RESEARCH ARTICLE

Clinical Outcome of Anatomical Arthroscopic Posterior Cruciate Ligament Reconstruction with Achilles Tendon Allograft

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Abstract

Background: Regarding this, the present study aimed to assess the clinical outcome of anatomical arthroscopic posterior cruciate ligament (PCL) reconstruction using Achilles tendon allograft.

Methods: This cross-sectional retrospective study was conducted on 24 patients undergoing anatomical arthroscopic PCL reconstruction using Achilles tendon allograft during 2008-2014. The patients were examined in terms of knee stability by clinical examinations and KT-2000 arthrometer, as well as regarding health and knee status, over a mean follow-up of 36 months. In addition, the 36-Item Short-Form Health Survey (SF-36), International Knee Documentation Committee Subjective Knee Form (IKDC), Knee Injury and Osteoarthritis Outcome Score (KOOS), Kujala, and Lysholm were adopted to collect data.

Results: The participants had a mean age of 30±8 years and a mean body mass index of 25±2 kg/m^2. Based on the results of the SSD-KT2000 arthrometer, 12.5%, 34.37%, 28.12%, and 25% of the patients had normal, nearly normal, abnormal, and severely abnormal laxity, respectively. In addition, the mean KOOS, Lysholm, IKDC, and Kujala scores were estimated at 73.92±15, 79.50±17, 58.20±10.47, and 80.06±16, respectively. The patients with concomitant partial meniscectomy had a significantly lower IKDC score (*P<0.01*).

Conclusion: Based on the findings, the use of Achilles tendon allograft in the surgical reconstruction of PCL would yield excellent results both subjectively and objectively. In addition, patient selection and surgeon's choice and preference should be considered in determining the treatment plan for the patients.

Level of evidence: III

Keywords: Achilles tendon, PCL, Reconstruction

Introduction

Based on the evidence, the knee joint is the most commonly damaged joint in adult athletes accounting for 2.5 million knee injuries per year. Moreover, this injury is the most common cause of long-term and permanent athletic disabilities (1-3).

Injuries to the posterior cruciate ligament (PCL) is infrequent; accordingly, it comprises approximately 3% of all knee injuries (4-6). The rupture more commonly occurs in a multi ligament-injured knee and leads to altered loads and kinematics during functional activities (7).

The PCL injury occurs following a traumatic event resulting in the posterior translation of the tibia on the femur (8). The PCL injuries, specifically those of higher grade, hardly occur in isolation and are usually associated with other ligament injuries, such as anterior cruciate

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ligament (ACL) (46%), medial collateral ligament (MCL; 31%), or posterolateral corner (62%) injuries (79% of all cases). The PCL injuries commonly occur as a result of high-energy trauma, such as sport and motor vehicle or road accidents (57%).

The management of PCL injuries remains a challenging issue in a clinical setting. Recent studies worked on PCL anatomy and bundles and have greatly elucidated its overall functional role. The advancement of imaging techniques (e.g., increased magnetic resonance imaging [MRI] precision) has reportedly resulted in the improvement of PCL rupture diagnosis. Increased individuals' expectations and the need for having an effective knee are other factors necessitating the diagnosis of this condition (9-12).

Today, with the development of arthroscopic tools and advancement of technological methods, surgical treatment has become the preferred approach for arthroscopic PCL rupture restoration (9). A certain percentage of patients with isolated PCL injury treated non-operatively will develop chronic symptomatic posterior instability and may require surgical intervention. In high-grade unstable knees, non-operative treatment will probably increase clinical instability and risk of articular cartilage damage, thereby leading to secondary osteoarthritis. That is why there has been consensus on managing patients suffering from grade III posterior translation and giving-away episodes, with surgical reconstruction.

Based on the evidence, PCL reconstruction is accompanied by promising outcomes with approximately 80% return to pre-injury activity levels (6, 13, 14). Therefore, the purpose of PCL reconstruction is to prevent osteoarthritis and restore the normal knee kinematics. After the surgery, some of PCL fibers remaining intact will help by activating spontaneous healing, and therefore leading to better joint resistance and proprioception (15).

Controversies exist surrounding the issues of PCL reconstruction, including indications, graft choice, allograft versus autograft tissue, and reconstruction techniques. In recent years, different kinds of allografts have been widely used in sports medicine surgical procedures. The allografts decrease surgical duration, morbidity of the donor site, and preoperative pain while improving surgical site shape and versatility in graft size, as well as accelerating rehabilitation. They are also easy to handle and provide sufficient strength (13, 16, 17).

Moreover, the quadriceps tendon allograft has been an interesting alternative in this reconstruction by surgeons because of its stiffness and large size. This allows them to maintain the anatomic footprint and stiffness of the native PCL more accurately. However, there is little data on the efficacy and biomechanical function of the quadriceps to overall construct stability in PCL reconstructions; moreover, the utilization of the quadriceps tendon allograft as an option for PCL reconstruction has not been extensively studied so far. With this background in mind, the present study aimed to determine the long-term clinical and functional results of arthroscopic single-bundle PCL reconstruction using Achilles tendon allograft.

Materials and Methods

Study design

This cross-sectional retrospective study was conducted on patients who had undergone isolated anatomical arthroscopic PCL reconstruction using Achilles tendon allograft at Ghaem Hospital, Mashhad, Iran, from 2008 to 2014. The present research was a single-center study, in which the intervention was performed by the same surgeon. The study was approved by the local institutional review board.

Inclusion and Exclusion Criteria

The exclusion criteria were: 1) injury to other ligaments besides PCL, such as MCL, lateral collateral ligament, ACL, and meniscus, as confirmed by physical examination and MRI, 2) previous surgical treatment, 3) history of distal femur or proximal tibia fracture, 4) severe arthrosis or high-grade chondral damage, and 5) chronic disease.

Study Design

Out of 59 cases, 32 patients were eligible based on our inclusion criteria and accepted the invitation. Among the remaining, 10 patients were unavailable, and 17 cases did not consent to participate in the study. The data were collected using clinical examinations, KT-2000 apparatus, and questionnaires. Based on physical examination and MRI, all 32 patients were diagnosed with symptomatic (pain or instability) isolated PCL tear and had normal limb alignment. They all had participated in 3 months rehabilitation programs while showing no response to a period of conservative treatment.

All 32 patients were examined clinically by one of the authors who had not participated in the surgery. The objective tests included posterior drawer test, instrumental testing by KT-2000 arthrometer, and thigh circumference measurement. In addition, all patients filled out a number of questionnaires, including the Short-Form Health Survey (SF-36 item), International Knee Documentation Committee Subjective Knee Form (IKDC), Knee Injury and Osteoarthritis Outcome Score (KOOS), Kujala, and Lysholm. These questionnaires were used to investigate the association between weight and duration of the injury. The clinical and physical inspection of the thigh was accomplished using the KT-2000 arthrometer (18).

Operative technique

The procedure started with routine examination under anesthesia and arthroscopy in all cases for the confirmation of diagnosis and any other concomitant injuries using standard anterolateral and anteromedial portals. To this end, a posteromedial portal was created for obtaining a better and safe view of tunnel placement and graft passing. At 90 degree knee flexion, a transtibial guide pin was used from the anteromedial tibia through the center of the tibial footprint. This pin is usually located 1 cm below the joint line, just lateral to the center of the lateral tibial eminence.

A lateral fluoroscopic image was then taken to verify the appropriate pin placement. The tibial tunnel was carefully drilled and then compressed with a reamer. Subsequently femoral guide pin was placed in the anatomic footprint through the anterolateral portal. In the next stage, the edges of both tunnels were shaved and smoothed to facilitate graft passage.

The allograft trim and resize was done to be fit to the tunnel and then sutured with braided nonabsorbable running suture. An 18-gauge wire loop was passed from outside into tibial tunnel and grasped from inside and exited from femoral tunnel. This wire loop was then used as a guide for allograft passage through tunnels and knee joint. A metal interference screw used from outside-in for femoral side bone plug fixation. Subsequently, the graft was tensioned in the following technique and fixed with screw and spiked washer. The knee was brought through several flexion-extension cycles. Then at 90-degree knee flexion and an anterior drawer force to the tibia tensioning was applied [Figure 1].

The knee was braced in full extension. It is well-known that PCL graft healing usually takes more time than the ACL healing. This is why PCL rehabilitation is the keystone of a successful recovery. Therefore, the knee was immobilized for 4 weeks with only 90 passive flexion and then progressive and resistive motions were initiated (12).

Ethical considerations

This project was approved by Mashhad University of Medical Sciences, Mashhad, Iran. Informed consent was obtained from all patients. To observe the ethical considerations, the participants were informed about the confidentiality of the data, stages of the study, and research techniques. Moreover, they were ensured about the possibility of study withdrawal at any stage.

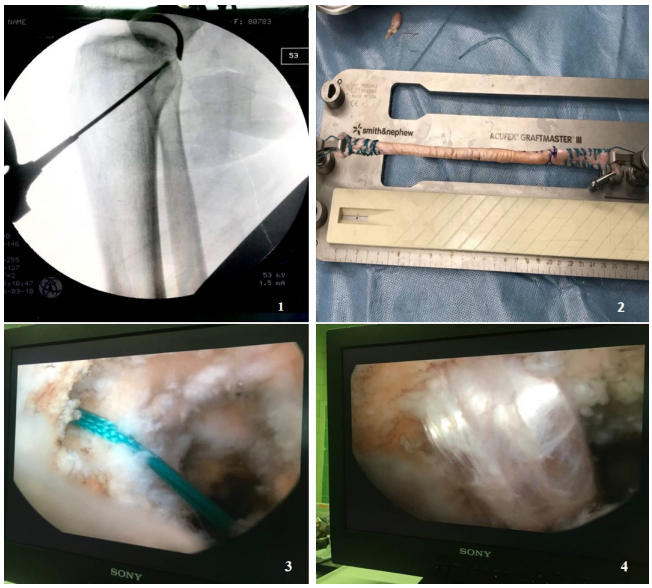

Figure 1. Graft preparation, tunnel placement and graft passing.

Statistical analysis

The data were entered in IBM SPSS software (version 16) and then analyzed by t-test, Chi-square test, and ANOVA. A *P-value* less than 0.05 was considered statistically significant.

Results

Based on the obtained results of this study, 93.75% of the patients (n=30) were male. The subjects had a mean age of 30±8.45 years (age range: 20-49 years) and a mean BMI of 25.15±2.85 kg/m^2 (range: 19.60-30.13 kg/m2). In addition, the mean weight, height, and thigh gap of the patients were 76.84±10.9 kg (range: 59-102 kg), 174.65±7.12 cm (range: 160-188 cm), and 2.53±1.66 cm (range: 0-6 cm), respectively. In addition, 34.37% (n=11) and 65.62% (n=21) of the patients had left and right knee injuries, respectively. Furthermore, the mean follow-up duration was 36.34±17.95 months (range: 12-60 months).

With regard to the mechanism of injury, 22 (68.75%) and 10 (31.25%) patients had motor vehicle accident and sports injury, respectively. Time interval between injury and operation was less than 6 months in 12 patients and more than 6 months in 20 cases, rendering a mean interval of 9.5 months. Based on the results of the SSD-KT2000 arthrometer, 4 (12.5%), 11 (34.37%), 9 (28.12%), and 8 (25%) patients had normal (0-2), nearly normal (3-5), abnormal (6-10), and severely abnormal (>10) laxity, respectively. The results revealed no correlation between SSD-KT2000 results and topographic criteria.

The study population with PCL reconstruction demonstrated good results in all KOOS subscores (i.e., symptoms, pain, ADL, sport, quality of life) with the total mean KOOS score of 73.92±15.08 (range: 31.17-95.50). There was a significant relationship between total KOOS score and KT-2000 results (P=0.008). At the final clinical review of Lysholm knee score, 12 patients (37.5%) had excellent or good results (a score of >84). The median postoperative Lysholm knee score was 79.5 (range: 26-100), and there was a good relationship between lysholm score and KT-2000 results, especially in groups with normal and nearly normal laxity. At the final follow-up, the mean post-reconstruction IKDC and Kojula scores were 58.20±10.47 and 80.06±16.47, respectively (range: 32-100) [Table 1].

The scores of the eight categories of the SF-36 suggest that the patients were functioning physically, mentally, and socially at average levels when compared with the standard population. The scores of the physical and mental components were presented in a single combined score of the eight categories of the SF-36. The mean physical and mental component scores were 41.52 and 48.41, respectively.

Physical function score was slightly below and mental function was slightly above the average US population scores [Table 2]. After surgery, 2 and 4 patients had giving way sensation and extension lag in the follow-up, respectively. There was no other post-operative knee or general complication, except for two cases of superficial

Table 1. Mean scores of Lysholm, Kujala, International Knee Documentation Committee Subjective Knee Form, and Knee Injury and Osteoarthritis Outcome in patients

Scores	Number	X̄±SD	Median	Minimum	Maximum
IKDC	32	58.20±10.47	54.00	25.30	95.40
Lysholm	32	79.50±17.02	83.50	26	100
Kujala	32	80.06±16.47	85.00	32	100
Final Koos	32	73.92±15.08	76.15	31.17	95.50
KOOS Pain	32	28.75±5.34	30.00	16	36
KOOS Symptoms	32	20.87±4.47	21.00	10	28
KOOS ADL	32	58.56±7.57	60.00	41	68
KOOS Sport/Recreation	32	12.96±5.15	15.00	0	20
With QoL	32	10.28±3.45	11.00	1	19

IKDC: International Knee Documentation Committee, KOOS: Knee Injury and Osteoarthritis Outcome Score, OoL: quality of life

Table 2. Mean scores of 36-Item Short-Form Health Survey indicators

SF-36	PF	RP	BP	GH	VT	SF	RE	MH	PCS	MCS
Number	32	32	32	32	32	32	32	32	32	32
Average score of the patients	63.45	43.10	57.72	58.90	58.97	72.84	57.47	65.79	41.52	48.41
Average score in Persian speaking population (30)	85.3	70	79.4	67.5	65.8	76	65.6	67		
Standard deviation	27.65	38.32	25.87	21.16	21.31	26.95	46.21	20.02	12.83	13.68

SP-36: 36-Item Short-Form Health Survey

infection treated with medication and one case of transient paresthesia.

Discussion

Based on the obtained results of our study, the majority of the patients were young males. This is in line with the results of a couple of studies reporting that most of PCL rupture patients are young males (19, 20). Motor vehicle accident was the most common cause of symptomatic isolated PCL. In the current study, high-energy trauma accounted for the majority (81.5%) of the PCL injuries, and only 18.5% of such injuries had been caused by sports-related accidents.

Our findings revealed no correlation between SSD-KT2000 results and topographic criteria, which is consistent with other reports (9, 21).

Moreover, in the current study, good results were obtained for all KOOS domains. A significant relationship was reported between Lysholm score and KT-2000 results, especially in groups with normal and nearly normal laxity. Based on our results, the physical function was below the US population norms, while mental function was slightly above this level. Sensation, extension lag, and superficial infection were the reported side effects in our study.

The management of PCL injuries remains a controversial in knee surgery. Some evidences consider isolated PCL injury as a functionally benign condition as patients usually do well without surgical intervention. In a natural history study of acute, isolated, non-operatively treated PCL injuries, Shelbourne et al. reported that after 14 years of PCL injury patients had good subjective and objective outcomes (22). In contrast, others recommended surgical reconstruction due to reduce the risk of knee osteoarthritis changes and increase knee function . Studies have also provided a scientific rationale for PCL reconstruction (single-bundle vs. double-bundle), graft selection, tunnel placement, and fixation (23).

All patients in our study had isolated PCL injury and were managed with single-bundle reconstruction. However, no single PCL reconstruction technique is consistently accepted by all orthopedic surgeons. In a study performed by Clancy et al., degenerative changes in the knees with chronic PCL injury and recommended surgical reconstruction were reported to have an incidence rate of 48% (24).

Cross and Powell reported 55 sports-related PCL injuries which 47 did well with conservative treatment, but just 5 out of 61 high-energy trauma-related PCL injuries did as well. Furthermore, they showed 80 % satisfactory result with early repair of high-energy trauma-related PCL injuries (25). In the current study, high laxity and functional impairment were considered as main surgical indications. There are very few clinical studies reporting the outcomes of achilles allograft usage in isolated single-bundle PCL reconstructions. This can be due to the relatively low incidence of this injury pattern and its high

association with multi-ligament injuries.

In our study, the majority of the patients had abnormal laxity based on SSD-KT2000. Mariani et al. retrospectively reviewed 24 patients following arthroscopic single-bundle PCL reconstruction with a patellar tendon autograft. They reported a lower rate of abnormal laxity as compared to our results. In the present study, 46.8% and 53.12% of the patients were in the groups with normal/nearly normal and abnormal/severely abnormal laxity, respectively, based on SSD-KT2000. However, in the mentioned study, 79% and 21.8% of the subjects had normal and abnormal/severely abnormal laxity, respectively. They reported that with a minimum follow-up of 2 years, only 25% and 21% of patients were in normal and abnormal/severely abnormal laxity groups, respectively, according to the IKDC criteria (21).

Chen et al. compared quadriceps tendon with hamstring autograft for performing an isolated single-bundle PCL reconstruction with a mean follow-up of 2 years. Nonetheless, they found no difference between the two grafts. In the mentioned study, 31%, 57%, and 12% of the patients were reported to have normal, nearly normal, and abnormal laxity, respectively, according to IKDC posterior drawer testing (26). In another study, Bjarne Mygind-Klavsen et al. reported an IKDC subjective score of 63.8 for isolated PCL group using a mean follow-up of 5.9 years (27).

In the current study, there was a significant correlation between the results of SSD-KT2000 and the scores of KOOS, Lysholm, and Kojula questionnaires, except for subjective IKDC scores showing a weak association. In addition, there was a significant relationship between trauma-surgery interval and these scores. However, SSD-KT2000 results had no significant relationship with the KOOS, Lysholm, and Kojula scores. This shows that patient satisfaction and functional results do not have a prominent relationship with knee laxity and that no distinct laxity makes an acceptable outcome for patients. However, trauma-surgery interval exerts a significant effect on patient outcome.

Results of this study revealed that PCL reconstruction using single-bundle arthroscopy and Achilles allograft is a complicated procedure with low complications and is fruitful for the patient. This finding is comparable to other studies performed elsewhere.

Research limitations and recommendation

Based on the results, it was concluded that it is possible to achieve satisfactory objective and subjective outcomes with arthroscopic posterior cruciate ligament reconstruction using Achilles tendon allograft. The main limitations of the current study are small sample size and lack of pre-operative data on the clinical and functional status of the injured knee. The findings of the present study cannot be generalized due to our small sample size affecting the outcome by uncontrolled intervention variables and the impossibility of long-term follow-up. Future studies are suggested to employ a large sample size and long-term follow-up to obtain more accurate findings. In addition, it is recommended to perform more studies, especially with a comparative and prospective design, to examine pre-surgical and post-surgical conditions of the patients.

As the findings of the present study indicated, regardless of weight, height, age, and BMI, a shorter time interval between injury and surgery would result in better functional outcomes. This time interval was found to be the most important factor in this regard. On the other hand, it was revealed that functional results decreased due to irreversible degenerative changes in the knee joint, and it had a lower correlation with the amount of knee laxity. Therefore, in young patients who are candidates for PCL surgical reconstruction, it is best to perform the surgery as soon as possible, right after the acute period.

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References

1. Simon TD, Bublitz C, Hambidge SJ. Emergency department visits among pediatric patients for sports-related injury: basic epidemiology and impact of race/ethnicity and insurance status. Pediatric emergency care. 2006;22(5):309-15.
2. Yang J, Marshall SW, Bowling JM, Runyan CW, Mueller FO, Lewis MA. Use of discretionary protective equipment and rate of lower extremity injury in high school athletes. American journal of epidemiology. 2005;161(6):511-9.
3. Kujala UM, Taimela S, Antti-Poika I, Orava S, Tuominen R, Myllynen P. Acute injuries in soccer, ice hockey, volleyball, basketball, judo, and karate: analysis of national registry data. BMJ : British Medical Journal. 1995;311(7018):1465-8.
4. Fox RJ, Harner CD, Sakane M, Carlin GJ, Woo SL. Determination of the in situ forces in the human posterior cruciate ligament using robotic technology. A cadaveric study. Am J Sports Med. 1998;26(3):395-401.
5. Miyasaka K, Daniel D, Stone M. The incidence of knee ligament injuries in the general population. Am J Knee

Surg 1991.
6. MacGillivray JD, Stein BE, Park M, Allen AA, Wickiewicz TL, Warren RF. Comparison of tibial inlay versus transtibial techniques for isolated posterior cruciate ligament reconstruction: minimum 2-year follow-up. Arthroscopy : the journal of arthroscopic & related surgery : official publication of the Arthroscopy Association of North America and the International Arthroscopy Association. 2006;22(3):320-8.
7. Voos JE, Mauro CS, Wente T, Warren RF, Wickiewicz TL. Posterior cruciate ligament: anatomy, biomechanics, and outcomes. The American journal of sports medicine. 2012;40(1):222-31.
8. Forsythe B, Haro MS, Bogunovic L, Collins MJ, Arns TA, Trella KJ, et al. Biomechanical evaluation of posterior cruciate ligament reconstruction with quadriceps versus achilles tendon bone block allograft. Orthopaedic journal of sports medicine. 2016;4(8):2325967116660068.
9. Wang CJ, Chen HS, Huang TW. Outcome of arthroscopic single bundle reconstruction for complete posterior cruciate ligament tear. Injury. 2003;34(10):747-51.
10. Deie M, Adachi N, Nakamae A, Takazawa K, Ochi M. Evaluation of Single-Bundle versus Double-Bundle PCL Reconstructions with More Than 10-Year Follow-Up2015. 1-5 p.
11. Sekiya JK, West RV, Ong BC, Irrgang JJ, Fu FH, Harner CD. Clinical outcomes after isolated arthroscopic single-bundle posterior cruciate ligament reconstruction. Arthroscopy : the journal of arthroscopic & related surgery : official publication of the Arthroscopy Association of North America and the International Arthroscopy Association. 2005;21(9):1042-50.
12. Hermans S, Corten K, Bellemans J. Long-term results of isolated anterolateral bundle reconstructions of the posterior cruciate ligament: a 6- to 12-year follow-up study. Am J Sports Med. 2009;37(8):1499-507.
13. Yang JH, Yoon JR, Jeong HI, Hwang DH, Woo SJ, Kwon JH, et al. Second-look arthroscopic assessment of arthroscopic single-bundle posterior cruciate ligament reconstruction: comparison of mixed graft versus achilles tendon allograft. Am J Sports Med. 2012;40(9):2052-60.
14. Boutefnouchet T, Bentayeb M, Qadri Q, Ali S. Long-term outcomes following single-bundle transtibial arthroscopic posterior cruciate ligament reconstruction. International Orthopaedics. 2013;37(2): 337-43.
15. Kwon JH, Han JH, Jo DY, Park HJ, Lee SY, Bhandare N, et al. Tunnel volume enlargement after posterior cruciate ligament reconstruction: comparison of achilles allograft with mixed autograft/allograft--a prospective computed tomography study. Arthroscopy : the journal of arthroscopic & related surgery : official publication of the Arthroscopy Association of North America and the International Arthroscopy Association. 2014;30(3):326-34.
16. Wang CJ, Chan YS, Weng LH, Yuan LJ, Chen HS. Comparison of autogenous and allogenous posterior cruciate ligament reconstructions of the knee. Injury. 2004;35(12):1279-85.
17. Heinzelmann AD, Barrett GR. Posterior cruciate ligament reconstruction: Achilles tendon allograft, double bundle. Clinics in sports medicine. 2009;28(2):245-57, viii.
18. Motamed N AA, Zare N, Sadeghi Hassanabadi A. Validity and reliability of the Persian translation of the SF-36 version 2 questionnaire. EMHJ-Eastern Mediterranean Health Journal. 2005:349-57.
19. McGuire DA, Hendricks SD. Comparison of anatomic versus nonanatomic placement of femoral tunnels in Achilles double-bundle posterior cruciate ligament reconstruction. Arthroscopy: The Journal of Arthroscopic & Related Surgery. 2010;26(5):658-66.
20. Kim S-J, Jung M, Moon H-K, Kim S-G, Chun Y-M. Anterolateral transtibial posterior cruciate ligament reconstruction combined with anatomical reconstruction of posterolateral corner insufficiency: comparison of single-bundle versus double-bundle posterior cruciate ligament reconstruction over a 2-to 6-year follow-up. The American journal of sports medicine. 2011;39(3):481-9.
21. Mariani PP, Adriani E, Santori N, Maresca G. Arthroscopic posterior cruciate ligament reconstruction with bone-tendon-bone patellar graft. Knee surgery, sports traumatology, arthroscopy : official journal of the ESSKA. 1997;5(4):239-44.
22. Shelbourne KD, Davis TJ, Patel DV. The natural history of acute, isolated, nonoperatively treated posterior cruciate ligament injuries. A prospective study. Am J Sports Med. 1999;27(3):276-83.
23. Nyland J, Hester P, Caborn DN. Double-bundle posterior cruciate ligament reconstruction with allograft tissue: 2-year postoperative outcomes. Knee Surgery, Sports Traumatology, Arthroscopy. 2002;10(5).
24. T. Janousek A, Jones D, Clatworthy M, D. Higgins L, H. Fu F. Posterior Cruciate Ligament Injuries of the Knee Joint2000. 429-41 p.
25. Cross MJ, Powell JF. Long-term followup of posterior cruciate ligament rupture: a study of 116 cases. Am J Sports Med. 1984;12(4):292-7.
26. Chen CH, Chen WJ, Shih CH. Arthroscopic reconstruction of the posterior cruciate ligament: a comparison of quadriceps tendon autograft and quadruple hamstring tendon graft. Arthroscopy: the journal of arthroscopic & related surgery : official publication of the Arthroscopy Association of North America and the International Arthroscopy Association. 2002;18(6):603-12.
27. Mygind-Klavsen B, Nielsen TG, Lind MC. Outcomes After Posterior Cruciate Ligament (PCL) Reconstruction in Patients With Isolated and Combined PCL Tears. Orthopaedic Journal of Sports Medicine. 2017; 5(4):2325967117700077.