



Original article

Total bilateral ruptures of the knee extensor apparatus[☆]



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ABSTRACT

Objective: Bilateral extensor tendon ruptures of the knee are rare and have only been published in the form of case reports or small series.

Methods: Seven patients corresponding to 14 extensor tendon ruptures of the knee were evaluated by the same examiner after a minimum one year post-surgery. Clinical and radiographic evaluations were performed; for statistical analysis, the level of significance was set at 0.05.

Results: The most common injury was patellar tendon rupture ($n=9$; 64.29%) followed by quadriceps tendon rupture ($n=5$, 35.71%). The intrasubstance was the most affected location (57.15%), followed by the myotendinous junction (21.43%) and the patellar bone insertions (21.43%). Quadriceps tendon ruptures were more prevalent in patients older than 50 years, while patellar tendon ruptures tended to occur in younger individuals. All but one patient had recognized risk factors for tendinous degeneration and rupture: 75% of the cases suffered from diseases, 50% had history of drug use and/or abuse, and 37.5% had both disease and drug use history. Mean attained values for flexion ROM were $124.64^\circ \pm 9.43$ (110–140°) and 89.57 ± 6.02 (78–94) for Kujala score. More than half of the patients complained of residual pain and quadriceps muscular weakness. Mean age was younger in the individuals who complained of residual pain.

Conclusion: Bilateral tendon ruptures of the knee extensor apparatus ruptures are rare and serious injuries, mostly associated with risk factors. Early surgical repair and intensive rehabilitation program for bilateral extensor tendon ruptures of the knee may warrant satisfactory functional outcomes in the medium to long term, despite non-negligible levels of residual pain, quadriceps muscle weakness, and atrophy.

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Ruptura bilateral total do aparelho extensor do joelho

R E S U M O

Palavras-chave:

Articulação do joelho
Lesões do tendão
Ligamento patelar/lesões
Ruptura

Objetivo: As rupturas bilaterais do tendão extensor do joelho são raras e só foram publicadas na forma de relatos de casos ou de pequenas séries.

Métodos: Sete pacientes (14 rupturas do tendão extensor do joelho) foram avaliados pelo mesmo examinador após um período mínimo de um ano de pós-operatório. Foram realizadas avaliações clínicas e radiográficas. Para a análise estatística, o nível de significância foi fixado em 0,05.

Resultados: A lesão mais comum foi ruptura do tendão patelar (n=9; 64,29%) seguida de ruptura do tendão do quadríceps (n=5, 35,71%). A intrasubstância foi a localização mais acometida (57,15%), seguida pela junção miotendinosa (21,43%) e inserção óssea patelar (21,43%). As rupturas do tendão do quadríceps foram mais prevalentes em pacientes com mais de 50 anos; por outro lado, as rupturas do tendão patelar tenderam a ocorrer em indivíduos mais jovens. À exceção de um paciente, todos os demais apresentavam reconhecidos fatores de risco para degeneração e ruptura tendínea: 75% dos casos sofriam de doenças, 50% tinham histórico de uso e/ou abuso de drogas e 37,5% apresentavam simultaneamente histórico de doença e uso de drogas. Os valores médios obtidos para a ADM de flexão foram de $124,6^\circ \pm 9,43$ ($110-140^\circ$); no escore de Kujala, os valores médios foram $89,57 \pm 6,02$ (78-94). Mais da metade dos pacientes se queixou de dor residual e fraqueza muscular no quadríceps. A idade média dos indivíduos que se queixaram de dor residual era menor.

Conclusão: As rupturas bilaterais do tendão nas rupturas do aparelho extensor do joelho são lesões raras e graves e na maioria dos casos estão associadas a fatores de risco. O reparo cirúrgico precoce e a instauração de um programa de reabilitação intensiva para rupturas bilaterais do tendão extensor do joelho podem levar resultados funcionais satisfatórios a médio e longo prazo, apesar dos níveis não negligenciáveis de dor residual, fraqueza muscular no quadríceps e atrofia.

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Introduction

The knee extensor apparatus encompasses two tendons, quadriceps and patellar, and the patellar bone. Unilateral ruptures are quite common, as opposed to the rare bilateral knee extensor ruptures. This is highlighted by the fact that the latter have only been published in the form of case reports or small series. Bilateral knee tendon extensor apparatus ruptures are serious and disabling injuries, mostly associated with risk factors. They are frequently reported as difficult to treat injuries, demanding long recovery periods.¹⁻¹⁰ This paper reports on our centre's experience treating patients with bilateral knee tendon extensor ruptures and represents the largest series published to date. The aim of this study is to provide information regarding prognosis on various clinical outcomes of these patients, increasing our understanding of the natural history of this rare clinical presentation. Also we hope our results may help clinicians identifying patients at risk, leading to the introduction of preventive measures.

Methods

Medical records were retrospectively reviewed and 7 patients were identified and included in our study. They had all been previously submitted to surgery due to total bilateral knee tendon extensor rupture (time between surgery and

clinical evaluation – average: 5.29 years; range 1–8 years). All patients were summoned and evaluated by the same examiner after a minimum of 1-year post-surgery. Clinical examination included range of motion (ROM) assessment and the application of Kujala score.¹¹ Additionally a satisfaction index (scale 0–5: 0 – insatisfied to 5 – totally satisfied), the presence of residual symptoms and its characterization were assessed. Radiographic evaluation aimed at detecting the presence of patellofemoral arthritis using Merchant patellar view and measuring patellar height with Insall–Salvati ratio.^{12,13} For statistical analysis we used SPSS (version23, IBM Corp, Armonk, New York) with the level of significance set at 0.05. Quantitative measures are presented as mean \pm standard deviation (SD; minimum value–maximum value) and qualitative measures with total number (n) or percent (%). We used Mann–Whitney test for comparing quantitative and Chi-square test for qualitative data. To study the association between quantitative outcomes we used Spearman correlation test.

Results

Demographic and injury characterization data

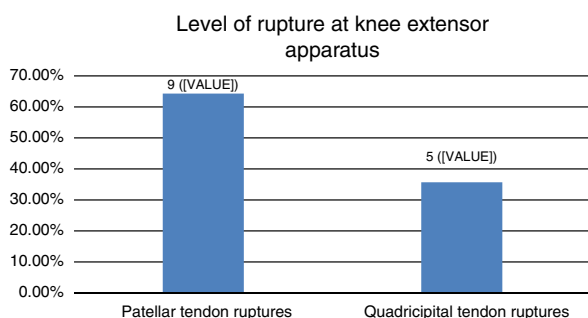
The sample includes seven patients, corresponding to a total of 14 ruptures (Table 1). The mean age was 46.43 ± 14.84 years

Table 1 – Demographic data of the 8 patients included in the series.

Patient	Age at the time of injury	Diagnosis	Rupture location	Rupture timing	Mechanism	Presence of risk factors for rupture of knee tendon extensor apparatus
1 M	35	Right patellar tendon rupture	Intrasubstance	Simultaneous	Knee flexion and sudden contraction of the quadriceps	Yes
		Left patellar tendon rupture	Intrasubstance	Simultaneous	Knee flexion and sudden contraction of the quadriceps	Yes
2 M	40	Right patellar tendon rupture	Intrasubstance	Simultaneous	Knee flexion and sudden contraction of the quadriceps	Yes
		Left patellar tendon rupture	Intrasubstance	Simultaneous	Knee flexion and sudden contraction of the quadriceps	Yes
3 M	45	Right patellar tendon rupture	Intrasubstance	Simultaneous	knee hyperflexion	No
		Left patellar tendon rupture	Intrasubstance	Simultaneous	knee hyperflexion	No
4 M	41	Right quadriceps tendon rupture	Myotendinous junction	Simultaneous	knee hyperflexion	Yes
		Left patellar tendon rupture	Patellar bone insertion	Simultaneous	knee hyperflexion	Yes
5 M	78	Right quadriceps tendon rupture	Patellar bone insertion	Isolated	Excessive rotational movement of the knee	Yes
		Left quadriceps tendon rupture	Patellar bone insertion	Isolated	Excessive rotational movement of the knee	Yes
6 F	36	Right patellar tendon rupture	Intrasubstance	Isolated	Excessive rotational movement of the knee	Yes
		Left patellar tendon rupture	Intrasubstance	Isolated	Excessive rotational movement of the knee	Yes
7 M	50	Right quadriceps tendon rupture	Myotendinous junction	Simultaneous	Knee flexion and sudden contraction of the quadriceps	Yes
		Left quadriceps tendon rupture	Myotendinous junction	Simultaneous	Knee flexion and sudden contraction of the quadriceps	Yes

M, male; F, female.

(35–78 y) and 85.71% were male. The most common injury was patellar tendon rupture ($n = 9$; 64.29%), followed by quadriceps tendon rupture ($n = 5$; 35.71%) (Fig. 1). With the sole exception of an individual with right patellar tendon and left quadriceps

**Fig. 1 – Level of rupture at knee extensor apparatus.**

tendon ruptures, all other injuries occurred bilaterally in the same structure. Patients were older in quadriceps tendon ruptures (59.5 ± 17.4 ; $p = 0.004$) as well as in ruptures occurring at the myotendinous junction (65.7 ± 21.4 ; $p = 0.021$) comparing with patellar tendon (39.2 ± 4) and intrasubstance tendinous ruptures (39.0 ± 4.2). The majority of the bilateral ruptures happened simultaneously (Table 1). There were two exceptions, with isolated unilateral ruptures being separated by a short period of time. Falls were the causative mechanism in 57.14% of the cases. All tendon ruptures were attributed to indirect traumatism: 3 cases of knee flexion coinciding with sudden contraction of the quadriceps; 2 cases of excessive rotational movement of the knee; 2 cases of knee hyperflexion. Regarding the level of the rupture, intrasubstance was more frequent (57.14%), followed by myotendinous junction (21.43%) and patellar bone insertions (21.43%). All intrasubstance ruptures took place in patellar tendons and all myotendinous junction ruptures occurred in quadriceps tendons. Risk factor

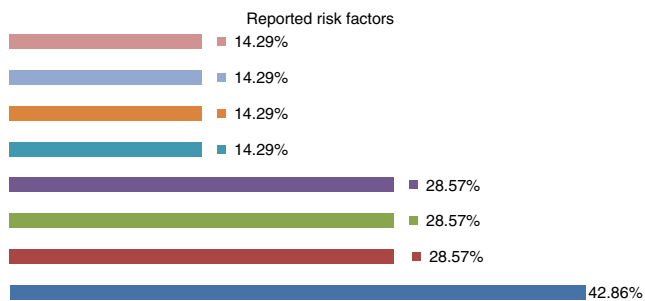


Fig. 2 – Reported risk factors of a case series of bilateral ruptures of the knee tendon extensor apparatus.

profile evaluation revealed that 85.71% of the sample suffered from diseases that are recognized risk factors for tendinous degeneration and rupture, 57.14% had history of drug use and/or abuse, 42.86% had both disease and drug use history. There was only 1 healthy patient without known risk factors. Corticotherapy (42.86%) and anabolic steroid use (28.57%) were the main recognized consumptions. Chronic kidney injury undergoing haemodialysis (28.57%), hypercholesterolaemia (28.57%), hyperuricemia (14.29%), rheumatoid arthritis (14.29%), systemic lupus erythematosus (14.29%) and osteogenesis imperfecta (14.29%) were the identified predisposing diseases (Fig. 2). All quadriceps tendon ruptures occurred in patients with known disease. On the other hand, patellar tendon ruptures were more closely related to drug use (66.7% of drug use and/or abuse versus only 40% in quadriceps tendon ruptures).

Treatment performed

Mean waiting time for surgery was 51.3 hours (5–120 h). Surgical repair was the treatment of choice in all patients (Table 2).

Employed techniques were end-to-end suture (50%), transosseous suture (28.57%) and tenodesis with suture anchors (21.43%). Cerclage protection wire was used in 3 patellar tendon ruptures with 7.3 months being the mean time to removal. Mean immobilization time post-surgery was 48.43 days (42–70), followed by rehabilitation program under physiotherapist support, which included initially isometric muscle strengthening and progressive knee flexion and strengthening exercises.

Outcomes

Mean attained values for flexion ROM (Table 3) were $124.64^{\circ} \pm 9.43$ (110–140°) and 89.57 ± 6.02 (78–94) in Kujala score. Full extension ROM was observed in all except one of the knees, while the remaining displayed a 5° deficit or less. Concerning the satisfaction index 28.57% chose grade 4 and 71.43% grade 5. Signs of patellofemoral arthritis were not identified in this sample, and there were 2 knees with patella baja in the same patient with patellar tendon ruptures (Insall-Salvati ratio = 1.25 and 1.3). Age demonstrated a significant inverse correlation with knee flexion ROM ($\rho = -0.60$; $p = 0.022$).

When comparing quadriceps with patellar tendon ruptures we noticed lower flexion ROM ($116^{\circ} \pm 5.5$ vs $129.4^{\circ} \pm 6.8$) and superior Kujala scores (94 ± 0 vs 87.1 ± 6.3) in patients who suffered from quadriceps tendon ruptures, although the differences were non-significant. Ruptures at the intrasubstance level were associated with lower Kujala score (86.3 ± 6.2 ; $p = 0.039$) when compared with ruptures at the myotendinous junction (94 ± 0) or at the bone insertion level (94 ± 0). However, they presented a significantly superior flexion ROM ($130.6^{\circ} \pm 6.2$; $p = 0.006$) when compared with ruptures at the myotendinous junction ($113.3^{\circ} \pm 5.8$). Those who had no predisposing disease attained superior flexion ROM ($135^{\circ} \pm 4.1$; $p = 0.002$) compared with the ones who did ($115.4^{\circ} \pm 13.4$). We

Table 2 – Specificities of the treatment performed to each of the 8 patients included in the series.

Patient	Surgical repair	Cerclage protection wire	Immobilization time (days)	Time between injury and surgery (hours)
1 M	End-to-end suture	Yes	45	5
2 M	End-to-end suture	Yes	45	5
3 M	End-to-end suture	No	42	72
4 M	End-to-end suture	No	42	72
5 M	End-to-end suture	Yes	56	96
6 M	End-to-end suture	Yes	56	96
7 M	End-to-end suture	No	42	120
8 F	Tenodesis with suture anchors	Yes	42	120
9 M	Tenodesis with suture anchors	No	70	120
10 M	Tenodesis with suture anchors	No	70	120
11 F	End-to-end suture	No	42	96
12 M	End-to-end suture	No	42	96
13 M	End-to-end suture	No	42	6
14 M	End-to-end suture	No	42	6

Table 3 – Outcomes of each of the 7 patients included in the series.

Patient	Time between injury and evaluation (years)	Flexion ROM (degrees)	Extension lag (degrees)	Kujala Score	Insall-Salvati ratio	Residual pain	Quadriceps weakness feeling	Quadriceps atrophy	Satisfaction index (0-5)
1 M	1	135	No	94	1.1	Yes	Yes	Yes	4
2 M	1 8	135 126	No No	94 88	0.8 1.05	Yes Yes	Yes Yes	Yes Yes	4 4
3 M	8 7	134 140	No No	88 78	1.08 0.88	Yes No	Yes No	Yes No	4 5
4 M	7 4	130 116	No No	78 94	0.95 1	No No	No No	No Yes	5 5
5 M	4 8	124 110	No Yes-3	94 94	1 0.8	No Yes	No Yes	Yes No	5 5
6 F	8 4	110 125	No No	94 85	1.1 1.25	Yes Yes	Yes Yes	No Yes	5 5
7 M	4 5	120 117	No No	85 94	1.3 0.9	Yes No	Yes No	Yes No	5 5
	5	123	No	94	0.9	No	No	No	5

found no differences in the functional results achieved with different surgical techniques and different immobilization periods.

Complications

More than half of the patients (57.14%) complained of residual pain and quadriceps weakness, symptoms elicited mainly by long periods of standing or walking, climbing and descending stairs and squatting. Nonetheless all patients denied important functional impairment in daily activities. The prevalence of residual pain was found to be superior in patellar tendon ruptures (66.7%), ruptures at the intrasubstance (75%) and myotendinous junction (66.6%) levels, although not reaching statistical significant differences. Mean age was significantly inferior (47.3 ± 19.1 vs 54.5 ± 17.3 ; $p = 0.038$) in the individuals who complained of residual pain. Thigh atrophy auto-perception was claimed in 8 ruptures, corresponding to 7 patellar tendon ruptures and 1 quadriceps tendon rupture.

Discussion

It takes a strength that is 17.5 times superior to our own body weight to cause rupture of a healthy patellar tendon. However the majority of the ruptures follow minor trauma or happen spontaneously.^{14,15} Kannus and Jozsa¹⁶ reported their findings on 891 patients with spontaneous tendinous rupture emphasizing that all of them had degenerative changes on histopathological examination. Accordingly, most knee extensor apparatus ruptures follow an inflammatory and degenerative process whereby tendon's mechanical properties become severely impaired. This occurs in systemic diseases

(rheumatologic diseases, diabetes, chronic kidney injury, hyperparathyroidism, gout, obesity), local diseases (patellar tendinopathy) and drug use (corticotherapy, anabolic steroids).^{1,2,10,14,17-21} Our series demonstrates a strong association between tendinous ruptures and personal history of disease and/or drug consumption, findings that are consistent with the literature.³⁻⁶

Most injuries were due to falls. As reported by other authors, knee flexion coinciding with sudden contraction of the quadriceps was the most common injury mechanism.^{17,21-23} Higher prevalence of ruptures at the intrasubstance tendon level have been reported previously and attributed to its tendency to degeneration under the influence of disease states or drug use. Instead, healthy tendons tend to tear at myotendinous junction or bone insertion level.^{9,20,23} Quadriceps tendon ruptures are more frequent in patients older than 50 years while patellar tendon ruptures tend to occur in younger individuals. Our findings are corroborated by other researchers.^{1,2,14,21,24}

Early diagnosis and surgical repair are needed to re-establish knee extensor mechanism. Tendon repair, followed by immobilization and rehabilitation have shown good outcomes.^{1,2,19} Cerclage protection wire use in this context is controversial.^{1,9,14,23,24} Although it allows early mobilization it also requires a second surgery for removal.

Clinical and functional results were satisfactory as reflected by near normal ROM and Kujala score. Similar results were found by Chang et al.³ in their work reporting on 5 patients with bilateral quadriceps tendon ruptures. Mean ROM levels attained was 129° flexion and no extension deficits were noted. Mean IKDC (*International Knee Documentation Committee*) score was 71.9 (range 34.4–91.6). Moreover, they did not find significant differences when comparing functional outcomes with the control group of unilateral

tendon ruptures. Provelegios et al.⁴ published the results of a series of 5 patient with spontaneous bilateral quadriceps ruptures. All suffered from CKI and hyperparathyroidism and had excellent functional outcomes.

Siwek et al.²⁵ stated that knee extensor mechanism ruptures must be repaired as soon as possible in order to maximize functional outcomes. They claim that a delay of more than two weeks can seriously compromise primary tendon repair due to retraction. In our series we could not find differences in functional outcomes attributable to different waiting times for surgery. Despite the absence of a healthy contralateral tendon to compare, we only had 14.29% of patellar height abnormal values in the 14 operated knees, assuming Insall-Salvati¹³ ratio normal values between 0.8 and 1.2.

A significant percentage of our patients complained of residual pain and quadriceps weakness. The comparison between patellar and quadriceps tendon ruptures showed that patellar tendon ruptures are more common in younger patients, tend to occur at the intrasubstance level, have superior residual pain and flexion ROM. Pain and quadriceps weakness and atrophy were more common in younger patients with patellar tendon rupture. Noteworthy this is a subset patients who have higher physical demands and superior auto-perception of pain and functional impairment (when compared with their older counterparts). Quadriceps tendon ruptures are more frequent in older patients, which may explain why they have lower flexion ROM but higher Kujala scores (possibly due to lower residual pain).

Present study limitations include its retrospective design, the small size of the sample and a subjective clinical and functional evaluation.

Conclusions

Bilateral knee extensor tendon apparatus ruptures are rare and serious injuries, mostly associated with risk factors. Nevertheless, we and other authors have demonstrated that an early surgical repair and intensive rehabilitation program may warrant satisfactory functional outcomes on medium term, despite non-negligible levels of residual pain, quadriceps muscle weakness and atrophy.

Conflicts of interest

The authors declare no conflicts of interest.

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