Summary

Introduction. Patellar tendon rupture is a rare injury which, if missed, leads to delayed surgical treatment and may result in the loss of the knee joint function. The aim of this study was to report our results of operative treatment of the patellar tendon rupture and point out the significance of timely diagnosis and surgical procedure. Material and Methods. This retrospective ten-year study included 20 participants, 15 males and 5 females, their mean age being 42 (20-84) years. Seven participants had an injury on the right side and 13 had an injury on the left side. Thirteen participants had the diagnosis set in the first seven days after the injury. The applied techniques were surgical suture of the tendon, bone-tendon-bone ligamentoplasty using allograft from a bone bank and bone-tendon-bone ligamentoplasty using contralateral autograft, and they were performed in 12, 5 and 3 patients, respectively. The treatment results were assessed by using the Lysholm score, measuring the range of movement in the knee joint and measuring the girth of the thigh 10 cm above the patella. Results. The follow-up period after the surgery was 4 years on average (1-10 years) and the average value of the Lysholm score was 83 (27-100). The result was found to be excellent in 11 cases, satisfactory in 5 cases and unsatisfactory in 4. A statistically significant difference (p=0.0197 p<0.05) was found in the average values of the Lysholm score between the patients with risk factors (71.78) and the subjects without risk factors (92.18). A statistically significant difference (p=0.008 p<0.01) was found in the Lysholm score between the patients with timely diagnosis (91.62) and cases of chronic tendon tear (67). Conclusion. Timely diagnosis and early surgical separation are the basic imperatives in the treatment of this injury. Comorbidity and risk factors are related to a poorer postoperative outcome. Key words: Tendons; Rupture; Treatment Outcome; Patellar Ligament; Early Diagnosis; Reconstructive Surgical Procedures; Risk Factors; Range of Motion, Articular

Introduction

The patellar tendon is the final connection of the extensor mechanism of the knee, connecting the inferior pole of the patella and the tibial tubercle. Technically, it is a ligament (connecting a bone to a bone), but it has historically been referred to as a tendon because the patella is a sesamoid bone [1]. A patellar tendon rupture is the third most frequent injury of the extensor mechanism of the knee, right after patella fracture and quadriceps tendon rupture [2–4].
A patellar tendon rupture occurs most often at its patellar insertion or at the middle of the tendon [2, 5–8]. In younger patients, this injury occurs because of repeated microtrauma or as a result of taking out medial part of the tendon during anterior cruciate ligament (ACL) reconstruction procedure. However, this injury is a result of degenerative changes in the tendon in older patients [9–11]. Corticosteroid infiltration and systemic diseases are predisposing factors for the tendon rupture. The patellar tendon rupture is diagnosed by symptoms such as pain, palpable infrapatellar defect, inability to extend the knee against gravity, high patella position (confirmed by lateral radiography) as well as by ultrasonography and magnetic resonance imaging (MRI) [12] (Figure 1).

Patellar tendon ruptures are technically difficult to repair and the main goal of the treatment is to reconstruct the extensor mechanism so that it would allow the active knee extension. Since only individual cases or small series up to 30 patients have been studied until now, there is still a dilemma about optimal treatment for this injury [13–17]; therefore, the aim of this study is to show our results of operative treatment of the ruptured patellar tendon and to point out the importance of timely diagnosis and surgical intervention.

Material and Methods

This study has been approved by the Ethics Committee of Clinical Centre of Vojvodina. In the period from January 1, 2003 to December 31, 2013, there were 25 patients with the complete patellar tendon rupture who were operated at the Department of Orthopedic Surgery and Traumatology, Clinical Centre of Vojvodina in Novi Sad. This retrospective study included 20 of those patients. The data were collected by reviewing the patients’ medical histories and by a questionnaire. There were 15 male and 5 female patients, their mean age being 42 (20–84) years. One patient had a bilateral patellar tendon rupture. The rupture was on the right side in six cases and on the left side in 13 cases. In 13 cases, the injury was diagnosed during the first 7 days and in 7 cases it was diagnosed after that period. Since the operation was mainly performed in the acute phase, the most frequent technique was suturing the tendon (12 patients). In four cases where the patellar tendon rupture occurred after taking a bone-tendon-bone (BTB) autograft for the anterior cruciate ligament reconstruction, the substitution was made by a BTB allograft taken from the bone bank [18]. In two cases, the reconstruction of the contralateral patellar tendon was also made by using a BTB graft - in one case the rupture occurred after taking a BTB autograft for the reconstruction of the ruptured patellar tendon of the other leg and the substitution was also made by a BTB allograft taken from the bone bank. In another case, the reconstruction of the chronic patellar tendon rupture was made by using the contralateral BTB autograft [3]. In all cases, the knee was immobilized postoperatively for six weeks with a partial weight-bearing allowed. After that period, the patients underwent a three-month rehabilitation program in order to regain the range of motion.

The results were based on the average Lysholm score [19], which takes into account pain, swelling, instability, weight-bearing, climbing stairs, limping and squatting. The result of the operative treatment was rated excellent in the range from 90 to 100 points, satisfactory from 80 to 89 points and poor below 79 points. The range of motion in the knee and the girth of the thigh was measured 10 cm above the patella. The difference in volumes of the left and the right thigh exceeding 2 cm indicated hypotrophy of the quadriceps muscle.

Five patients who did not respond to the invitation or did not want to participate in this research were excluded from the study.

Results

The average follow-up period after surgery was 4 years (1–10 years) and the average Lysholm score was 83 (27–100). An excellent, satisfactory and unsatisfactory result was achieved in 11, 5 and 4 patients, respectively (Graph 1).

A statistically significant difference was found (p=0.0197 p<0.05) between the average Lysholm score of the patients with risk factors (71.78) and the patients without risk factors (92.18) (Table 1).
All four patients with poor results had a risk factor or comorbidity in their medical histories.

A statistically significant difference of the average Lysholm score (p=0.008 p<0.01) was found in patients whose injury was timely diagnosed (91.62) compared to the cases of chronic patellar tendon rupture (67) where the injury remained unrecognized for several months (Table 2).

Fourteen patients (70%) had hypotrophy of the thigh muscles above the patella and six patients had a limited range of motion as well. The limited range of motion was not observed in the knee of 11 patients who had the fixation material extracted. Sixteen patients returned to the activities of daily living without reduction, whereas in four patients these activities were reduced.

Discussion

The average length of the patellar tendon is 40-53 mm [20–23]. The patellar tendon is wider proximally than distally because the fascicles tend to converge toward the midline [24, 25]. Yoo et al. [26] found that the width of the proximal and the distal part was 30 mm and 24 mm, respectively.
The central third of the patellar tendon is significantly thicker than the medial and lateral thirds [27], and may be affected by continuing sports activity [28, 29]. The average thickness of the patellar tendon in cadavers measured by the MRI was found to be between 3-5 mm [27, 30].

A bilateral patellar tendon rupture is a very rare injury and only 20 cases have been published so far [15]. Since it is often unrecognized, it causes delays in diagnostics and treatment [30]. Siweck and Rao published that 28% cases of the bilateral rupture were misdiagnosed after the injury [2]. We had two patients with the bilateral patellar tendon rupture who had been on long-term hemodialysis due to renal insufficiency. Only one of them came back for a check-up and the result was unsatisfactory because of comorbidities and late diagnosis.

A patellar tendon rupture usually occurs in men under 40 years of age [31, 32], although our patients’ mean age was 42. In younger patients, the injury most often occurs during sports activities [33, 34], while landing or stumbling, when the quadriceps muscle contracts eccentrically while the knee is flexed [12]. An unchanged patellar tendon has a substantial strength and the force needed for the rupture is 4366N [35]. The tendon load is maximal at its inscriptions where collagen fibers are tougher, during active extension when the knee is at an angle of 60 degrees so the rupture occurs at the insertions or in their vicinity, most often unilaterally [2, 12].

The mechanism of patellar tendon rupture is an eccentric overload of the extensor mechanism with a planted foot and flexed knee. Repetitive micro-injuries leading to tendon weakness usually precede the tendon rupture. Ruptures of the patellar tendon can occur secondary to trauma, in conjunction with systemic illnesses, after total knee arthroplasty or ACL reconstruction, as a late complication of tibial nailing, or after local or systemic steroid administration [3].

In case of associated systemic illnesses which lead to collagen weakness, such as systemic lupus erythematosus, rheumatoid arthritis, diabetes, chronic renal insufficiency or secondary hyperparathyroidism, the patellar tendon rupture can occur even without a significant trauma [15, 16]. Local or systemic steroid administration affects the sensitivity of the patellar tendon as well [34, 35]. Half of our patients had some of the risk factors.

The rupture of the patellar tendon occurred after total knee arthroplasty in three patients. Disruption of the extensor mechanism after total knee arthroplasty is an infrequent but catastrophic complication after total knee arthroplasty with the prevalence of 0.17% to 2.5% [36, 37]. Prevention is important in order to avoid problems during primary total knee arthroplasty and to identify those patients who are at risk preoperatively (obesity, history of corticosteroid use, stiffness, previous extensor mechanism complications, osteolysis, previous osteotomy, and patella baja). This includes the use of appropriate extensile exposures when necessary to avoid damage. If it occurs, however, the treatment is reconstruction rather than repair. Allograft tissue provides the best means for reconstruction. With proper surgical technique that includes full tensioning of the allograft, acceptable functional outcome can be achieved. On the other side, results of direct repair of extensor mechanism failure are dismal.

Results of direct repair of extensor mechanism failure are dismal. Failure rates have been reported to exceed 90% using a variety of techniques [38, 39]. Allograft tissue provides the best means to reconstruct the disrupted patellar tendon adequately [40, 41]. The options for allograft reconstruction include an Achilles tendon bone block allograft or a whole extensor mechanism allograft. Achilles ten-
don allografts are indicated in patients with an intact patella and patella component, which can be mobilized to within 2 to 3 centimeters of the joint line. It should be noted that they might also be used in patients with a chronically disrupted quadriceps tendon for which there is extreme retraction that could not be reached with a whole extensor mechanism allograft.

Bone-patellar tendon-bone remains the most common graft material for anterior cruciate ligament reconstruction. A rupture of the patellar tendon after harvesting a BTB autograft occurs very rarely [42, 43]. Patellar tendon rupture after ACL reconstruction may occur during the first month after the operation, usually as a result of trauma [43], or it may occur much later, 7 months to 10 years after the procedure, as a result of a very strenuous physical activity (strong kick or high jump). In our three patients, the rupture of patellar ligament occurred after 10 months on average (7–12) during the jump and in one patient in a car accident 60 months after ACL reconstruction. One patient received corticosteroids due to the pain in the top of the kneecap. Etiology of the patellar tendon rupture after ACL reconstruction is multifactorial: devascularization of the tendon during graft harvesting will result in an avascular degeneration [44] and the reason may be also mechanical when the donor tendon might be weaken even more than by one half when the central third of it is removed during graft harvesting [43]. Lairungruang at al. [35] compared the ultimate load bearing capabilities of the normal patellar tendon (4365.59N) to the patellar tendon after its central third was removed (2226.58N) and concluded that taking out the central third of the patellar tendon reduced both its cross-section area and ultimate load to one half.

The aim of repairing the patellar tendon ruptures is the restoration of the muscle-tendon complex to its original position as well as of the quadriceps function, preservation of the reconstructed tendon blood supply, splinting of the patellar tendon and preventing degenerative changes of the patella. The most common surgical treatment of the acute patellar tendon rupture is sutureting which was done in 12 of our patients. This method provides lesser morbidity, better preservation of the ligament integrity, faster regaining of the range of motion and quicker overall recovery compared to other techniques. Marder and Timmerman [8] reported excellent results in 15 patients with acute patellar tendon rupture which had been treated with suture. Early surgical treatment imposes itself as an imperative in treatment of patellar tendon rupture [2]. In this study, better postoperative results were achieved in cases of early operative treatment compared to late operative treatment of the rupture.

Operative treatment of obsolete ruptures leads to contracture of the quadriceps muscle with fibrous adhesions which additionally complicates surgical intervention and recovery as well as the functional outcome thus causing patients’ dissatisfaction [2]. In these cases, the surgical substitution is done by using autograft [2, 45, 46], allograft [1, 47] or synthetic materials [2, 48]. The reparation is often protected with a wire [13, 49] or external fixation [2] and some form of postoperative immobilization is recommended [45]. The wire reduces the load on the reconstructed ligament and enables early rehabilitation but additional surgery is required in order to extract the wire. In our patients, the knee was postoperatively immobilized in extension for 6 weeks [2, 14] followed by three months of physical therapy.

We used the Lysholm score for the assessment of operative treatment results [19]. The average value of 83 in our study is most similar to the result reported by Enad and Loomis [49]. Frequent complications of the operative treatment are reduced mobility of the patella, low lying patella, limited flexion of the knee, persistent pain and muscle weakness [14]. Our most frequent complication was hypotrophy of the quadriceps muscle, which could be explained by insufficiently aggressive physical therapy. On the other hand, an aggressive physical therapy could lead to the patellar tendon re-rupture so the physical therapy must be balanced.

Besides small size of our sample, one of the shortages of our study was the inability to do control X-rays and MRI scans because of the technical reasons so we could not correlate the length of the patellar tendon between the injured and the uninjured knee. A histopathology analysis of the ruptured tendon could provide answers to some unresolved questions about etiology and pathogenesis of this complex injury. Some future studies could take into account some other factors which could potentially affect the treatment outcome such as length, aggressiveness and type of physical therapy.

**Conclusion**

Patellar tendon ruptures can have a significant effect on the athletic and nonathletic patient. The diagnosis can be made acutely based on careful history and physical examination. Predisposing medical conditions and activity level may present as risk factors. Upon diagnosis, immediate orthopedic referral is necessary to avoid costly delays in definitive surgical repair. The impact of the injury to the patient may be long-standing, even after operative treatment. Contemporary surgical and rehabilitative techniques give the best opportunity for restoration of functional activity.
Literatura

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