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QUADRICEPS TENDON INJURIES

POVREDE TETIVE ČETVOROGLAVOG MIŠIĆA BUTA

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Summary

Introduction. The aim of study was to analyze risk factors, mechanisms of injury, symptoms and time that elapsed from injury until operation of complete quadriceps tendon ruptures. **Material and Methods.** This retrospective multicenter study included 30 patients operated for this injury, of whom 28 (93.3%) were men. The average age was 53.7 years (18-73). Twenty-six patients had reconstruction of unilateral rupture and four of bilateral one. **Results.** Eighty percent of them had some risk factors for rupture of the tendon with degenerative changes. Eight patients had diabetes, seven patients were on renal dialysis, two patients had secondary hyperparathyroidism, five patients were obese and two patients had former knee operations. These injuries occurred in 80% following minor trauma caused by falls on stairs, on flat surfaces and squatting. The most frequent symptoms were: pain, swelling, lack of extension of knee and defect above patella, and three cases were initially misdiagnosed. During the first 10 days after injury, acute and chronic ruptures were reconstructed in 22 (73.3%) and 8 patients, respectively. **Conclusion.** Quadriceps tendon injuries most often happen to male patients with predisposing conditions in their fifth and sixth decade of life due to trivial trauma. Patients on renal dialysis are the most vulnerable population group.

Key words: Tendon Injuries + etiology; Quadriceps Muscle; Risk Factors; Male; Diagnosis

Sažetak

Uvod. Cilj studije bila je analiza predisponirajućih faktora rizika, mehanizama povređivanja, simptoma i vremena proteklog od povrede do operacije, kompletnih prekida tetive četvoroglavog mišića buta. **Materijal i metode.** Retrospektivnom multicentričnom studijom, obuhvatili smo 30 operativno lečenih pacijenata sa navedenom povredom. Među njima 28 (93,3%) bilo je muškog pola, a prosečna starost iznosila je 53,7 godina (18–73). Kod 26 pacijenata izvršeno je operativno lečenje jednostrane rupture, kod četiri pacijenta – obostrane. **Rezultati.** Kod 80% ispitanika postojao je neki od faktora rizika za pucanje degenerativno izmenjenih tetiva. Osam pacijenata je imalo šećernu bolest, sedam su bili na dijalizi zbog hronične bubrežne insuficijencije, petoro su bili gojazni, dva su imali sekundarni hiperparatiroidizam, dva prethodne operacije zgloba kolena. Bezazlenim padovima na stepeništu, okliznućem i pri čučnju povređeno je 80% pacijenata. Najčešći simptomi bili su: bol, otok, nemogućnost opružanja potkolenice i defekt iznad čašice, ali je ipak došlo do tri (10%) početno previđena slučaja. Tokom prvih deset dana nakon povrede rekonstruisana je sveža povreda kod 22 pacijenta (73,3%), a zastarela kod 8. **Zaključak.** Povrede tetive četvoroglavog mišića buta češće se dešavaju kod muškaraca u petoj i šestoj deceniji života, bezazlenom traumom, sa predisponirajućim oboljenjima. Najrizičniji deo populacije za povredu ove tetive su dugogodišnji pacijenti na bubrežnoj dijalizi.

Cljučne reči: Povrede tetiva + etiologija; Butni mišić; Faktori rizika; Muško; Dijagnoza

Introduction

Quadriceps femoris muscle is the largest muscle of anterior group of thigh muscles. It is a part of extensor mechanism of knee joint [1] and consists of four muscles (rectus femoris, vastus medialis, vastus lateralis and vastus intermedius). They begin from the pelvis, anterior surface of femur and intermuscular septa and end on the patella as

conjoined quadriceps tendon. The distal end of extensor mechanism is the patellar tendon extending from the pole of patella to the tibial tubercle.

This muscle has an important function in the knee motion. Fibers rupture and tendon retraction can cause a limited range of motion, stiffness, arthritis and disability in patients [2,3]. Partial ruptures are most common and they are usually treated non-operatively, with cylinder casts [2,3]. Com-

plete ruptures of the quadriceps tendon usually occur in patients older than 40 years [2,3]. Bilateral ruptures are highly correlated with systemic diseases [2-4]. Since these injuries are rather rare and often misdiagnosed, surgical treatment is usually delayed and thus the repair is more difficult and post-operative results may be compromised [2-4].

The aim of study was to emphasize the importance of early diagnosis and to analyze risk factors, mechanisms of injury, symptoms and diagnostic methods for quadriceps tendon ruptures.

Material and Methods

This retrospective study was performed at general hospitals in Subotica and Zrenjanin and Clinical Centre of Vojvodina in Novi Sad from 2002 to 2011 and it included 30 patients operated for complete ruptures of the quadriceps tendons. The data were collected from patients' discharge lists and questionnaires.

Generally speaking, men are more commonly affected so the study sample consisted of 28 (93.3%) men and only two women. Their average age was 53.7 years. The youngest and the oldest patients were 18 and 73 years old, respectively. At the moment of injury, 26 patients (86.7%) were older than 40 years, with the peak incidence during the fifth and sixth decades of life (53.3%) (Graph 1).

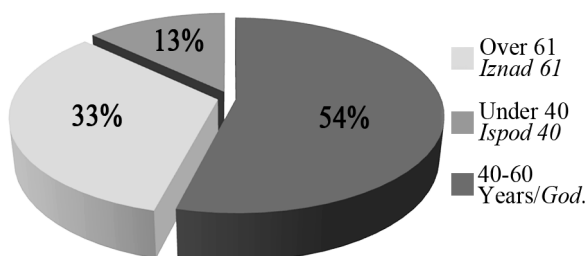
We performed 26 reconstructions of unilateral ruptures (86.7%). The left leg was injured in 16 cases, and the right one in 10. Four patients (13.3%) had simultaneous bilateral injuries.

The study excluded the patients with partial ruptures, and those who were treated non-operatively, or who had died in the meantime (two of them).

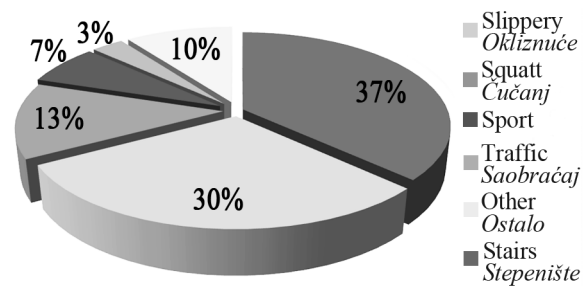
The results were analyzed, compared and presented in graphs.

Results

By analyzing causes of quadriceps tendon ruptures, we found that nine injuries had been caused by falls from the stairs and three by other types of falls, nine by sliding on flat surfaces, four by squatting, two occurred in recreational sports activities (volleyball, bicycling) and one in traffic accident (Graph 2).



Graph 1. Age groups of injured patients
Grafikon 1. Starosne grupe povredjenih pacijenata



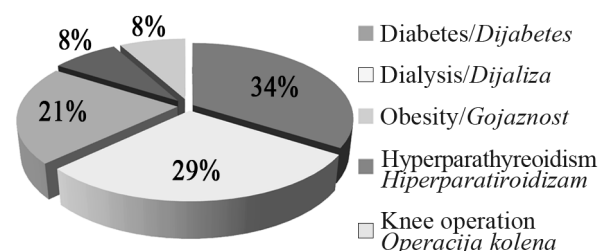
Graph 2. Causes of quadriceps tendon injuries
Grafikon 2. Uzroci povređivanja tetive četvoroglavog mišića

Eighty percent of them were injured by trivial trauma resulting from falls. The common mechanisms of trauma included a stumble, a simple fall, falling from the stairs or from a height.

Twenty-four patients (80%) had some of the risk factors for rupture of tendons with degenerative changes. Eight patients had diabetes, seven patients suffered from severe renal diseases, five patients were obese, two patients had secondary hyperparathyroidism and two patients had former knee operations (patellar fracture and total knee replacement) (Graph 3).

Diabetes and chronic renal failure dominated among metabolic diseases. They were recorded in every other case. The patients who had been waiting for kidney transplantation between 4 and 8 years were at higher risk of getting injured which was proportional to the length of period they were on dialysis.

General Hospitals in Subotica and Zrenjanin and Clinical Centre of Vojvodina in Novi Sad cover the territory with a population of about one million people. Complete ruptures of quadriceps tendon are rare and only three patients are operated per year on average in this region. In these three regions of Vojvodina province there are 379 patients with chronic renal disease undergoing renal dialysis [5] and the incidence of getting injured among them is 0.7 patient a year, whereas the annual incidence in general population is 0.3/100.000. However, it is higher among the diabetics (8/100.000) and the highest incidence is in patients with chronic renal failure (185/100.000). It can be concluded that a patient on dialysis is at 555 times higher risk for tendon rupture than other people.



Graph 3. Risk factors for quadriceps tendon injuries
Grafikon 3. Faktori rizika za pucanje tetive četvoroglavog mišića

In our study sample, acute rupture was reconstructed in 22 patients (73.3%) within the first 10 days after injury, whereas 8 patients were operated for chronic rupture (1-9 months after rupture). Among delayed operated ruptures, three were initially misdiagnosed. Operations in other five patients were contraindicated at the beginning because of uremia, poor kidney conditions and complications of diabetes.

The most common observed symptoms after the injury were: pain, swelling, lack of extension of knee and defect above patella. The combination of all these clinical signs was found in 60% of patients. The inability of weight bearing and knee flexion, muscle weakness and other symptoms occurred much more rarely (**Graph 4**).

Ten patients (33%) said that they had felt pain in tendon even before the injury.

Standard initial X-ray examination was performed in all patients, whereas additional diagnostic methods were applied only in three patients (ultrasonography in one and magnetic resonance imaging in two patients).

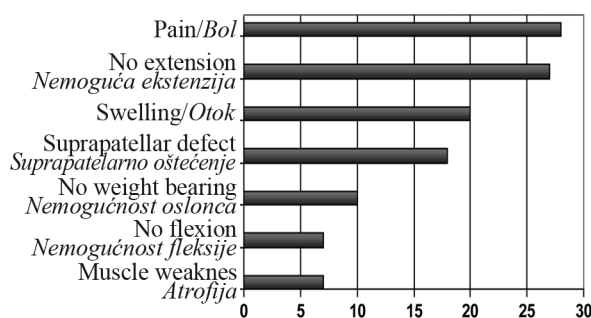
Discussion

Quadriceps tendon ruptures are rare injuries, and they are presented most often as individual case reports [4-15] or reported as small series of 20-39 patients [3,16-18]. Less than a hundred cases of bilateral tendon ruptures have been published in international literature until now [2-4]. We operated 30 patients during the period of ten years, and four of them had simultaneous bilateral ruptures.

An epidemiologic study from the United Kingdom [19] reported an incidence of 1.37/100,000 (partial and complete ruptures) per year, with a mean age of 51 years. The average age in our sample was similar (53.7 years), and the incidence of complete ruptures was much lower due to the lack of data on partial ruptures.

Ruptures of patellar ligament occur in patients under the age of forty, while quadriceps tendon ruptures occur in older patients [1,2,20,21]. Although they can happen in young population [6,7], as it was the case in 13% of our sample, the greatest risk is in the fifth and the sixth decades of life [2,3,22,23]. As it has been shown in our study, men are more commonly affected [3,19,22] for reasons not well described in literature. We assume that reasons lie in increased load on knee joints in men and degenerative changes of tendon in former athletes, who are mostly men in the Republic of Serbia.

The quadriceps tendon is formed by the convergence of all 4 quadriceps muscles just proximal to the superior patella. The tendon has an average thickness of 8 mm and an average width of 35 mm [24]. The superficial layers are well vascularized. In the deep layer, there is an oval, avascular area that is 30 x 15 mm in size. It probably plays a significant role in tendon degeneration [24]. However,



Graph 4. Symptoms of injury
Grafikon 4. Simptomi povrede

quadriceps tendon rupture is rare even among older people. A tendon thickness of >6.1 mm, a superior pole of patella erosion, the patellar enthesophytes and intratendinous calcification are all signs of chronic tendinopathy [24]. This tendon is an inherently very strong structure that is extremely resistant to heavy load. About 50-75% of its fibres need to be severed before it ruptures totally under a physiological load [2]. Rupture usually occurs distally 0-2 cm from the superior pole of the patella through pathologic tissue [25]. Various systemic conditions may cause damage to the tendon vascular supply or may disrupt its structure. Diabetes can cause arteriosclerotic changes in tendon vessels. Fibrinoid necrosis of tendons is seen with chronic synovitis. Hyperparathyroidism causes dystrophic calcifications and subperiosteal bone resorption at the tendon insertion. Obesity causes its fatty degenerative changes [25]. Fatty or fibrinoid degeneration and decreased collagen are seen with normal aging. Kannus and Jozsa [25] examined histopathological changes in 891 ruptured tendons; about 97% of the pathologic changes were degenerative. That is the reason why one third of our sample had previous pain above patella for months before injury.

According to different studies [2,4,22] 30-76% of quadriceps ruptures occur in patients with underlying medical predispositions, and this percentage was even higher in our study (80%). The associated disease had been diagnosed before the injury in all our patients except in those having dysfunction of parathyroid glands. Their condition was diagnosed after surgery when accumulation of calcium was observed in reconstructed tendon. The high level of calcium in serum was decreased after partial removal of parathyroid glands, so heterotopic ossification did not develop further.

It is well documented that many conditions can contribute to degeneration of the quadriceps tendon, including the following: hyperparathyroidism [8], chronic renal failure [9], obesity [25], rheumatoid arthritis [25], diabetes mellitus [25], long term immobilization [23], jumper's knee [2]. Our patients also had these risk factors. Gout, systemic lupus erythematosus, infection, metabolic disease, steroid abuse, tumors and leukemia are also potential risk factors [15,23,25], which were not found

in our study sample. Our patients with chronic renal failure were the most vulnerable group for quadriceps tendon injury. This risk is higher in patients who are on dialysis for longer time, as it was the case in our study sample, when the patients had to wait for kidney transplantation for at least four years.

As other structures of extensor mechanism, quadriceps tendon can also get injured iatrogenically. Rare iatrogenic cases that have been reported are: rupture after total knee arthroplasty [10,26], lateral retinacular release [11], meniscectomy [12], anterior cruciate ligament reconstruction with central-third patellar tendon graft [13,20], local steroid injections [14], knee and patellar dislocations [23]. We had one case of tendon rupture after total knee arthroplasty. The prevalence of a quadriceps tendon tear after this procedure was only 0.1% (twenty-four out of 23,800) [26].

Most of these injuries have been reported to occur spontaneously and after seemingly trivial trauma as a result of an indirect mechanism [2-4,22,23,25]. The mechanisms of trauma include a stumble, a simple fall, falling from the stairs or from a height. Shah et al [22] have reported that 72% of ruptures are caused by falls, which is similar to our results (80%). Most of the injuries occur during an eccentric contraction of the quadriceps against the body weight, when the knee is flexed more than 60 degrees [23]. Other mechanisms of injury include direct blows, lacerations, and iatrogenic causes, which are considerably less frequent [23].

Chronic enthesopathy of the quadriceps can present as an anterior knee pain. The superior pole of the patella is the site of pathology in 25% of patients [2]. Every third patient had this symptom for months before injury. This was attributed to frequent jumping, squatting and kneeling at the beginning, and even at rest in the chronic phase [2]. Symptoms can be detected by X-rays with calcific shadows in tendon. However, the majority of injured do not have previous signs of chronic enthesopathy. Therefore, any underlying predisposing causes must be taken into account. The patients should be specifically asked about any history of systemic disease, steroid use, infection, tumors, or prior surgeries. There may be a history of an audible pop at the time of injury [23,27]. Obvious suprapatellar swelling, ecchymosis, and tenderness, palpable defect in the suprapatellar area and a low-lying patella are usually present. Testing for full, active extension against gravity is the most important aspect of the examination [2,4]. The degree of extension depends on the amount of retinaculum damage. The contralateral knee should be examined to rule out bilateral rupture. According to other authors [3], unilateral ruptures oc-

curred 10-21 times more often than bilateral. This ratio was only 6.5:1 in our study sample. Some other studies [23], including ours [23], have shown that the non-dominant left leg is more often injured, but others disagree with this finding [3].

Profile X-rays show low-lying patella after tendon rupture (patella baja, inferior). X-rays should be made to exclude fractures. Ultrasonography and magnetic resonance imaging are helpful if the diagnosis is questionable and in determining whether the rupture is complete [4,28]. These additional diagnostic methods were not necessary in the majority of our cases. Laboratory analysis should be done prior to surgery, paying special attention to bone, lipid and renal profiles, blood glucose and serum uric acid. We did not have the opportunity to control the level of parathyroid hormones and thus we were unable to prevent heterotopic ossification.

If the patient is not seen in the acute phase, it becomes more difficult to diagnose the rupture. It can easily be missed especially in elderly patients. They were mistreated for strokes, radiculopathy, and myelopathy. Some studies, published forty years ago [27, 29], reported as many as 38-40% of initial misdiagnoses, when quadriceps tendon rupture was misdiagnosed as a neurological condition and less harmful knee injuries [27,29], as it was the case in 10% of our study sample. The incidence of misdiagnosed patients today is much lower because of available modern diagnostic procedures, but clinical examination is still basic for a valid diagnosis. If it is made too late, the intervention is delayed, the repair is more difficult and final results may be compromised [30].

The limitations of this study are connected with the lack of additional diagnostics in the majority of cases. Ruptures can be prevented if risk factors and mechanisms of quadriceps tendon injuries are well defined. Better operative results and early return to everyday activities are achieved if symptoms are recognized in due time and modern diagnostic methods are applied [28].

Conclusion

Quadriceps tendon injuries, although rare, happen to male patients with predisposing conditions (such as chronic renal failure, diabetes, hyperparathyroidism, former knee operations) most often in their fifth and sixth decade of life due to trivial trauma. Patients on renal dialysis are the most vulnerable population group.

Since reconstructions of acute injuries yield much better results than reconstructions of old ones, particularly those initially misdiagnosed, the importance of defining risk factors, mechanisms of injuring and recognition of symptoms is even greater.

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