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Diagnosis and surgical treatment of the posterior knee instability

Dijagnostika i operativno lečenje zadnje nestabilnosti kolena

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Abstract

Background/Aim. Posterior cruciate ligament is the primary stabilizer of the posterior tibia translation and secondary stabilizer of external tibial rotation as well as *varus*, *valgus* knee angulation. It is the strongest ligament in the knee that hurts the rarest. The aim of this study was to show the indications for surgery, present the surgical technique and give results of surgical treatment of posterior knee instability. **Methods.** The study icluded 12 patients who were tretaed surgically for posterior knee instabilility at the Institute for Orthopaedic Surgery "Banjica", Belgrade, in the period from 1st January 2010 to 1st January 2014. All of them had arthroscopically assisted anatomic reconstruction of posterior crucuate ligament done with 4-strand hamstring tendon graft. Postoperative follow-up lasted approximately 42 months and Lysholm values and International Knee Documentation Committee (IKDC) score were compared as well as the clinical status. **Results.** All treated patients had Grade III of posterior instability. Combined injuries of the posterolateral corner and anterior cruciat ligament (75%) were very frequent. Preoperative mean value of Lysholm score was 45.92 and postoperative 85.92 what was statistically significant improvement, the same as subjective IKDC score whose mean value was 38.58 preoperatively and 89.75 after the surgery and rehabilitation. Clinical examination showed better posterior knee stability although in 50% of patients certain level of instability remains. **Conclusion**. Arthroscopic reconstruction with 4-strand hamstring tendon gives satisfactory result with posterior cruciate ligament reconstruction. The result of subjective feeling of patient is much better then objective clinical examination. Although surgical procedure is technically demanding, with physically active patients having grade III of posterior instability it provides better result than non-surgical treatment.

Key words:
knee injuries; diagnosis; posterior cruciate ligament; orthopedic procedures; arthroscopy; treatment outcome.

Apstrakt

Uvod/Cilj. Zadnji ukršteni ligament je primarni stabilizator zadnje translacije tibije i sekundarni stabilizator spoljašnje rotacije tibije kao i *varus*, *valgus* angulacije u kolenu. To je najjača ligamentarna struktura u kolenu koja se najređe povređuje. Cilj ovog rada bio je da se prikažu indikacije za operaciju, operativna tehnika i rezultat operativnog lečenja zadnje nestabilnosti kolena. **Metode.** Studijom je bilo obuhvaćeno 12 pacijenata operativno lečenih zbog zadnje nestabilnosti kolena na Institutu za ortopedsko-hiruške bolesti „Banjica", Beograd, u periodu od 1.1.2010. do 1.1.2014. godine. Kod svih pacijenata rađena je artroskopski asistirana anatomska rekonstrukcija zadnjeg ukrštenog ligamenta četvorostrukim graftom tetiva *hamstrings*-a. Prosečno postoperativno praćenje bilo je 42 meseca (24–60) a upoređivane su vrednosti Lysholm i *International Knee Documentation Committee* (IKDC) skora, kao i klinički status. **Rezultati**. Svi operisani pacijenti imali su III stepen zadnje nestabilnosti. Udružene povrede posterolateralnog ugla i prednje ukrštene veze bile su česte – 75%. Srednja vrednost Lysholm skora preoperativno bila je 45,92, a postoperativno 85,92, što je statistički značajno poboljšanje, slično kao i vrednost subjektivnog IKDC skora čija je preoperativna srednja vrednost bila 38,58, a nakon operacije i rehabilitacije 89,75. Klinički pregled je pokazao bolju zadnju stabilnost kolena, mada je kod 50% pacijenata ostao određeni stepen nestabilnosti. **Zaključak**. Artroskopska rekonstrukcija četvorostrukom tetivom *hamstrings*-a daje zadovoljavajući rezultat kod rekonstrukcije zadnje ukrštene veze. Subjektivni osećaj pacijenata bolji je nego objektivan klinički nalaz. Mada je sama operacija tehnički zahtevna, kod fizički aktivnih pacijenata sa III stepenom zadnje nestabilnosti ona daje bolji rezultat od neoperativnog lečenja.

Ključne reči:
koleno, povrede; dijagnoza; ligament, zadnji, ukršteni; ortopedske procedure; artroskopija; lečenje, ishod.

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Introduction

Posterior cruciate ligament (PCL) is very strong structure, according to literature data, maximum tensile strength is 739–1,627 N [1–3]. Starting from posterior tibial attachment set 10 mm below the knee level it goes anteromedially to medial condyle of femur spreading into two functional bundles – anterolateral and posteromedial [4]. PCL is the primary stabilizer with posterior tibia translation (posterior instability) and secondary stabilizer of external tibial rotation as well as *varus*, *valgus* knee angulation [5, 6].

Injuries of PCL are quite less frequent in comparison to injuries of anterior cruciate ligament (ACL) and according to data from the literature they make 3.4–23% of all knee injuries and they occur isolated in less than 3.5% [7]. The most frequent injury mechanism in traffic is an impact on the anterior surface of proximal tibia – dashboard, while in sports it is knee hyperflexion and rather less common knee hyperextension as well as extreme *varus*, *valgus* stress. Combined injuries of posterior capsule and posterolateral knee corner are frequent and also, in case of serious trauma, the damages of anterior cruciate ligament, collateral ligament, meniscus and cartilage occur.

The ligament itself has a good potential of healing thanks to good vascularization and very specific position – intraarticular and extrasynovial [8, 9]. That is why partial and isolated tear is mostly treated nonsurgically – with cast immoblization and physical procedures [10, 11]. Still, the quality of such healing and tissue structure may not be adequate to keep normal knee kinematics. Disturbed biomechanics and nonphysiological micromovements with such joint lead to degenerative changes more often [9]. That is especially emphasized with complete tear followed by damages of posterior capsule and posterolateral corner. Dejour et al. [9] and Lobenhoffer et al. [10] differentiate 3 phases of adaptation which the knee goes through after the injury of PCL: the first phase of functional adaptation lasting 3–18 months, the second phase of functional tolerance lasting 10–20 years and the third phase of degenerative decompensation.

The objective of surgical treatment is to regain the knee stability and normal kinematics in order to prevent its rapid deterioration. The good result requires an adequate preoperative diagnostics and patient's evaluation [12]. The clinical examination is preceded with the medical history of typical injury mechanism. There are numerous tests for posterior instability (Table 1) and the most important of which is posterior drawer test, posterior sag and quadricepcs test [13]. Posterolateral corner is evaluated with dial test and reverse pivot shift test [13]. It is mandatory to perform tests for other knee structures because isolated injury is quite rare. With an acute trauma within 3 weeks the neurovascular status should always be evaluated.

The most frequently used test for evaluation of instability grade is the test of posterior drawer which evaluates the ratio between medial tibial plateau and medial femure condyle [14]. With normal knee, medial tibial plateau is 1 cm in front of medial femure condyle [15] (Table 2).

Additional diagnostics includes standard and stress imaging as well as nuclear magnetic resonance (NMR) imaging which has the highest sensitivity (97%) [16, 17].

Acute injury of PCL [18, 19] frequently remains overlooked. Patients complain of pain, swelling and limited movements so it is difficult to perform the above- mentioned tests. We begin with nonsurgical treatment using the cast immobilization and then follow the physical procedures. After that, most often the patients do not have big problems but depending on instability degree, it comes to degenerative changes development sooner or later. Arthrosis occurs at first in patellofemoral joint and medial compartment [20]. Thanks to better perceiving of consequences of such treatment, there are increasingly more advocates of surgical treatment [20, 21].

There are numerous dilemmas regarding surgical treatment in terms of graft choice, tunnel position, mode of tunnel placement, double or single reconstruction [22, 23]. In our

Table 1

Physical examination tests for posterior and posterolateral instability [13]

Test	Clinical target, description
Posterior drawer	Knee is flexed to 90°; posteriorly directed force is applied to proximal tibia
Posterior sag	Ipsilateral hip and knee are flexed to 90°; observe the knee from a lateral position for abnormal contour or sag at proximal anterior tibia
Quadriceps	Knee is flexed to 90°; patient either contracts quadriceps muscle or active test slides foot down table. Observe for tibia translating anteriorly from a posteriorly subluxed position
Dial test	External rotation of legs is compared with the knee at 30° and 90° of flexion
Reverse pivot shift	With leg externally rotated, *valgus* stress is applied to knee while it is extended from 70° to 80° of flexion. Test is positive when tibia reduces at approximately 20° of flexion

Table 2

Grading posterior knee instability [15]

Grade	Description of posterior knee instability
I	Tibia is still located anterior to the medial femoral condyle and can only be translated 0 to 5 mm posterior to the femoral condyle
II	Tibia is situated flush with the medial femoral condyle and can be translated 5 to 10 mm posterior to the femoral condyle
III	Tibia is displaced posterior to the medial femoral condyle and can be translated greater than 10 mm posterior to the femoral condyle

work we used arthroscopically assisted single bundle technique by using four-strand hamstring tendon graft.

Methods

The study includes 12 patients who had surgery at Institute for Orthopaedic Surgery "Banjica", Belgrade in the period from 1st January 2010 to 1st January 2014, and had PCL reconstruction performed. Patients with grade III of clinical instability who had difficulties in terms of pains and feeling of instability had surgery. The reconstuction of posterolateral corner was performed in 5 patients and the reconstruction of anterior cruciate ligament (ACL) was done in 3 patients during the same procedure. With 1 patient the ACL reconstruction was done afterwards. The technique used was arthroscopically assisted anatomic reconstruction with four-strand hamstrings tendon graft. This observational analytical study, follow-up and analyzed the following parameters: clinical exmination, Lysholm and subjective International Knee Documentation Committee (IKDC) scores before the surgery and 2 years after the surgical treatment.

Surgical technique

Surgeries were done in ischiofemoral block or spinal anaesthesia, with the use of Esmarch bandage. Clinical examination in anaesthesia was done preoperativelly and then the diagnostical arthroscopy through standard anterolateral and anteromedial portals was performed. The tear of PCL and diagnosed combined injury of ACL, meniscus and chondral lesion were verified. If needed, partial meniscectomy and damage debridman on cartilage were done. Performing diagonal cut as high as *pes anserinus*, distal attachment of *musculus* (m) *gracilis* and m. *semitendinosus* were approached. Tendons were preparated and removed and then 4-strand graft was made out of them. Under arthroscope control, the debridman notch and medial femure condyle were performed, then under arthroscope control posteromedial portal was opened. Debridman of posterior tibial edge and of tibial attachment of PCL was performed on about 1 cm of plateau edge (Figure 1). With the help of guide and under control of arthroscope a guide needle was set for transtibial tunnel. The tibial tunnel whose size was determined by graft size was placed over the guide needle. A guide needle for femoral attachment on medial femure condyle was set through AL portal.

Then, the femoral tunnel was also placed (Figure 2). The passing suture was pulled through tibial tunnel back and forth into femoral tunnel. The mentioned graft was pulled out through it. It was being fixed first femorally and then tibially by interference biodegrading screw with the knee at 90 degree flexion.

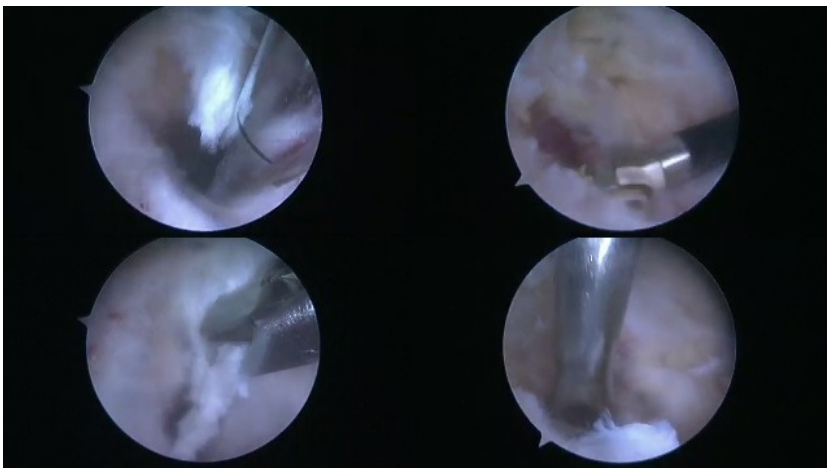

Fig. 1 – Debridman of posterior tibial edge and of tibial altachment of posterior cruciate ligament done on about 1 cm of platea edge – arthroscopic view.

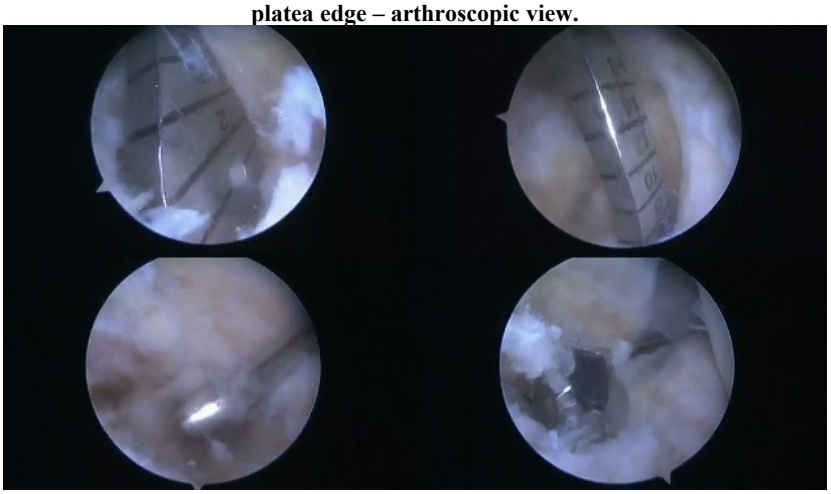

Fig. 2 – The procedure for femoral tunel placement – arthroscopic view.

In patients with posterolateral instability, the reconstruction of posterolateral corner was done with tendon of m. *semitendinosus* by technique per Coobs et al. [24].

In cases when there was a tear of ACL, the reconstruction of this ligament was done by Bone-Patellae tendo-Bone (B-Pt-B) graft from the other leg.

Rehabilitaion protocol

Postoperative surgically treated leg was immobilized with splint in extension up to 6 weeks. The patient was verticalized on the first postoperative day and started walking using crutches with partial weight-bearing. Patients started with passive movements from week 4, slowly increasing their weight-bearing. Active exercises of open kinetics chain avoiding flexion exercises started from month 3. Rehabilitation was long and gradual, so the complete recovery was expected after 9–12 months [25, 26].

Results

In this group of 12 patients who had surgery there were 9 men and 3 women, 34 years old on average (20–43). An average follow-up time was 42 months (from 24–60 months). The most frequent cause of injury was traffic trauma occured at 7 patients, then sports trauma at 4 and falls with bended knee at 1 patient. Average time from injury to surgery was 12 months (from 6 to 36 months). All patients were primarily treated nonoperatively. Eight patients had cast immobilization in the period from 2 to 6 weeks and 4 patients were treated with rest and elastic bandage. Futher treatment continued with physical procedures. All patients had primarily radiology images x-ray (XR) and physical examination done. Knee effluence was present with all patients suffered from pain and limited movements. Not all tests could have been done due to swelling and pain and test of posterior drawer was primarily positive in 6 cases (50%). The XR findings were mostly normal – there were no signs of fresh bone trauma. Additional diagnosis, NMR was primarily done at 7 patients and 5 had it done afterwards, upon completion of physical therapy.

Stress XR imaging was made to 4 patients after the rehabilitation in a way that the patient was kneeling and weight-bearing first his/her injured and then his healthy knee. In all cases posterior tibial translation was emphasized with injured knee (Figure 3).

After conducted physical therapy patients still had problems in terms of pain, limited movements and they felt instability. All patients had obvious hypothrophia of the above-knee muscles. Clinical tests were performed more easily and they precisely showed the posterior knee instability of grade III (Figure 4). Dilemma existed only with patients having torn both anterior and PCLS due to combined anterior and posterior instability.

Arthroscopic examination with all patients verified complete tear of PCL while distribution of accompanying damages was shown in Figure 5. Cartilage damages were dominantly in medial and patellofemorally compartment. Out of 6 patients who had ACL tear, 3 had reconstruction done of both anterior and posterior within the same procedure and 1 patients had the ACL reconstructed afterwards. Two patient with ACL lesion had no subjective feeling of disfunction and they did not want additional surgical treatment. Meniscus damage was treated with partial meniscectomy while cartilage damage was treated with debridman and microfractures technique. Posterolateral corner reconstruction was performed at 5 patients. In average, surgical procedure lasted for 1 h and 45 min.

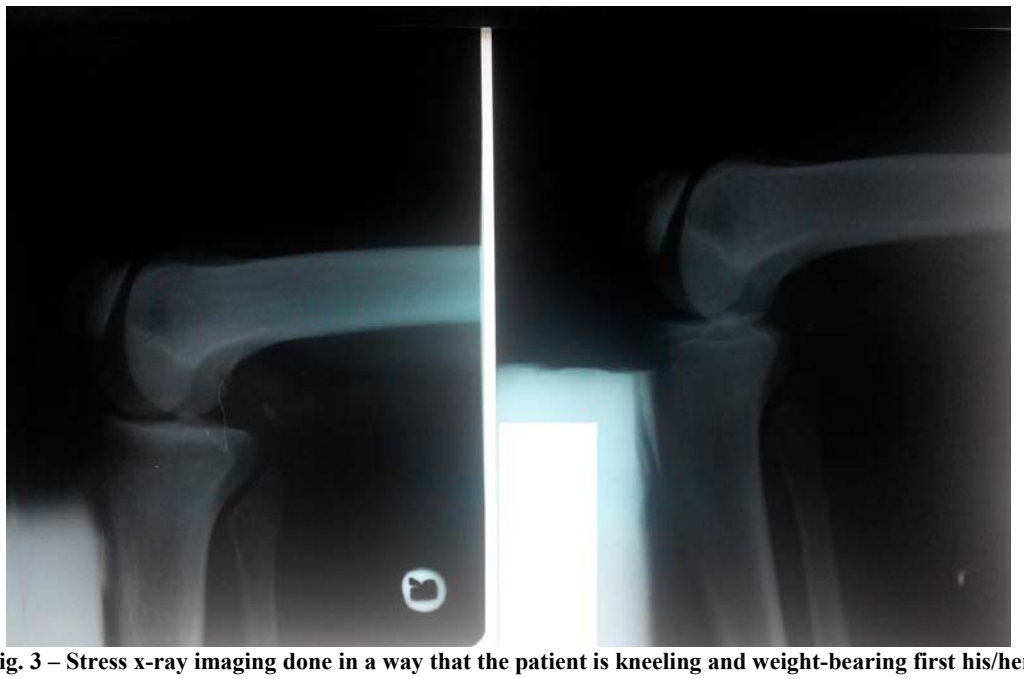

Fig. 3 – Stress x-ray imaging done in a way that the patient is kneeling and weight-bearing first his/her injuried and then his/her healthy knee revealed posterior tibial translation is emphasized with injured knee.

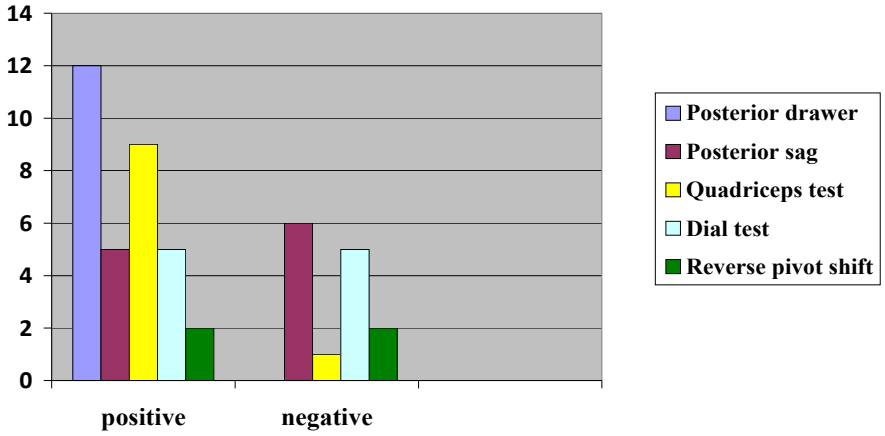

Fig. 4 – Physical examination tests after physical therapy.

Fig. 5 – Arthroscopic knee examination.
PCL – posterior cruciate ligament; LCA – ligamentum cruciale anterior.

Lysholm knee scores

Average value of Lysholm score was preoperatively 45.92 ± 5.6 (39–55) and 2 years after the intervention it was 85.92 ± 8.898 (65–95). There is an important statistical difference in value of this score after the operation ($p < 0.02$, Wilcoxon signed rank test).

Subjective IKDC scores

Preoperative average value of IKDC score was 38.58 ± 7.948 (25–48), after the surgery and adequate rehabilitation, 2 years later, it came to significant improvement and therefore the average value was 89.75 ± 4.864 (80–96) of subjective IKDC score, which is, according to Wilcoxon signed rank test ($p < 0.02$), statistically important difference.

Clinical examination

Clinical examinations after rehabilitation showed the improvement of posterior stability measured through posterior drawer test, although in 6 patients certain grade of posterior instability remained (Figure 6). Other tests were not always done, however they were improving (Figure 7).

Complications

One patient had deep infection and an additional intervention was required, infection calmed down but the patient stopped coming to check-ups. Sensibility problem was recorded in 5 cases in the knee region on the spot below taking the tendon graft. We had 3 cases of deep venous thrombosis. Pain and limited movements occurred in 3 patients which required prolonged physical rehabilitation.

Discussion

The PCL injury is the rarest knee ligament injury. We have very little experience regarding surgical treatment of this injury. In the literature there are also numerous dilemmas regarding surgical treatment [10, 11, 27]. Generally, it is accepted that a tear with instability of grades I and II should be

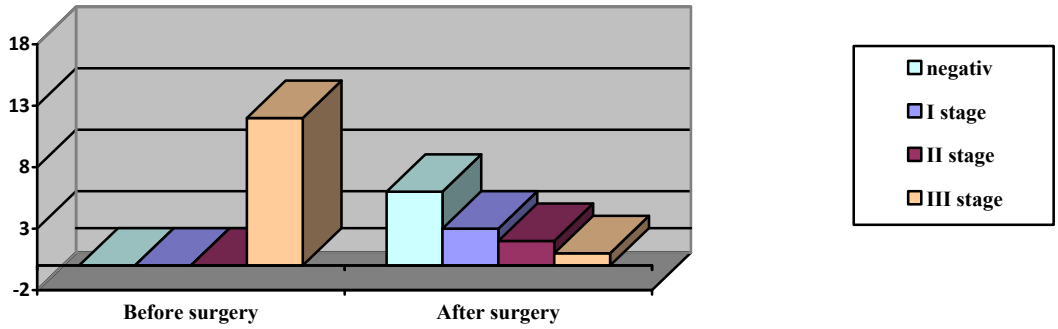

Fig. 6 – Posterior drawer test.

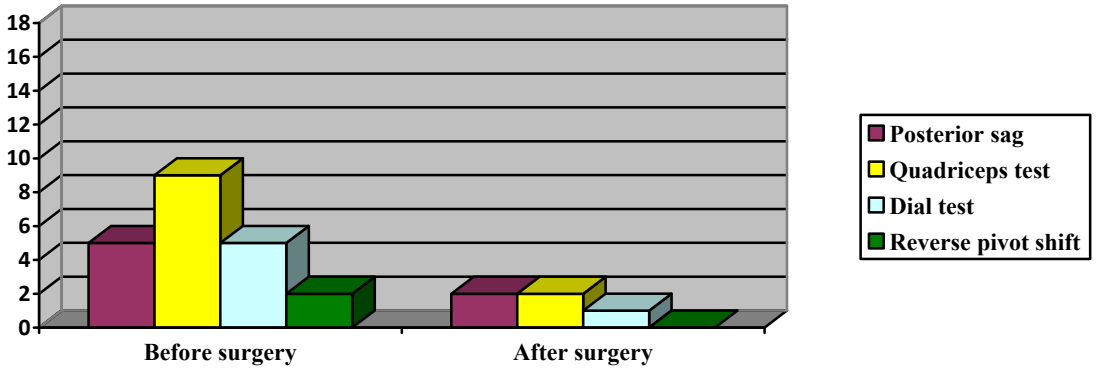

Fig. 7 – Other tests for posterior instability.

treated non-operatively [28, 29] while III of instability and multiligament injuries should be treated surgically [30–32]. The surgical procedure by itsef is technically very demanding. It takes a lot of time when not performed very often and that is related to risk of neurovascular structures injury, increased risk of infection and thromboembolic complications. The surgery objective is to gain stable joint of normal kinematics to prevent rapid deterioration – gonarthrosis. Most often injury is not isolated but it is combined with other ligaments, meniscus and cartilage injuries which affect the final results of the treatment. Dilemmas regarding the operative treatment are choice of surgical technique, graft choice, graft position and rehabilitation protocol.

Surgical technique could be open or arthroscopic, transtibial or inlay technique. It could also be one-bundle or double-bundle reconstruction. Arthroscopic transtibial technique, if done properly, gives satisfactory and comparable result in most patients [14, 33, 34]. There are also dilemmas regarding graft choice. B-PT-B graft of patella ligament was often used before; it has good potential of healing, but technically it is more demanding for placing arthoscopic transtibial and it brings complications in the donor place (pain and patella fractures). Tendon graft of Achilles tendon is acceptable as alograft and has adequate power; the morbidity of donor place is avoided but it is not yet available in our country. Quadriceps tendon graft is becoming more popular. It has adequate power, it is easily taken and easily placed to adequate position. At the moment, 4-strand hamstring tendon graft is the most used graft with this surgery – it has adequate power, it is easily placed and there are no bigger complications of donor's place [35–37]. More important than the graft choice is the graft position, i.e. position of tibial and femoral attachment. Anatomic reconstruction which places the graft into the center of original attachment femorally and tibially will provide the best functionality, isometrics and potentially better graft ingrowth [38–40]. Rehabilitation after such intervention is also specific and very important for the final outcome. It is long-lasting, gradual and individual for each patient. It begins with adequate immobilization aiming to prevent early graft damage. Then, the patient starts gradually with movement exercises and strengthening the muscles avoiding the load in tibiofemoral and patellofemoral joint [26, 41].

The final functional result of surgical treatment of PCL is not easily predicted due to numerous factors affecting it [42]. First of all, it depends on injury grade and combined injuries of other knee structures. According to data from the literature, 50–90% of PCL injuries are combined with injuries of some other knee structures [43]. In our series out of 12 patients, 4 had the ACL tear, 3 had injury of posterolateral corner, 2 patients had accompanying injury of both structures, 8 had meniscus damage and 6 patients had osteochondral lesions. The frequency of combined ligament injuries was 75%. The injury of posterolateral corner is, according to the literature, the most frequent accompanying ligament injury with LCP

damage. According to Fanelli et al. [38], 60% of 222 patients in their series had posterolateral corner injury. Such injury requires additional treatment in terms of reconstruction and in our series it was done in 5 (41.67%) patients. We think that if there is a damage of posterolateral corner, its reconstruction should be done following the same procedure with the LCP reconstruction. Without recognizing these combined ligament lesions there would certainly come to poor postoperative result. Therefore, we emphasize the importance of additional diagnostics (NMR, stress XR), clinical examination (after the injury, after the physical procedures and in anaesthesia) and diagnostic arthroscopy, if required. Only after that, the surgical treatment plan is prepared.

Sex distribution in our series shows significantly more men than women and the ratio is 3:1. This was probably affected by the mechanism of injury since in 58.33% of cases it was traffic trauma, while in the second place there were sports injuries 33.33%. All of them had grade III of injuries and after conducted nonsurgical treatment they still had problems. Average time until the surgery was 12 months. The average age of patients was 34.

The main difficulties that patients complained were pain and feeling of instability. Knee arhtroscopic examination discovered cartilage damage with 6 patients which makes 50%. We cannot say with certainty if they occurred at the moment of injury or they are resulting from the instability. Predominantly, damages were in the medial and patellofemoral part of the knee joint. It could be explained with disturbed biomechanics of movements and bigger pressure in the medial and patellofemoral part [44]. Findings of other authors showed similar results: Strobel et al. [45] – medial damages in 36.6% and patellofemoral in 34.1%; Geissler and Whipple [46] – 49% damage of the medial compartment in patients with the PCL tear who did not have surgery.

Clinical examination after 2 years showed that there were no posterior instability in 6 patients, while in other 5 certain instability remained (3 of grade I and 2 of grade II) and 1 patient showed no improvement. Other tests were not always done in a routine manner but the postoperative findings were better in most cases. It should be mentioned that Dial test and Reverse pivot shift are important for making decision for surgical treatment of posterolateral corner. The impression is that obtained posterior stability after this intervention is better, but still some degree of instability remains in 50% of patients. Other authors are of similar opinion in their series [17, 47, 48]. Anyway, patients treated nonsurgically after the PCL injury do not show improvement in posterior stability after the treatment completion.

Opposite to clinical examination that showed certain level of instability, the patients were mostly satisfied after the intervention and therapy. Average value of Lysholm score preoperatively was 45.92 ± 5.6 (39–55) and 2 years afer the intervention 85.92 ± 8.898 (65–95), which is a significant difference in values in terms of statistics. Also, the average value of subjective IKDC score preoperatively was 38.58 ± 7.948 (25–48), while after the surgery and adequate rehabilitation, significant improvement occurred and the average value was 89.75 ± 4.864 (80–96). We could find similar results in these scores with other authors, too [49, 50].

We did not have any bigger surgical complications during the surgeries. One patient had early postoperative infection, which was treated with arthroscopic washout and debridman while graft was not touched. Later on, the patient did not conduct rehabilitation in accordance with the protocol so we did not have complete follow-up of this case.

The question is whether this technique could regain knee stability required for prevention of its further deterioration. The difference in objective clinical examination and subjective feeling of patient could mislead us. It has been known that patients most often do not mention posterior instability as a big problem. Clinical tests showing stability improvement are static tests. It should be also mentioned that we were not able to objectively measure this instability using some of devices such as K1000, K2000, what is probably one of the shortages of this study. Dynamical instability which occurs while moving in everyday life is the cause of unbalanced load and knee deterioration. We need the devices which could measure dynamic instability. Only based on such measurement and longer follow-up period for patients, we could say whether the knee after such surgery has normal kinematics as the healthy one, and it will not come to rapid degenerative deterioration.

Conclusion

Arthroscopic reconstruction with 4-strand hamstring tendon gives satisfactory result with posterior cruciate ligament reconstruction. The result of subjective feeling of patient is much better then objective clinical examination. Although surgical procedure is technically demanding, with physically active patients having grade III of posterior instability it provides better result than non-surgical treatment.

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