Original Article
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Alternative Techniques of Ligament Reconstruction in Patients with Combined Cruciate and Postero-lateral Corner Injuries of the Knee

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Abstract

Background. In recent years, there has been an increase in the number of the patients with multiligament knee injuries. A significant proportion of unsatisfactory outcomes of such injuries treatment is associated with this injury features and the objective difficulties of its surgical correction. This determines the need for searching the optimal methods of diagnosis and treatment of such an injury. ***The purpose of this study*** was to compare the results of surgical treatment of the patients with multiligament knee injury, including the injury of the ligament-tendon complex of the knee posterolateral angle with two different techniques. ***Materials and Methods.*** The study included 51 patients with multiligament knee injury undergone the surgical treatment from 2007 to 2019. The average age of the patients was 32.1±9.2 years. The patients were divided into two groups. The patients of the main group (24 patients) underwent reconstruction of the cruciate ligaments and the main structures of the posterolateral angle: the fibular collateral ligament, the popliteofibular ligament, and the popliteus tendon. The patients of the comparison group (27 patients) underwent the reconstruction of the cruciate ligaments supplemented with isolated fibular collateral ligament grafting. The results obtained were evaluated clinically using the Lysholm scale (1982), by determining the subjective assessment of treatment outcomes, and by functional X-ray and MRI. The results of the treatment were studied in all injures: in the main group in 9 months, in the comparison group on average in 16 months after the surgery (from 9 to 43 months). ***Results.*** The use of the developed diagnostic and surgical methods made it possible to improve the clinical and functional results by the Lysholm scale: the main group 82 [70; 86] points vs the control group 68 [64; 76] points (p = 0.003). The II degree residual lateral instability was observed in 2 patients of the main group and in 7 patients of the control. 19 (79.2%) patients in the main group and 18 (66.7%) in the control were satisfied with treatment outcomes according to the scale of subjective assessment. There were no patients who rated the result of their treatment as "good" in the both groups. ***Conclusion.*** The practical employment of the proposed modification of the fibular collateral ligament grafting by the LaPrade in the patients with multiligament knee injury makes it possible the statistically significant improvement of the treatment functional results after the reconstructive surgery in the medium term (9 months) compared with the patients undergone isolated fibular collateral ligament grafting. The unsatisfactory results of the treatment caused by the severity and morphological features of the injuries. They require further study, as well as the improvement of the surgical techniques.

Keywords: multiligament injury, fibular collateral ligament injury, knee ligament apparatus reconstruction.

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Introduction

Multiligament knee injuries (MLKI) include the injuries that characterized by the rupture of two or more of its main stabilizing elements: anterior cruciate ligament (ACL) and posterior cruciate ligament (PCL), as well as fibular collateral ligaments (FCL) and tibial collateral ligaments (TCL). In most cases, the cause of these injuries is the dislocation of the lower leg, resulting from an indirect (rotation around the fixed lower leg) or, less often, direct (impact on the upper third of the lower leg in the sagittal plane) mechanical impact on the knee joint. The prevalence of these injuries ranges from 0.02 to 5.3% among all injuries of the musculoskeletal system [1, 2, 3, 4, 5, 6]. The most recognized MLKI classification is by Jr. R.C. Schenck [7] (Table 1).

One of the most complex, prognostically unfavorable and poorly studied is the MLKI with FCL rupture. These include R.C. Schenck KDIL, KDIIIL, KDIV and KDV types injuries. As a rule, such injuries are the result of a high-energy trauma. They are inevitably accompanied by the development of multidirectional (multiplanar) knee instability with pronounced limb dysfunction [1, 3, 8, 9, 10, 11].

A serious complication of such types of MLKI is the common peroneal nerve (CPN) neuropathy, the rate of which in case of tibial dislocation reaches 40% [6, 9, 11, 12, 13]. The rate of CPN functional recovery after axonotmesis/neurotmesis in such injuries vary from 14 to 40% [6]. It is the persisting post-traumatic neuropathy that largely determines the lower extremity functionality, including after the knee ligamentous apparatus (KLA) plastic surgery [6, 12, 13, 14, 15].

It is well known that the refusal of surgical treatment of the patients with MLKI leads to the preservation of its pronounced multiplanar instability, progression of degenerative-dystrophic changes and significant dysfunction of the limb [1, 2, 3, 9, 10, 15, 16]. Cruciate ligament reconstructions, including simultaneous reconstructions, become routine in everyday orthopedic practice. However, diagnostic methods, tactics, and plastic surgery techniques in the patients with MLKI, including FCL rupture, are the subject of scientific discussions. These issues, together with the objective difficulties of the above mentioned injuries diagnostics, determine the need for further improvement of the patients with MLKI surgical treatment.

The purpose of this study was to compare the results of surgical treatment of the patients with MLKI by two different techniques, including the ligament-tendon complex injury of the knee posterolateral angle (KPLA).

Table 1

The R.C. Schenck multiligament injuries classification [7]

Type of injury		Injured structures
Knee dislocation I	Knee dislocation I medial	ACL or PCL, TCL
	Knee dislocation I lateral	ACL or PCL, FCL
Knee dislocation II		ACL + PCL
Knee dislocation III	Knee dislocation III medial	ACL + PCL + TCL
	Knee dislocation III lateral	ACL + PCL + FCL
Knee dislocation IV		ACL + PCL + TCL + FCL
Knee dislocation V		Knee dislocation I–IV combined with knee periarticular fractures

KD – knee dislocation, ACL – anterior cruciate ligament, FCL – fibular collateral ligament, PCL – posterior cruciate ligament, TCL – tibial collateral ligament.

Materials and Methods

The study design

It was an observational cohort non-randomized trial.

The study included 58 patients with MLKI treated at the Combat Traumatology and Orthopedics Department of the Kirov Military Medical Academy from 2007 to 2019.

The inclusion criteria for the study were damage to one or both cruciate ligaments in combination with FCL rupture and a healthy contralateral knee.

The exclusion criteria were concomitant severe knee dystrophic-degenerative changes, intraarticular fractures, and the multiple injury. Seven patients were excluded from the study. It was not possible to track the long-term outcome in 4 patients, the fibular head fracture was diagnosed in 1 patient, and severe articular cartilage degenerative changes were diagnosed in 2 patients (Fig. 1).

Patients

The age of the patients varied from 19 to 57 years (on average 32.1±9.2 years), all the injured were men. On admission, 4 patients out of 51 (8%) had a lower leg subluxation, requiring urgent reduction; 20 patients (39%) had a fresh self-corrected lower leg subluxation. The remaining 27 (53%) patients were admitted to our Department with chronic KLA injury occurred from 1 month up to 3 years (average 14±8.2 months) with their lower leg dislocations or subluxations reduced. The injury was high-energy in most cases: 23 of 51 (45%) patients obtained their injury during physical training (passing an obstacle course, unsuccessful parachute landing, riding a bicycle, etc.), 5 (10%) – exercising jumps over a horse, 4 (8%) – falling from a height, 12 (24%) – playing sports and martial arts, one (2.0%) – explosing in an armored vehicle. Six (12%) patients received a low-energy injury in everyday life conditions when the lower limb was twisted. Four of these patients had a body mass index greater than 32 kg/m^2.

All our patients were divided into 2 comparing groups depending on the chosen technique for FCL reconstruction.

The patients of the main group underwent reconstruction of the cruciate ligaments and the main structures of the PLA: the FCL, the popliteofibular ligament (PFL) and the popliteus tendon. The patients of the comparison group underwent the cruciate ligaments reconstruction supplemented with isolated FCL grafting.

The hypothesis that the both groups were formed from the same population was tested using the Pearson χ^2 test. There were no sta-

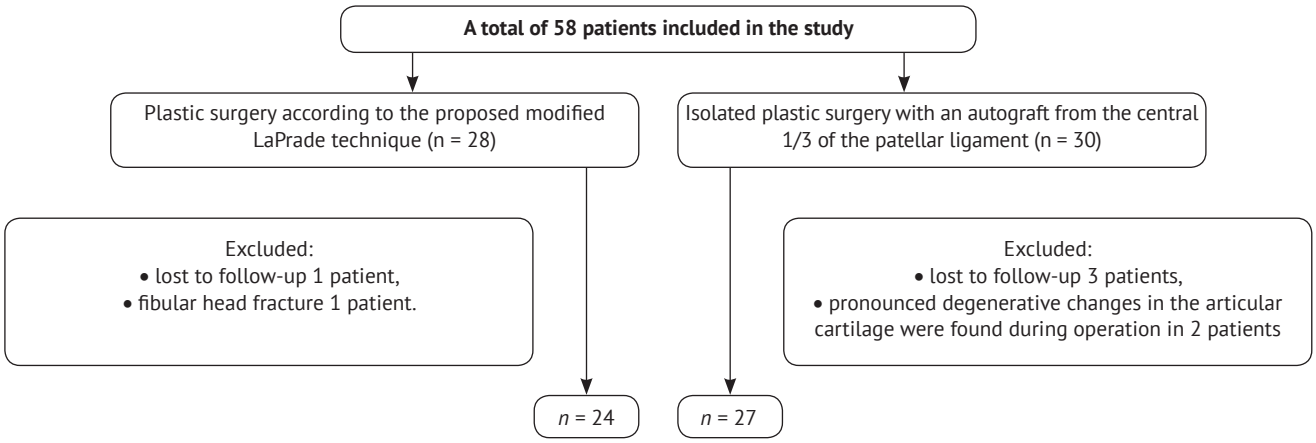

Figure 1. A patients flowchart

tistically significant differences (p> 0.05) between the comparing groups.

The patients distribution according to the R.C. Schenck MLKI classification is presented in Table 2.

Twelve out of 51 patients (7 in the main group and 5 in the control) were diagnosed with CPN neuropathy; 3 patients recovered by their own within 6 to 8 weeks after the injury. The rest patients needed the surgical treatment.

Surgical technique

Our proposed method comprised the use of a soft tissue autograft from the semitendinosus tendon and its precision anatomical four-point fixation on the femoral epicondyle, the lateral tibial condyle and the fibular head (RF patent 2735997). The principal differences of our modification from the original LaPrade operation [17] were the use of a single semitendinosus tendon autograft with a minimally sufficient length of 22 cm, the refusal to form a through channel in the proximal tibial metaepiphysis, and the use of the autograft cortical fixation to the tibia for autograft tension (Fig. 2).

This operation was supplemented with the ACL (7 cases out of 24 or 29%), PCL (3 cases or 13%) or both (14 cases or 58%) grafting (Table 3).

Twelve (50%) patients underwent ACL and PCL grafting simultaneously with FCL, 2 (8%) patients underwent two-stage FCL grafting. The 1st stage comprised only PCL grafting. The 2nd stage, consisted of ACL grafting, was carried out in 3 to 9 months after the 1st stage. In the case of a one-stage reconstruction, the grafting began from the PCL.

Table 2

Distribution of patients according to the R.C. Schenck classification

Type of injury	The main group n/%	The comparison group n/%	Total n/%
Knee dislocation I lateral	10/42	11/41	21/41
Knee dislocation III lateral	12/50	15/55	27/53
Knee dislocation IV	2/8	1/4	3/6
ALTOGETHER	24/100	27/100	51/100

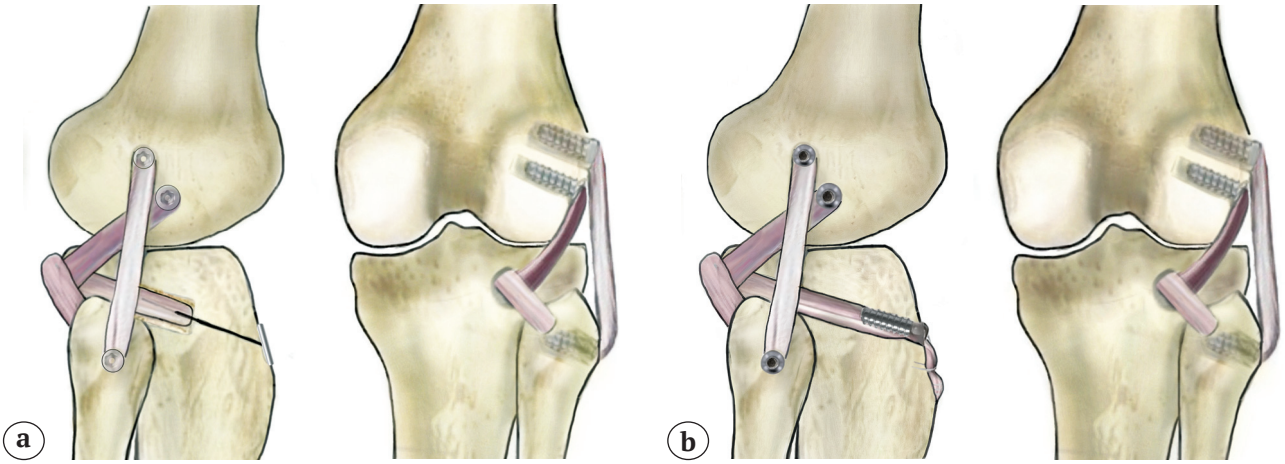

Figure 2. The schemes of modified (a) and classical (b) reconstruction of the popliteus tendon, popliteofibular ligament and fibular collateral ligament by LaPrade (author - I.S. Bazarov)

Table 3

Distribution of the patients in the comparing groups depending on the selected graft for ligament reconstruction

Grafts	The object of reconstruction								
	ACL			PCL			KPLA		
	MG	CG	Total	MG	CG	Total	MG	CG	Total
Semitendinosus autograft	19	15	34	–	10	10	24	–	24
Bone-tendon-bone autograft	2	8	10	14	7	21	–	27	27
Achilles tendon allograft	–	–	–	3	3	6	–	–	–

ACL – anterior cruciate ligament, CG – comparing group, MG – main group, PCL – posterior cruciate ligament, KPLA – knee posterolateral angle.

The final tension of the cruciate ligament grafting was performed after the reconstruction of the KPLA stabilizing structures as a separate surgical step.

The comparison group included 27 of 51 patients (53%) undergone only FCL grafting with the implant taken from the central third of the patellar ligament by the LaPrade method [18] (Fig. 3).

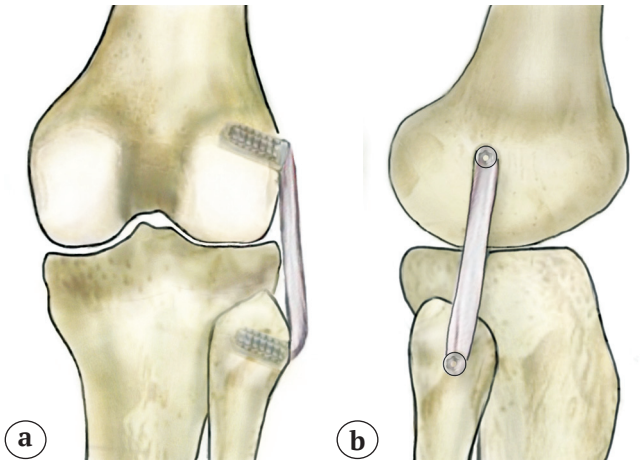

Figure 3. The scheme of the isolated fibular collateral ligament reconstruction (author - I.S. Bazarov)

This operation was also supplemented with the ACL (7 out of 27, 26%), PCL (4 observations, 15%) or both cruciate ligaments (16 observations. 59%) grafting (see Table 3). Nine patients (33%) underwent the ACL and PCL grafting simultaneously with FCL reconstruction, 7 patients (26%) underwent the FCL reconstruction performed at the same time with the PCL grafting. The ACL grafting was performed on a delayed basis, 3 to 9 months after the 1st step.

In both comparing groups, the surgery of the patients with the fresh trauma was performed in 21 to 27 days after the injury. This time was enough to relieve soft tissue edema and seal the injured joint capsule. The latter made it possible to perform the surgery arthroscopically.

The patients distribution in the comparing groups depending on the selected graft for ligament reconstruction is shown in Table 3. It follows from the table data that in the ACL reconstruction, the preference was given to semitendinosus autograft, and in the PCL repair – to bone-tendon-bone autograft. The both types of grafting were used for the KPLA reconstruction. The autograft was taken from the contralateral limb.

Six patients, out of 9 with CPN neuropathy persisted by the grafting time, underwent the KPLA structures grafting with simultaneous neurolysis, and the other 3 patients – to simultaneous delayed epineural suture.

The patients examination

On admission, all the patients underwent the clinical examination supplemented by the standard X-ray, full support load on the limb in the frontal plane X-ray, functional X-ray in the full extension (0°) and with 140° flexion, as well as the knee MRI. The patients

of the main group underwent the functional X-ray assessment of the instability type and severity by the original method using a specially developed device (the patent for utility model No. 197909 of October 1, 2020) (Fig. 4).

The severity of the knee joint instability was determined in accordance with the X-ray criteria described in the decree of the Government of the Russian Federation No 565 of 04.07.2013 "On the Approval of the Regulations of the Physical Disability Evaluation in the Military." The presence of varus instability II and III degree along with MRI data were considered a confirmation of the FCL rupture.

The patients with concomitant CPN neuropathy additionally underwent the electrophysiological study of impulse conduction along sensory and motor fibers using the Neuro-MEP-4 apparatus (Neurosoft, Russia), as well as the nerve ultrasound (US) examination using the SonoSite M-Turbo apparatus (Fujifilm, USA). In order to exclude the lower extremities venous thrombosis, all the patients underwent the lower extremities vessels US examination.

The clinical picture of the patients with fresh trauma (9 injured in the main group and 15 in the control) was determined by the severe pain syndrome, painful muscle hypertonia, hemarthrosis, and extensive bleeding in soft tissues, which interfere with the knee joint instability diagnosis. The functional X-ray testing in these patients was performed no earlier than in 3 weeks after the injury. 27 patients with chronic MLKI (14 in the main and 13 in the comparison group) presented the clinical picture of prevailing multidirectional instability of the knee joint and, as a consequence, the impaired support function of the lower limb. Individuals with CPN neuropathy had characteristic peripheral sensory disturbances and the absence of foot dorsiflexion.

The MRI made it possible to diagnose MLKI, the morphology of which formed the basis for the distribution of the injured in accordance with the R.C. Schenck classification. The MRI also revealed concomitant damage to the menisci and cartilage. All traumatic changes verified by MRI were confirmed during diagnostic arthroscopy and were treated.

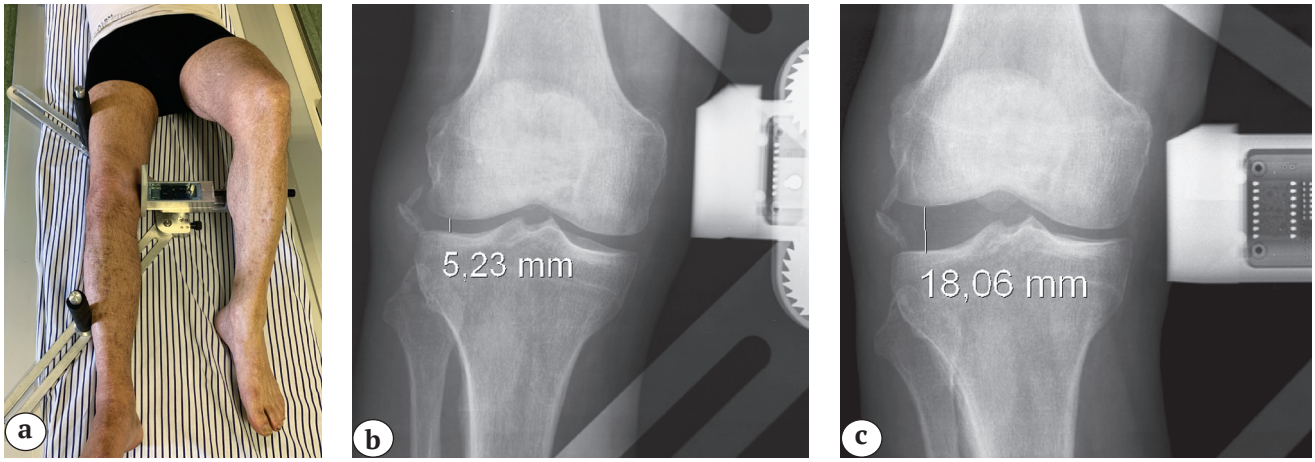

Figure 4. The functional knee X-ray in the patient with fibular collateral ligament injury:
a — the appearance of the limb with a device for functional X-ray; b — the knee X-ray in frontal plane without load; c — the knee X-ray in frontal plane with a load in the patient with fibular collateral ligament complete rupture

The functional X-ray examination provided the diagnosis of multidirectional knee instability, including lateral instability.

US examination revealed lower extremities veins thrombosis in 5 (10%) patients with fresh leg subluxation (in 2 patients – superficial and in 3 patients – deep). 3 patients with floating thrombotic masses underwent surgery no earlier than 3 weeks later after repeated US examination confirmed the thrombus recanalization. A removable vena cava filter was implanted for a floating thrombus over 70 mm long in 2 patients. There were no US signs of the lower extremity arteries injury.

Assessment of results

The control examination of the main group patients was carried out in 9 months after the surgery. The control examination of the comparing group patients was undertaken in 9 to 42 months after their knee ligaments reconstruction (on average in 16 months). It included a traditional local status clinical examination, Lysholm testing to assess the patient's satisfaction with the treatment result according to a traditional ranking scale (good, satisfactory, and unsatisfactory), the knee MRI, and functional knee X-ray.

Statistical analysis

The distribution of the assessment results on the Lysholm scale (1982) and on the scale of subjective assessment of treatment outcomes according to the Shapiro-Wilk test showed no compliance with the law of normal distribution ($p<0.01$). Therefore, the median and quartiles Me [Q25%; Q75%] were used to describe the numerical characteristics of these quantitative characteristics. The quantitative traits differences in both groups were assessed using the Student's t-test and for not normally distributed data – by the Mann-Whitney U test. The hypothesis on the origin of the groups formed according to a qualitative trait from the same population was tested using the Pearson χ^2 test.

Results

The functional results

During the control clinical examination of the patients in the main group, the II degree residual lateral instability was observed in 2 patients. One of them required a revision (FCL allografting). In the control group, the II degree residual lateral instability was observed in 7 patients, 4 of them underwent revisions with the FCL, popliteus tendon and the PFL allografting. All just mentioned 9 patients with clinically identified lateral instability underwent a control functional X-ray examination according to our method (patent for a useful model No. 197909 of October 1, 2020). This allowed us to determine the degree of instability. One patient of the main group revealed the flexion limitation to an angle of 135°. Two patients of the comparing group were found to have the flexion limitation to an angles of 130° and 120°, although without signs of residual instability.

All 9 patients with CPN post-traumatic neuropathy, undergone neurosurgery, kept the signs of neurological deficit to one degree or another in the form of dorsiflexion lack and sensory impairment.

The assessment of functional results by the Lysholm scale after the treatment was 73 [65; 82] points, the range – 41 points (48; 89). The patients with KDIL-type injuries had the Lysholm score 78 [74; 86], which was significantly ($p<0.01$) higher than in the patients with KDIIIL-type lesions – 68 [64; 82] (variability from 56 to 88 points). There were 3 patients with type KDIV lesions, with scores of 64, 72 and 73 points.

The lowest Lysholm score was noted among the patients with unrecovered CPN function – 62 [60; 68] points, which significantly ($p<0.001$) differed from the patients without neuropathy – 78 [68; 86] points.

In the patients undergone the surgery relatively early after the injury (up to 5 weeks, the Lysholm score was 72 [65; 81] points

(variability from 48 to 88 points), and in the sample of the patients with chronic KLA injury – 74 [68; 86] points (variability from 48 to 89 points) without statistically significant difference between the groups (p> 0.05).

Comparison of the results achieved in the study groups by the Lysholm scale indicates the advantages of the surgical approaches used in the patients of the main group. In this group the Lysholm score was significantly (p=0.003) higher and amounted to 82 [70; 86] points vs 68 [64; 76] in the comparing group (Fig. 5).

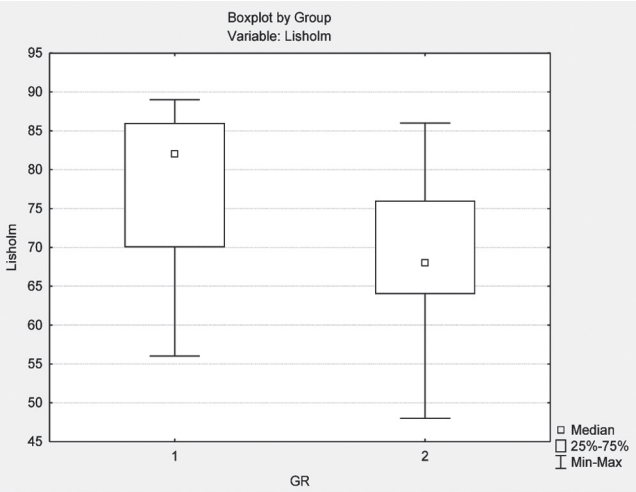

Figure 5. The treatment results according to the Lysholm scale in the compared groups:
1 - main group: 2 - control group

MRI

The MRI signs of degenerative-dystrophic changes of varying severity in the knee main and auxiliary elements observed in most patients: 15 (62.5%) in the main and 20 (74.1%) in the comparing groups, specifically synovitis (12 and 11), chondromalacia (8 and 11), trabecular edema (7 and 11), respectively. It should be noted that 2 patients in the main group and 7 patients in the comparing group with residual knee joint instability were included in the clinical cases described above with MRI signs of synovitis, chondromalacia, and trabecular edema.

The subjective assessment

The subjective assessment of the surgical results showed that the patients unsatisfied with their treatment outcomes were mainly those with persistent CPN neuropathy (5 in the main and 4 in the comparing group), with severe knee contracture (1 and 2) and persisted lateral instability (2 and 7), respectively. The young patients, actively involved in sports before injury and were not able to return to their previous type and level of physical activity, were unsatisfied either. 19 patients in the main and 18 in the comparing groups were satisfied with the achieved outcomes of the surgery. There were no patients rated the result of their treatment as good in the both groups.

Discussion

This article presents the experience of the Combat Traumatology and Orthopedics Department of the Kirov Military Medical Academy in the surgical stabilization of the knee of 51 patients with MLKI. The data analysis, provided using the Lysholm scale, showed that the FCL, popliteus tendon and FPL restoration demonstrated statistically significant advantages in comparison with FCL isolated repair (p=0.003). In the study by C. Shane et al., the patients with R.C. Schenck KDI (78 patients) and KDIIIL (22 patients) types of injury prevailed. There were only 4 KDIV-type injured. Therefore, the patients' ratio KDI/KDIIIL/KDIV was 20/6/1 [19]. All our patients had an FCL injury, combined with a rupture of one or both cruciate ligaments (51 injured) with the KDIL – 41%, KDIIIL – 53% and KDIV – 6%, which correlated as 7/9/1. The lower proportion of the KDIL type of injury among our patients in comparison with C. Shane et al. study can be explained by the fact that in their work the KDI type included MLKI to both FCL and TCL. Although, R. Schenck noted the predominance of precisely the knee lateral sta-

bilizing structures impairment among the KDI type injured [7]. The prevalence of the KDIIIL type of injury in our study in comparison with the literature can be explained, in our opinion, by our patients peculiarities (45 of injured or 88% were young men) and the nature of the traumas. They were predominantly high-energy traumas during combat, special or physical exercises.

Twenty four (47.1%) our patients were admitted to our Department in 3 weeks after the injury, and 27 (52.9%) had chronic knee instability due to its MLKI. Another ratio of acute (up to 3 weeks) trauma to chronic (more than 3 weeks) was shown by R. LaPrade et al. They analyzed 71 patients with MLKI: 30% to 70% [20]. T. Neri et al. reported one more ratio: 66% of their patients were presented with acute trauma (up to 3 weeks), 19% – with subacute (from 3 weeks to 3 months), 15% – with chronic injury [21].

The patients with damage to the CPN injury from the lower leg dislocation had poor functional results of the MLKI surgical treatment [6, 12, 13].

M.W. Jarret et al., based on the analysis of 13 publications containing the data on 686 tibial dislocations, reported the CPN injury average rate of 26% [13]. Our data were quite comparable to M.W. Jarret et al. results, namely the rate of the CPN injury reached 24%.

Also, according to the M.W. Jarret et al. data, the probability of the CPN function restoration after various treatment options, including conservative neurotropic therapy, neurolysis, nerve grafting, motor fiber transfer and a combination of these procedures, reaches 38% [13]. In our study, the complete restoration of the CPN function after the conservative treatment took place in 3 patients out of 12 (25%). The surgical treatment of the remaining 9 (75%) failed. This differed significantly from the literature data and largely determined the functional outcome of the treatment in the comparing groups.

Diagnostic and therapeutic tactics in the acute period of injury involves the implementation of the fastest possible reduction of the lower leg dislocation, knee stress X-ray and MRI, US examination of the lower extremity vessels, and electroneuromyography in case of neurological deficit [1, 6, 12, 13, 14, 22, 23]. The patients included in our study were also examined in accordance with these provisions, however, a feature of the diagnostics was the use of a specially designed device for functional X-ray to objectify the MLKI types and severity. Unlike the existing domestic and foreign analogues, this device made it possible to unify the method of stress X-ray and to objectify its results, which is of great importance for the physical disability evaluation and insurance coverage of military personnel. The proportion of the patients with popliteal vein thrombosis admitted to our clinic within 3 weeks after the injury (5 out of 24 injured) was comparable to the data of T.L. Sanders et al. [24].

To date, numerous types of the surgery for knee stabilization in the patients with MLKI have been developed and used in the world. However, an unambiguous opinion on the surgical treatment of such patients has not yet been developed [9, 15, 23, 25, 26, 27, 28, 29]. M. Srtrobel et al., emphasizing the need to restore all torn ligaments in one stage, considered the 1st week after the injury to be optimal for the surgery [30]. At the same time, other researchers, based on the results of their own studies, believed that the staged reconstruction of the injured ligaments was also possible [25, 31, 32]. Our clinical experience indicates that it is advisable to reconstruct the injured ligaments no earlier than in 3 weeks after the trauma. This can be explained by the need to create favorable conditions for the healing of the torn knee capsule.

Most orthopedic traumatologists agree that both in the case of cruciate ligaments and structures of the lateral ligament complex rupture, the maximal anatomical reconstruction of all injured knee stabilizers is required, since only this provides the full recreation of the knee normal biomechanics [2, 9, 10, 17, 21, 27, 32, 33].

The modern options of the knee ligaments reconstruction in case of MLKI, accompanied by the KPLA structures injury, include the anatomical restoration of all impaired elements, including the FCL, the popliteus tendon and the PFL [2, 9, 10, 11, 16, 33, 35, 36]. However, in practice, the surgical treatment of KPLA structures total rupture is often limited only to FCL grafting [9, 11, 17]. According to the Mayo Clinic, in the period from 2004 to 2014, in the treatment of the patients with MLKI, accompanied by the KPLA structures total injury, the reconstruction of all impaired structures was performed only in 17.1% of cases. 75.5% of the patients underwent only limited FCL grafting [37].

Currently, the most popular method of MLKI treatment is the proposed in 2004 by R. LaPrade [17]. It comprises the anatomical two-bundle FCL reconstruction with the popliteus ligament and PFL grafting. We used the modified R. LaPrade technique to treat the patients of the main group (24 injured). Our method consisted of the knee lateral stabilizing structures autoplasty by a single autograft formed from the semitendinosus tendon combined with various injured cruciate ligaments grafting. A significant difference between our variant and the R. LaPrade method is the employment of the single autograft from the semitendinosus tendon for anatomical reconstruction of all injured KPLA structures.

G. Fanelli et al. presented the analysis of the MLKI surgical treatment based 20 clinical cases. Their data indicated that the anatomical reconstruction of the cruciate ligaments and KPLA structures should be performed not later than 2 to 3 weeks after the injury. Their assessment of the patient treatment results by the Lysholm scale was 91.1 points [38]. Our results, on average 82 points, are comparable with G. Fanelli et al. data. In our opinion, the main value of our study results is the confirmation of significant differences in the anatomical and functional outcomes of surgical treatment of the comparing groups. This convincingly testifies to the advantages of our method of knee joint stabilization.

Study limitations

It should be borne in mind interpreting the results of this study that it is not without a number of limitations. Our research included a prospective group with retrospective control. The trial was devoted to the results of treatment outcomes of a fairly rare pathology. The consequences of this were the heterogeneity of the patients age distribution and MLKI morphology. Besides, the comparing groups were heterogeneous in terms of the cruciate ligament grafting technique and the presence of the menisci and articular cartilage injury. These factors were likely to also determine the outcome of surgical treatment. In our observational study, we made an attempt to evaluate the functional and subjective results of treatment using two fundamentally different options of the knee lateral stabilizing structures restoration, namely the isolated FCL and all KPLA stabilizers grafting. The authors are aware that our follow-up for 9 months cannot be considered as full evidence of the significant role of our method in achieving and maintaining the lateral stability of the knee. The further follow-up is required to confirm the effectiveness of the presented surgical technique.

Conclusion

The treatment results of the patients with FCL injury depend on the features of the KLA reconstruction, the degree of the knee residual instability and developed postoperative contracture. The surgical treatment outcomes in the patients with persisting CPN neuropathy and high functional demands, remain unsatisfactory. One of the ways to improve the functional results of such patients treatment may be the one-stage anatomical reconstruction of the FCL in combination with the popliteus tendon and PFL grafting. This type of surgery, when it is performed

as a components of the KLA reconstruction, makes it possible to reach the statistically significant (p = 0.003) improvement of the treatment outcomes in the patients with MLKI.

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Ethical approval for this study was obtained from local ethics committee of Kirov Military Medical Academy.

Informed consent

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V.V. Khominets – research concept and design, text editing.

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