic illness. However, to date comorbidities linked to BEM ruptures still remain particularly unclear.

One aim of this systematic review was to consolidate and present studies reporting results of patients that underwent surgical repair of BEM ruptures. The main finding of this work is surely the paucity of literature available on this topic, especially for bilateral tendon ruptures. Even we considered all the papers reported in literature limiting restriction on date of publication or surgical approach, only 14 articles were included in this review with just 44 patients surgically treated for BEM rupture. Analysing the relevant data from each included study, it was impossible to find any sort of comparable parameter. This was observed because of a high heterogeneity in terms of patients' features and demographics, treatment options, and associated comorbidity. One of the main limitations of the present study is a low average Modified Coleman Score of the included articles, showing a poor overall methodological quality of the reports published. Further, all articles included are case reports and retrospective studies with a low level of evidence. In addition, because outcome measurements were poorly described, it was not possible to evaluate any association between clinical outcomes and delayed surgical repairs and tendon re-ruptures (Table 5).

Concerning comorbidity, in this study it was found that CRD represent the most frequent comorbidity in patients with bilateral quadriceps/patellar tendon ruptures. Diabetes mellitus, obesity, and rheumatic disease were other medical comorbidities present in patients observed in this review (Table 3). These predisposing conditions are responsible for tendon degeneration, altering collagen synthesis or strength, causing sclerosis and fibrosis in the tendon, predisposing it to rupture.

In patients with CRD, tendon injury occurs primarily in weight-bearing tendons; structures most likely to be placed under the excessive force of associated muscle groups contracting against resistance.²³ Further, the main cause of tendon ruptures has been reported to derive from all classical complications of long-term chronic haemodialysis including duration of dialysis, malnutrition,

accumulation of uremic toxins, renal osteodystrophy and hyperparathyroidism. Specifically, as kidney function declines, a progressive deterioration in mineral homeostasis could be observed, with a disruption of normal serum and tissue concentrations of phosphorus and calcium, and Parathyroid hormone (PTH) and Vitamin D. In addition, in presence of hyperparathyroidism, high PTH levels result in high bone turnover, which is responsible for subtendinous bone reabsorption and secondary weakness of bone-tendon junction.^{24,25} The occurrence of repeated minor fractures of the weakened bone cortex at the tendon insertion site precedes the final total tendon rupture, which then occurs after a minor trauma (spontaneous rupture).²⁶ Moreover, it was reported that in uremic patients who underwent dialytic treatment with insufficiently permeable filters an increased blood level of β_2 -microglobulin could be observed (Dialysis-related Amyloidosis). In these patients, plasma β_2 -m tends to collect in particular areas such as joints, bones, and tendon structures causing a reduction of the tendon's elasticity and predisposing it to rupture following minimal stress.²⁷ Even if dialysis-related amyloidosis could be effectively a predisposing condition for tendon degeneration, any clinical correlation was observed in patients included in this review.

In diabetes, tendon damage could be caused by an excess of advanced glycation end products (AGEs) and by their ability to form a covalent cross-link within collagen fibers. This circumstance, associated with inflammatory cytokines release and tenocyte apoptosis could lead to progressive tendon damage. In patient affected by diabetes, collagen fibrils appear twisted, curved, and highly disorganized, while fibroblasts and tenocytes decrease in terms of number per unit of surface area. In addition, the number of capillaries per unit of surface area (arterial blood flow) is reduced, particularly in elderly subjects.²⁸ Biomechanically, collagen toughness, stiffness and the elastic modulus are strongly influenced by AGE cross-link formation.²⁹

In obese patients, it could be hypothesized as a cause of tendon ruptures an increased yield on the load-bearing tendon. Further, it has been reported that in obese patients fatty degeneration of the tendon's microstructure could be observed, predisposing tendon rupture. In addition, in obese patients high insulin concentrations fail to stimulate increased glucose uptake into muscle, which leads to fasting hyperglycemia, impaired glucose tolerance and Type II

Table 3

Outcomes and comorbidity of studies reviewed.

Authors	Number of Patients	Follow-up (Months)	Outcome scale	Comorbidity
Pierides et al. ¹⁰	3	30 months 13 months not reported	N/A N/A N/A	hydronephrotic kidney familial medullary cystic disease. Peritoneal dialysis CRF in treatment with haemodialysis
Mac Eachern et al. ¹¹	5	9 months 2,5 months 6 months 8 weeks 4 months	N/A N/A N/A N/A N/A	not reported not reported obese – mentally subnormal not reported Diabetes Mellitus
Bhole et al. ¹²	2	4 months 4 months	N/A N/A	CRF in treatment with haemodialysis in the last 6 years CRF in treatment with haemodialysis in the last 2 years (secondary hyperparathyroidism)
Dhar S. ¹³	3	4 months 5 months 6 months	N/A N/A N/A	no comorbidity Obese patient not reported
Keogh et al. ¹⁴	4	60 months 60 months 4 months 16 months	N/A N/A N/A N/A	High serum acid uric level Diabetes Mellitus no comorbidity no comorbidity
Spencer et al. ¹⁵	2	not reported not reported	N/A N/A	CRF in treatment with haemodialysis in the last 4 years (previous unsuccessful renal transplantation). Familial gout CRF in treatment with haemodialysis in the last 16 years (previous unsuccessful renal transplantation)
Hannon et al. ¹⁶	2	6 months 7 months	N/A N/A	No Comorbidity No Comorbidity
Provelegios et al. ¹⁷	5	3 months 36 months 9 months 12 months not reported	N/A N/A N/A N/A N/A	CRF in treatment with haemodialysis with secondary hyperparathyroidism CRF with secondary hyperparathyroidism CRF in treatment with haemodialysis in the last 3 years with secondary hyperparathyroidism CRF in treatment with haemodialysis CRF
Neubauer et al. ³	3	54 months 14 months 21 months	N/A N/A N/A	Obese patient, Diabetes Mellitus Obese patient Obese Patient
Kara et al. ²²	2	51 months 24 months	N/A N/A	CRF in treatment with haemodialysis in the last 14 years (diabetic nephropathy) CRF in treatment with haemodialysis in the last 8 years
Popov et al. ¹⁸	4	mean 3.5 years	Lysholm score mean 92	Not mentioned
Chang et al. ¹⁹	5	26 months 25 months 25 months 29 months 22 months	34,38 91,6 IKDC 90,3 89,65 54	No Comorbidity No Comorbidity Diabetes Mellitus No Comorbidity No Comorbidity
Goldstein et al. ²⁰	2	12 months 24 months	N/A	Previous Bilateral TKR – Obese Patient, chronic obstructive pulmonary disease Previous Bilateral TKR – Obese Patient, Rheumatoid arthritis, diabetes mellitus
Seng et al. ²¹	2	6 months 12 months	N/A N/A	Undifferentiated Connective Tissue Disease (Prednisone 60 mg/day and Azathioprine 100 mg/die) CRF in treatment with haemodialysis in the last 12 months

diabetes mellitus.³⁰ In this condition, obesity and diabetes share common pathogenetic pathways characterized by increased AGEs with deleterious effect of tendon structure.

Even several authors reported an association between tendon ruptures and prior use of fluoroquinolones, local steroid injections and a history of steroid usage, in this review only one patient (1/44) was reported to have a daily intake of steroids.^{21,31} This data is surprisingly interesting, specifically based on what reported in the literature concerning the risk of tendon injuries in patients with a

history of rheumatic disease, that notoriously requires a long time steroid treatment.

The present review has several limitations, mainly due to the low methodological quality of included studies. The evidence here was derived from observational studies, which was inherently at risk of bias. Further, this study included only data available in the English language; thereby, a possible language selection bias exists. A second limitation of this study was the heterogeneous nature of the highly variable characteristics of patients in each

Table 4
Surgical techniques of included studies.

Authors	Number of Patients	Treatment
Pierides et al. ¹⁰	3	The tendons were sutured through patella drill holes Tendon repair Tendon repair (on the left knee a wire loop was used to secure the patellar tendon to the patella)
Mac Eachern et al. ¹¹	5	Tendons repaired using sutures passed through drill holes in the patella Tendons repaired using polyglycolic acid sutures Tendons repaired using nylon sutures placed circumferentially around lower patella and through the quadriceps tendon Tendons repaired using catgut mattress sutures Figure-of-eight stainless steel sutures passed through patellar drill holes + polyglycolic acid sutures to reinforce the repair
Bhole et al. ¹²	2	The tendons were sutured with nonabsorbable suture through patella drill holes + reinforcement with a layer of end-to-end absorbable suture The tendons were sutured with nonabsorbable suture through patella drill holes + reinforcement with a layer of end-to-end absorbable suture
Dhar S. ¹³	3	Tendons ruptures were sutured with polyglycolic acid interrupted mattress sutures. Quadriceps tendon were repaired with chromic catgut mattress sutures The ruptures were sutured with mattress polyglycolic acid sutures
Keogh et al. ¹⁴	4	Tendons were repair using direct suture Tendons were sutured through a direct repair Tendons were sutured through a direct repair + steel wire loops through the patella Tendons were sutured through a direct repair with trans-osseous fixation
Spencer et al. ¹⁵	2	Surgical repair using sutures anchored via drill holes into the superior border of the patella Surgical repair using sutures anchored via drill holes into the superior border of the patella
Hannon et al. ¹⁶	2	Open repair using absorbable suture Open repair using absorbable suture
Provelegios et al. ¹⁷	5	surgical repair with transosseous technique using Dexon sutures + reinforcement of the quadriceps tendon according Codivilla's technique surgical repair with transosseous technique using Dexon sutures + reinforcement of the quadriceps tendon according Codivilla's technique surgical repair with transosseous technique using Dexon sutures + reinforcement of the quadriceps tendon according Codivilla's technique surgical repair with transosseous technique using Dexon sutures + reinforcement of the quadriceps tendon according Codivilla's technique surgical repair with transosseous technique using Dexon sutures + reinforcement of the quadriceps tendon according Codivilla's technique
Neubauer et al. ³	3	Tendons were refixed with transosseous sutures Tendons were refixed using transosseous sutures and the retinacula repaired Tendons were repaired with transosseous sutures.
Kara et al. ²²	2	Krackow suture – transosseous technique Krackow suture – transosseous technique
Popov et al. ¹⁸	4	Not correctly described Not correctly described Not correctly described Not correctly described
Chang et al. ¹⁹	5	Surgical repair with a 3-hole patella, transosseous technique, using nonabsorbable sutures placed in a locked, running arrangement (Krackow's technique) Surgical repair with a 3-hole patella, transosseous technique, using nonabsorbable sutures placed in a locked, running arrangement (Krackow's technique) Surgical repair with a 3-hole patella, transosseous technique, using nonabsorbable sutures placed in a locked, running arrangement (Krackow's technique) Surgical repair with a 3-hole patella, transosseous technique, using nonabsorbable sutures placed in a locked, running arrangement (Krackow's technique) Surgical repair with a 3-hole patella, transosseous technique, using nonabsorbable sutures placed in a locked, running arrangement (Krackow's technique)
Goldstein et al. ²⁰	2	Extensor mechanism allograft reconstruction Extensor mechanism allograft reconstruction
Seng et al. ²¹	2	Reconstruction with allograft placed in a figure-of-8 configuration (tibial tunnel and defunctioning wire) Suture with trans-osseous fixation – defunctioning wire in the patellar tendon

Table 5

Delayed diagnosis and tendon re-ruptures of patients included in the review.

Authors	Number of Patients	Delayed Diagnosis	Re-rupture
Pierides et al. ¹⁰	3	1) — 2) 14 days 3) —	1) re-rupture after 12 months 2) — 3) —
Mac Eachern et al. ¹¹	5	1) — 2) 6 days 3) — 4) — 5) —	1) — 2) — 3) — 4) — 5) —
Bhole et al. ¹²	2	1) — 2) —	1) — 2) —
Dhar S. ¹³	3	1) 7 days 2) — 3) —	1) — 2) — 3) —
Keogh et al. ¹⁴	4	1) 108 days 2) — 3) 10 days 4) —	1) re-rupture after 4 months 2) — 3) — 4) —
Spencer et al. ¹⁵	2	1) — 2) —	1) — 2) —
Hannon et al. ¹⁶	2	1) — 2) —	1) — 2) —
Provelegios et al. ¹⁷	5	1) 40 days 2) — 3) 4 days 4) — 5) —	1) — 2) — 3) — 4) — 5) —
Neubauer et al. ³	3	1) 2 days 2) 4 weeks 3) 1 day	1) — 2) — 3) —
Kara et al. ²²	2	1) — 2) —	1) — 2) —
Popov et al. ¹⁸	4	1) — 2) — 3) — 4) —	1) — 2) — 3) — 4) —
Chang et al. ¹⁹	5	1) — 2) — 3) — 4) — 5) —	1) — 2) — 3) — 4) — 5) —
Goldstein et al. ²⁰	2	1) — 2) —	1) — 2) re-rupture in a previous patellar tendon repair
Seng et al. ²¹	2	1) — 2) —	1) — 2) —

study. Further, the studies often used different outcome measures or reported them with different scales, making a meta-analysis of data not possible for these studies. Clinical results may be influenced by some potential factors, such as surgical techniques used for tendon repairs, proficiency of surgeons, and postoperative rehabilitation.

Therefore, it should be taken into account when interpreting the results. Third, short-term follow-up reported in different studies may lead to underestimation of complications. Finally, well-designed longer follow-up studies are further required for definitive conclusions.

Conflict of interest

The authors have none to declare.

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