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Romanian Journal of Orthopaedic Surgery and Traumatology, Volume 2, Issue 1, January-June 2019. pp:9-17
doi:10.2478/rojost-2019-0003

CASE REPORT

Simultaneous quadriceps and contralateral patellar tendon ruptures in a patient with chronic renal failure following electric shock; a case report and review of the literature

Bilgin Emre*, Vincenten Cornelis, Kati Yusuf Alper***, Kose Ozkan***, Kalenderer Onder***
*Tepecik Training and Research Hospital, Department of Orthopaedics and Traumatology, Izmir, Turkey
**Elisabeth-Tweesteden Hospital, Department of Orthopaedics, Tilburg, Netherlands
***Antalya Training and Research Hospital, Department of Orthopaedics and Traumatology, Antalya, Turkey

Correspondence to: Assoc. Prof. Ozkan Kose, MD, FEBOT,
Antalya Egitim ve Arastırma Hastanesi, Ortopedi ve Travmatoloji Klinigi,
Kazım Karabekir cd. Soğuksu, Muratpaşa, Antalya, Turkey,
Mobile phone: +90 5326422612, E-mail: drozkankose@hotmail.com

Abstract
Bilateral extensor tendon ruptures of the knee are not uncommon. However, simultaneous ruptures of the patellar tendon (PT) and contralateral quadriceps tendon (QT) are relatively rare injuries. These ruptures are frequently associated with chronic renal failure and minor trauma. However, they can occur spontaneously in healthy individuals. In this case report, a 43-year-old male with chronic renal failure who sustained bilateral extensor tendon ruptures (right knee: QT rupture, left knee: PT rupture) following an alternating current electrical shock was reported. To our knowledge, simultaneous quadriceps and contralateral patellar tendon rupture following an electric shock have not been reported yet. Etiology, mechanism of injury and treatment options of this rare injury are discussed together with a thorough literature review.
Keywords: quadriceps tendon rupture, patellar tendon rupture, renal failure, electric shock

Introduction

Although rarely seen, simultaneous bilateral rupture of the extensor tendons of the knee is a well-known injury. There are numerous reported cases with bilateral quadriceps tendon (QT) ruptures or bilateral patellar tendon (PT) ruptures in current literature [1,2]. Clinical characteristics and etiologic factors of QT and PT ruptures differ from each other. PT ruptures are particularly seen in young healthy individuals as a result of acute trauma or repeated microtrauma and overuse. However, QT ruptures are frequently seen in patients older than 40 years of age and usually related to secondary systemic diseases

such as chronic renal failure [1-3]. On the other hand, simultaneous QT rupture on one side and PT rupture on the contralateral side is an extremely rare injury. In our extensive search in English literature, only eleven previous cases with this type of injury were identified up to date (Table 1) [4-14].

Herein, one further case with simultaneous rupture of QT and contralateral PT ruptures has been described. This is the first reported case which happened following an alternating current electrical shock. Etiology, mechanism of injury and treatment options of asymmetric bilateral extensor tendon ruptures are discussed together with a thorough literature review.

Table 1. Previously reported cases with simultaneous QT and contralateral PT ruptures in current English literature. Abbreviations: M = Male, F = Female, NR = Not reported, ROM = Range of motion

Case #	Author	Age	Sex	Mechanism of injury	Predisposing risk factor	Surgical technique	Additional augmentation	Follow-up	Outcome at final visit
1	Loehr and Welsh [**4**] 1983	27	M	While light lifting	Chronic renal disease (6 years hemodialysis)	Primary repair with Bunnell -type suturing	NR	6 months	Full ROM in both knees and returned to the work
2	Munshi et al. [**5**] 1996	47	M	While squatting	Healthy	Primer repair with absorbable sutures	None	22 weeks	Full flexion in both knees
3	Rogers et al. [**6**] 2003	47	M	Fall down while running	Healthy	NR	NR	NR	NR
4	Muratlı et al. [**7**] 2005	21	M	Fall down from standing level	Chronic renal failure (7 years hemodialysis)	Primary repair with suture anchors	Quadriceps and patellar tendon with cerclage wire	18 months	Able to walk and 0°-120° ROM in both knees
5	Chen et al. [**8**] 2006	30	M	Spontaneous	Chronic renal failure (9 years hemodialysis)	Primary repair with nonabsorbable sutures through drill holes	Quadriceps and patellar tendon with nonabsorbable sutures	2 years	Returned to full daily activity QT strength 5/ 5 for both knees 0°-140° ROM in right knee 0°-130° ROM in left knee
6	Jalgaonkar et al. [**9**] 2008	41	F	Spontaneous	Healthy	Primary repair with suture anchors	Patellar tendon with cable	6 months	Able to walk with pain free and 0°-100° ROM in both knees
7	Grecomoro et al. [**10**] 2008	48	M	Spontaneous	Chronic renal failure (2 years hemodialysis)	Primary repair with nonabsorbable sutures through drill holes and additional V-Y lengthening of quadriceps	None	12 months	Excellent results in terms of pain and movement 0°-110° ROM in both knees
8	Kumar et al. [**11**] 2010	48	M	Exposure to sudden weight on back	Healthy	Primary repair with nonabsorbable sutures	Patellar tendon with figure eight absorbable sutures	28 weeks	Able to walk and returned to the normal daily activity 0°-115° ROM in right knee 0°-120° ROM in left knee
9	Karadimas et al. [**12**] 2011	67	M	Spontaneous	Systemic Lupus Erythematosus	Primary repair with nonabsorbable sutures	Patellar tendon with cerclage wire	2 years	Able to walk 0°-100° ROM in right knee 0°-110° ROM in left knee Oxford knee score is 15 for both knees (excellent)
10	Zabala et al. [**13**] 2012	31	F	Spontaneous	Chronic renal failure (2 years hemodialysis)	Primary repair with nonabsorbable sutures	None	10 months	Able to walk with pain free 0°-100° ROM in both knees
11	Al-Jawad and Al-Ammari [**14**] 2014	53	M	Fall down from stairs	Chronic renal failure (15 years hemodialysis)	Primary repair with nonabsorbable sutures through drill holes	Patellar tendon with figure of eight cable	18 months	Active extension and full flexion were restored in both knees
12	Current case	43	M	Electric shock	Chronic renal failure (6 years hemodialysis)	Primary repair with nonabsorbable sutures through drill holes, and suture anchor	None	6 months	Returned back to previous level of activity, Lysholm knee score right: 94, Left: 92 (Excellent for both knees)

Case Report

A 43-year-old male electrician was brought to our emergency service with bilateral knee pain and unable to walk after he was exposed to electric shock while repairing the electrical water pump in a greenhouse. The patient was conscious and the vital signs were stable on the admission to the hospital. The patient reported that he was kneeling on the ground with his right knee in extreme flexion and contacting on the ground, but his left knee was about 900 of flexion just before the electrical shock threw him back.

Past medical history revealed that the patient was suffering from chronic renal failure, and has been receiving hemodialysis twice a week for the last 6 years. On physical examination, no skin lesion or burn was observed on his body. Cardiac monitoring and fluid resuscitation were started immediately. Normal sinus rhythm was observed on his electrocardiogram. The orthopedic examination revealed serious hematoma and ecchymosis in both knee joints (Fig. 1). A palpable gap and tenderness were noted in the infrapatellar region at the left knee and suprapatellar region at the right knee. Active extension of the knee was absent on both sides. Neurovascular examination of the lower extremity was otherwise normal.

Fig. 1 Clinical appearance of the patient. Ecchymosis and hemarthrosis can be observed on both knees

Direct radiographic examination of the knee joints showed patella alta on the right side and patella baja on the left side. Fleck, like small fragments, was hardly seen on both lateral knee radiographs (Fig. 2). In order to understand the origin of these fragments, computerized tomography (CT) examination was performed. On CT examination, it was confirmed that fragments were avulsed from the superior pole of the patella on the right, and inferior pole on the left side (Fig. 3). No other bony injury was observed. Thereafter, extensor tendon injury was strongly suspected and magnetic resonance imaging (MRI) was performed for both knees. MRI clearly demonstrated the complete rupture of the QT on right knee and rupture of PT on the left knee from their patellar insertions. Soft tissue lesions such as meniscal and ligamentous injuries were excluded based on MRI examination (Fig. 4). The knee joints were aspirated because of the severe hemarthrosis and above knee splints were applied to both legs. Surgical intervention was planned for tendon injuries. Because the patient had chronic renal failure, the anesthesiologist and nephrologist evaluated the patient before the surgery. Complete blood count showed anemia. In laboratory tests; creatinine 3.45mg/ dL, blood urea nitrogen 22 mg/ dL, parathyroid hormone (PTH) 314 pg/ mL, 25-hydroxy vitamin D 9 ng/ mL were identified. After receiving a hemodialysis session, the patient underwent surgery 24 h after the trauma.

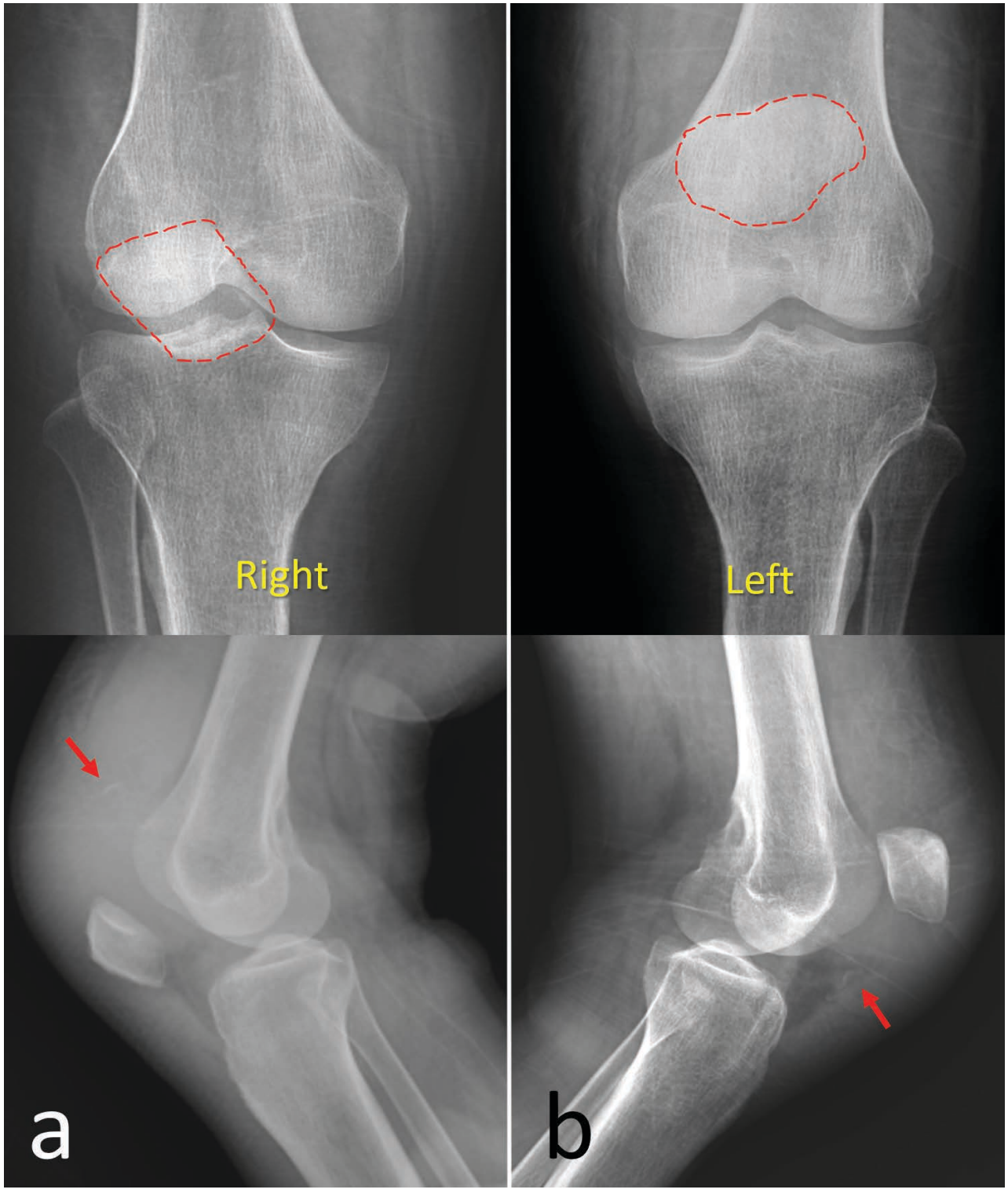

Fig. 2 Anteroposterior and lateral direct radiographs of right (a) and left (b) knees. Patella baja at right knee (red dotted circle), and patella alta at left knee is observed. On lateral views, small avulsion fractures are observed (red arrows).

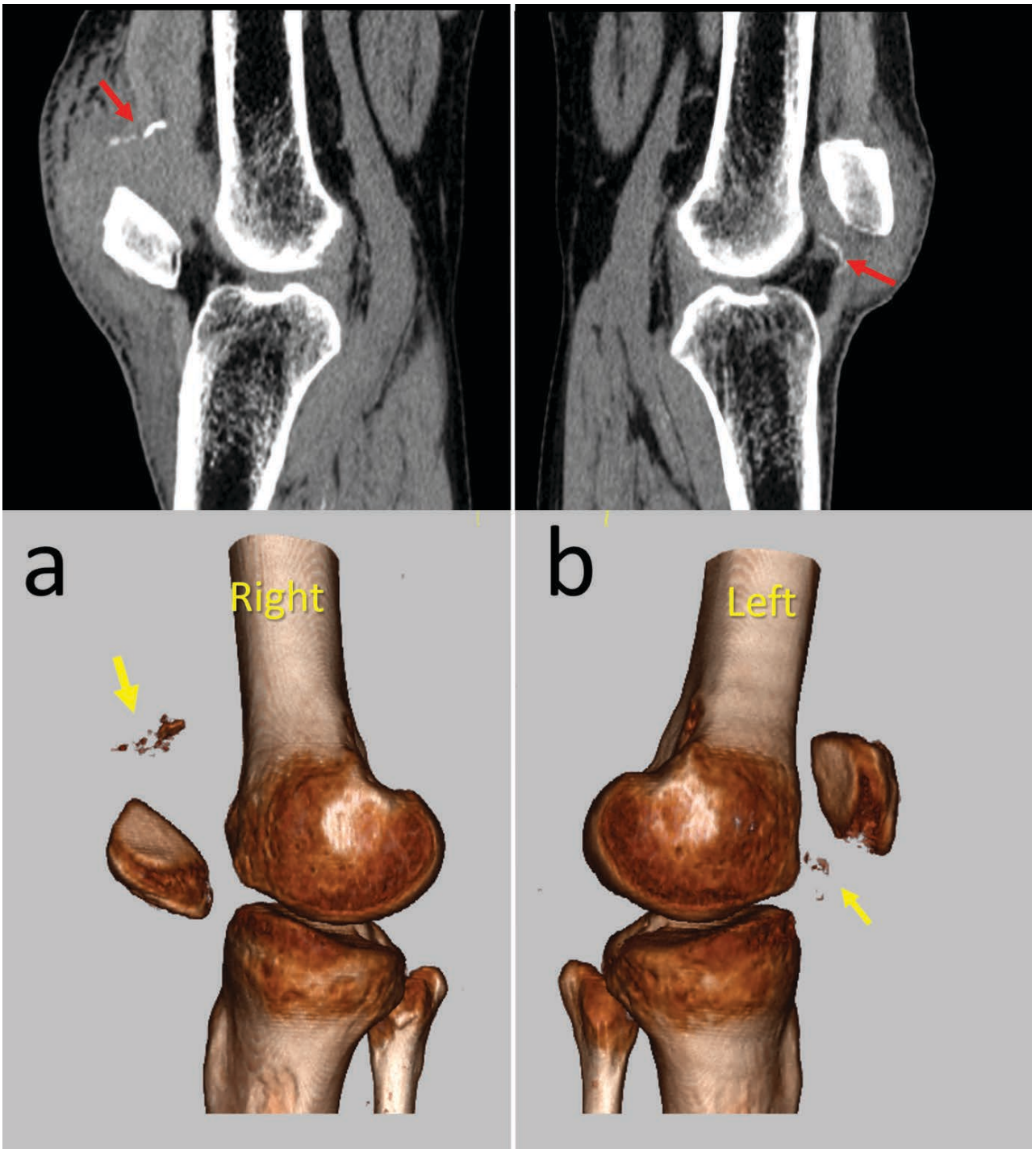

Fig. 3 Sagittal and 3D CT images of both knees. The avulsion fractures from superior pole of right patella on right and inferior pole of left patella are clearly observed (arrows).

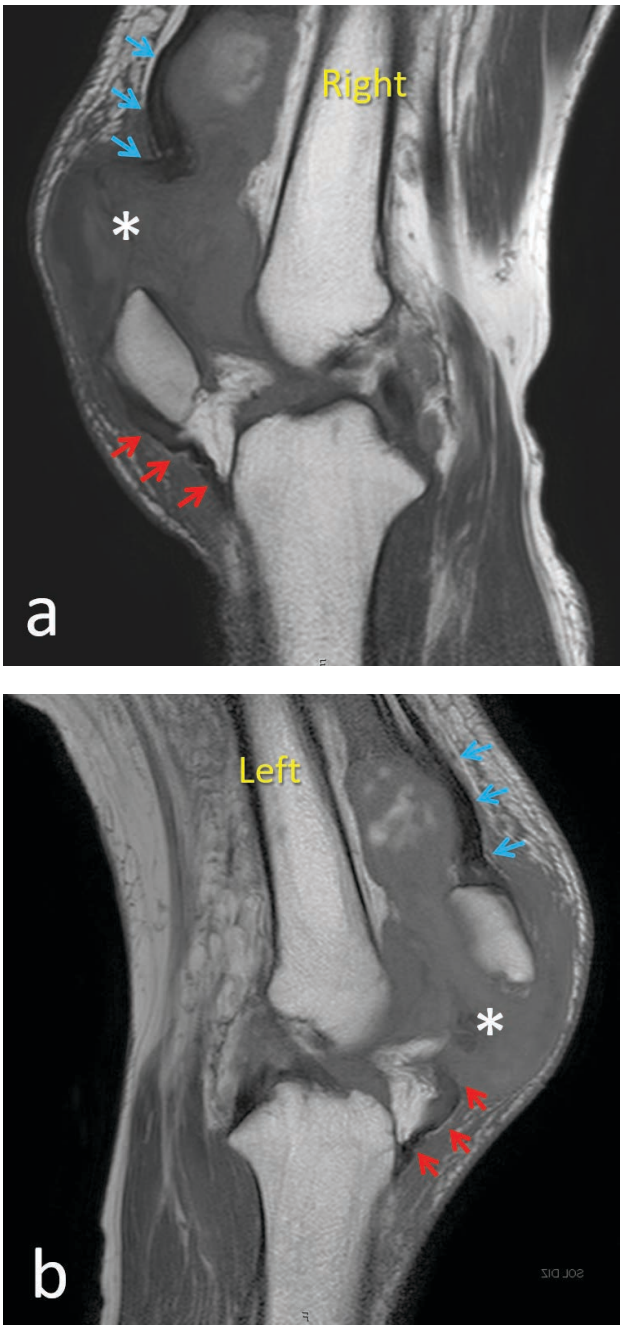

Fig. 4 T1 weighted sagittal MRI of right and left knees. Asterix denotes the site of ruptures. Blue arrows show the QT, and the red arrows show the patellar tendon on both sides.

Surgical technique

Under spinal anesthesia and tourniquet control, a longitudinal midline incision was used in both knees. On the left side, the PT was found totally and irregularly ruptured from its patellar bone margin (Fig. 5). The tendon edges were refreshed and Krakow technique was performed for tendon sutures with No. 5 non-absorbable sutures. The sutures were passed through the 4 bone tunnels, which were drilled by 2.5mm K-wires and then tightened. On the right knee, total rupture of the QT was observed at the osteotendinous junction. The tendon edges were refreshed and primary repair was performed with No. 5 non-absorbable after preparing 3 bone tunnels on the patella via the similar technique. Medial retinaculum and the medial side of the QT were repaired by inserting a 5 mm metallic anchor on the superomedial edge of the patella. Because it was an acute, lengthening was not required for the quadriceps tendon repair. Both tendon repairs were observed as stable and additional augmentation with cerclage wire was not required to support the repairs.

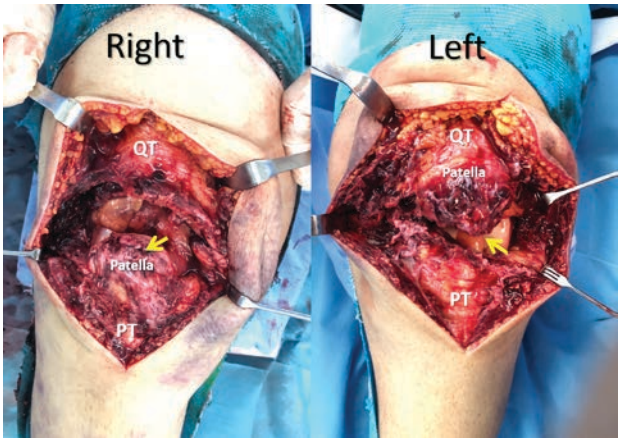

Fig. 5 Intraoperative appearance of right (a) and left (b) knees. Yellow arrows show the site of rupture.

Postoperative care

Post-operatively, both lower extremities were immobilized in adjustable hinged knee braces. Partial weight bearing was allowed with two crutches as tolerated. Gradually increasing and controlled range of motion, and quadriceps strengthening exercises were immediately started and continued until the 8th week. At the end of the 8th week, 1200 of flexion and full weight bearing were achieved. The braces were removed at 8th week after the surgery. After 6 months, the patient was able to walk without any support and fully extend both knees (Fig. 6). The degree of flexion was 1200 and 1300

on the right and left knee respectively. Knee extension strength was 5/ 5 on both sides. At the final follow-up, Lysholm knee score was 94 and 92 points for right and left respectively.

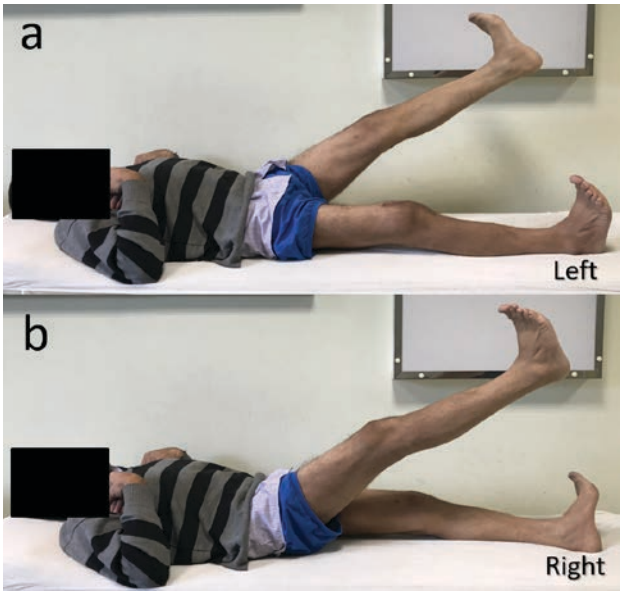

Fig. 6 Final clinical follow-up at the 6th month. Full extension was obtained in left (a) and right (b) knees.

Discussion

Various injury mechanisms and associated risk factors have been reported in simultaneous extensor tendon ruptures. Although the pathogenesis is not clear in detail, the most commonly seen predisposing risk factor is chronic renal failure followed by other systemic inflammatory disorders that affect the quality of tendons such as rheumatoid arthritis, gout, chronic steroid intake, and fluoroquinolone use. It is proposed that phosphate retention (hyperphosphatemia) and reduced synthesis of 1,25 (OH_2) Vit D causes hypocalcemia and eventually result in secondary compensatory hyperparathyroidism in chronic renal insufficiency. Increased PTH levels in uremic patients activate osteolysis at the osteotendinous junction and predispose to tendon ruptures [4,10,15]. Furthermore, deposition of beta-2 microglobulin in tendons as a complication of long-term hemodialysis decreases the elasticity of the tendons and leads to ruptures following even the presence of minimal stress [16]. In our review, six out of eleven patients (more than half of the cases) were suffering from chronic renal failure and were receiving hemodialysis. Similarly, the presented case had hyperparathyroidism and had been receiving hemodialysis for six years. However, apart from current literature, our patient sustained this injury following an electric shock. Of course, the patient already had a significant underlying risk factor, but forceful tetanic muscular contractions due to the alternating current resulted with this injury. Typically, the location of ruptures in our case was at the level of osteotendinous junctions.

Simultaneous tendon ruptures can also occur in healthy subjects without carrying a predisposing risk factor. However, most of these ruptures occurred following a traumatic event. Kumar et al. [11] reported a 48-year-old healthy man whose knees gave away after someone had jumped on his back during a fight. Munshi and Mbubaegbu [5] reported a healthy weight lifter who felt pain on his knees while he was squatting the weight over his shoulders just before he pushed it up. They stated that the weakness of PT was associated with repetitive stress during sports activity, and QT rupture was associated with age-related tendon degeneration. Rogers et al. [6] reported another simultaneous rupture in a healthy individual who fell down while he was running. They tried to explain why QT in one side and PT in other side was ruptured in their cases. According to their hypothesis, this injury pattern is mainly related to the position of the knees. As the sudden contraction of the patient's extended left knee caused to the patellar tendon rupture, and the relatively increased forces on flexed right knee due to changed slope caused to the quadriceps rupture. Probably, this mechanism explains both our patient's injury and the other similar conditions in literature. Our patient was working on his right knee with complete flexion while his left knee was about 90 degrees of flexion before he exposed to the electrical

shock. The alternating current contracted his leg muscles and his 90-degree flexed left knee pushed him back with full extension and completely flexed right knee came to about 90 degrees of flexion and forces directly loaded to the quadriceps tendon via a changed slope.

Musculoskeletal injuries after electrical shock vary from fractures and joint dislocations to tendon ruptures. The electrical resistance is highest in bones, and then follows with tendons and muscles among the musculoskeletal structures. Tetanic contractions frequently cause the fractures and dislocation of large joints. However, tendon ruptures are uncommon injuries after electric shock [17]. Butler and Gant et al. [17] reported only one case of a rupture of the long head of biceps tendon, which was related to the electrical injury in their series with 188 patients. Bhaskaran and Dharmarajan [18] reported a 67-year-old woman with Achilles tendon rupture after exposing electrical shock while using a hairdryer. The late rupture of the flexor profundus of the index finger has also been defined over 15 years after electrical injury [19]. To our knowledge, this is the first case report on the simultaneous patellar and the contralateral quadriceps tendon rupture related to the electrical shock in literature.

Early surgical repair is the gold standard treatment for knee extensor ruptures [3-14]. Early and primary repair of the tendons via patellar bone tunnels with nonabsorbable sutures is the most preferred surgical method. Suture anchors can also be used to prevent a possible fracture during drilling through the patella [7]. Moreover, augmentation with cerclage wires or cables can be performed to support the repairs [7,9,12,14]. However, it may require further surgery to remove the hardware after complete tendon healing. In our patient, tendon repairs were performed with No. 5 non-absorbable sutures through the patellar bone tunnels and 5mm suture anchor was inserted into the superomedial corner of the left patella to repair the medial side of the patellar tendon and medial retinaculum. Because the repairs were found to be stable and strong, augmentation was not required in our patient. The results of surgical repair were quite satisfactory in the reported literature [4-14]. Flexion degrees of the knees vary between 1000 to 1300 in the final follow-ups. Our patient had 1200 of flexion on the right side and 1300 on the left side at the end of the 6th month in accordance with literature.

Conclusion

We believe that the main predisposing factor of this injury pattern was the degeneration of osteotendinous junctions due to secondary hyperparathyroidism and hemodialysis-associated amyloidosis in our patient. However, the strong muscle contractions due to the electrical shock lead to tendon ruptures in already degenerated tendons. In addition, simultaneous rupture of the opposite structures is strongly related to the position of the knees at the time of the injury. The extended knee sustained PT rupture whereas the flexed knee sustained QT rupture. Performing an immediate surgery prevented the problems related to delayed surgery such as muscle shortening and satisfactory outcomes that could be obtained without an augmentation.

Conflict of interest

None.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Informed consent

Informed consent was obtained from the patient for the publication of his medical records and images.

Authorization for the use of human subjects

Ethical approval: The research related

to human use complies with all the relevant national regulations, institutional policies, is in accordance with the tenets of the Helsinki Declaration, and has been approved by the authors' institutional review board or equivalent commitee.

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