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Results of reconstruction of the structures of the posterolateral corner in combination with anterior cruciate ligament surgery

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The results of treatment of patients with damage to the structures of the posterolateral corner in combination with anterior cruciate ligament (ACL) surgery are presented. The purpose of the work was to evaluate the results of reconstruction of combined injuries of the anterior cruciate ligament and structures of the posterolateral corner under arthroscopic control based on a comparative analysis of the results and complications. The study group consisted of 26 patients, the comparison group consisted of 27. As part of the examination, the VAS, IKDS, Tegner, Lysholm and KOOS scales were determined in both groups of patients, and the dynamics of osteoarthritis progression according to the Kellgren and Lawrence classification were also assessed. The results of arthroscopically guided reconstruction of the posterolateral corner, combined with ACL reconstruction, were quite promising: the overall IKDS score was: A19, B5, C2, D0. The majority of patients (87.50 %) were very or moderately satisfied with the treatment results. A comparative analysis of functional and radiological results showed that the stability of the knee joint based on the IKDS score was better in the group of patients with arthroscopically guided reconstruction of the posterolateral corner in combination with ACL reconstruction, and this group also had a lower rate of progression of osteoarthritis. Arthroscopic intervention using the original technology using a tendon graft is combined with the minimally invasive arthroscopic technique "all-inside" for ACL reconstruction. The results of this work argue for the good stability of anatomical reconstruction by arthroscopic intervention technique, which can be recommended as a valuable alternative method of plastic surgery of the structures of the posterolateral corner of the knee joint. Conclusion. Arthroscopic surgery of the structures of the posterolateral corner of the knee joint in case of combined injury with rupture of the ACL can be recommended as an alternative method compared to open surgery.

Наведено результати лікування пацієнтів із ушкодженням структур задньолатерального кута в поєднанні з пластикою передньої схрещеної зв'язки (ПСЗ). Мета. На основі порівняльного аналізу результатів та ускладнень вивчити наслідки реконструкції комбінованих ушкоджень передньої схрещеної зв'язки та структур задньолатерального кута під артроскопічним контролем. Методи. Групу дослідження склали 26 пацієнтів, порівняння — 27 осіб. У межах обстеження в обох групах визначали показники шкал VAS, IKDS, Tegner, Lysholm та KOOS, а також аналізували динаміку прогресування остеоартрозу за класифікацією Kellgren та Lawrence. Результати. Відновлення структур задньолатерального кута під артроскопічним контролем, які поєднувалися з реконструкцією ПСЗ, виявилося досить багатообіцяючим: загальний показник шкали IKDS склав: A19, B5, C2, D0. Більшість пацієнтів (87,50 %) результатом лікування дуже чи просто задоволені. Порівняльний аналіз функціональних і радіологічних даних показав, що стабільність колінного суглоба на підставі шкали IKDS була кращою в групі пацієнтів із відновленням структур задньолатерального кута під артроскопічним контролем у комбінації з пластикою ПСЗ, у цій групі відзначено також меншу питому вагу прогресування остеоартрозу. Артроскопічне втручання за оригінальною технологією з використанням сухожилкового трансплантата комбінується з мінімально інвазивною артроскопічною технікою «all-inside» для реконструкції ПСЗ. Результати цієї роботи аргументують хорошу стабільність анатомічної реконструкції шляхом артроскопічної техніки втручання. Висновок. Артроскопічна пластика структур задньолатерального кута колінного суглоба за комбінованого ушкодження з розривом ПСЗ може бути рекомендована як альтернативний метод порівняно з відкритою пластикою. Ключові слова. Колінний суглоб, травма, нестабільність, передня схрещена зв'язка, реабілітація.

Key words. Knee joint, injury, instability, anterior cruciate ligament, rehabilitation

Introduction

The diagnosis and management of combined anterior cruciate ligament (ACL) injuries present significant challenges, due to ongoing questions regarding anatomical considerations, biomechanical factors, reconstruction techniques, and evaluation of patient clinical outcomes. ACL injuries are common, and the combination with lesions of the posterolateral corner structures occurs in 9 % of all ACL injuries [1, 3, 4, 10]. Concomitant injury to the posterolateral knee joint components is mostly diagnosed with lesions of the posterior cruciate ligament, the incidence reaches 80 % [2, 7, 11].

Damage to the structures of the posterolateral corner in combination with ACL tears is one of the most difficult cases to detect. Diagnostic criteria are described as very variable [8, 9, 16]. Such injuries occur much more often than they are suspected. Damage to the structures of the posterolateral corner may often go undiagnosed in clinical practice, which can result in repeated ACL ruptures or patients presenting years later with pain in the lateral aspect of the knee joint.

The debate surrounding the surgical approach to the posterolateral corner structures stems from the lack of consensus on the optimal technique and the limited number of published results that demonstrate complete restoration of knee joint stability. A solid understanding of the anatomy and biomechanics of the posterolateral corner is essential for grasping the injury mechanism and determining the appropriate treatment strategy for patients with combined rotational external knee instability.

It is quite difficult to track a large body of data on the results of restoration of the ACL and structures of the posterolateral corner. This is partly because signs of injuries in this area are most effectively detected during a clinical examination of the knee, while MRI can typically visualize them only within the first 2–4 weeks. The indications for reconstructing the posterolateral corner structures remain unclear, and surgical approaches vary depending on the hospital's practices. As a result, there is still much room for improvement, which drives the ongoing search for alternative treatment methods for this condition. The most commonly used approach involves auto- or allotendinous grafts, as described by LaPrade [12, 13], performed via an external approach, involving the preparation of the lateral structures of the knee. Recently, arthroscopic techniques have emerged, utilizing existing instruments and approaches to the knee joint in various ways. By employing a novel arthroscopic method for reconstructing the posterolateral corner structures, we have achieved promising results in restoring function in cases of combined injuries to the posterior cruciate ligament [6, 9, 15]. This method has also been applied in cases of ACL ruptures combined with injuries to the posterolateral corner structures.

Objective: to study the consequences of arthroscopic reconstruction of combined injuries of the anterior cruciate ligament and posterolateral corner structures based on a comparative analysis of outcomes and complications.

In line with the objective, we divided the patients into two groups. The first group consisted of patients who underwent the more commonly used method of arthroscopic ACL reconstruction combined with open surgery to reconstruct the posterolateral corner structures of the knee. The second group included patients who received arthroscopic ACL reconstruction alongside the original arthroscopic technique for restoring the posterolateral corner structures. We then analyzed and compared the outcomes of both groups to evaluate the effectiveness of the treatments.

Material and methods

The analysis of clinical material was carried out in accordance with the protocol of the Bioethics Commission of Zaporizhzhia State Medical and Pharmaceutical University (Protocol No. 8 dated 26.12.2022). The study was carried out in compliance with the requirements and provisions of the Helsinki Declaration of Human Rights (2000), including the revision of EC-GCP, the Constitution and the fundamentals of Ukrainian legislation on healthcare. All patients provided written consent for examination and treatment.

The results of treatment of two different groups of patients were analyzed. The first group comprised 26 patients who underwent arthroscopic reconstruction of the posterolateral angle using an autograft from the semitendinosus tendon and ACL reconstruction using an autograft from the quadriceps tendon. The second group involved 27 patients, ACL reconstruction was also performed using an autograft from the quadriceps tendon, and reconstruction of the posterolateral angle was performed using an open external approach using an autograft from the semitendinosus tendon.

The first group, arthroscopic reconstruction of the posterolateral angle

In the period from 2019 to 2023, 26 patients (22 men and 4 women) were operated on for acute or chronic posterior instability. Combined reconstructive and revision interventions were included in this

study. In all cases, there was a combined injury to the ACL and the structures of the posterolateral angle. In 11 (42.31 %) patients, the ligament rupture occurred due to sports injuries, in 12 (46.15 %) due to traffic accidents, in 3 (11.54 %) due to other reasons. The diagnosis was made on the basis of clinical examination, radiography and magnetic resonance imaging (MRI). The operations were performed arthroscopically: the ACL was restored with a graft from the quadriceps tendon (QT, one tendon bundle) using the all-inside method. Reconstruction of the posterolateral corner structures was performed using the original technique under arthroscopic control with an autograft from the semitendinosus tendon, the results of which were published previously [9, 15]. Additionally, medication, physical rehabilitation, and splint immobilization were administered according to the standard protocol followed after anterior cruciate ligament reconstruction.

Group 2, open reconstruction of posterolateral angle structures

27 patients (25 men and 2 women) were operated on between 2004 and 2015 for acute or chronic anterior instability. Combined reconstructive and revision interventions were included in this study. In all cases, there was a combined injury to the anterior cruciate ligament and the structures of the posterolateral angle. In 9 (33.33 %) individuals, the ligament rupture occurred due to sports injuries, in 16 (59.26 %) due to traffic accidents, and in 2 (7.41 %) due to other causes. The diagnosis was made on the basis of clinical examination, radiography and MRI. The operations were performed arthroscopically with an autograft from the quadriceps tendon using the all-inside method (QT, one tendon bundle). Reconstruction of the posterolateral angle structures was performed through external access using the LaPrade technique with an autograft from the tendon of the semitendinosus muscle [4, 5, 9, 12–14]. Additionally, medication, physical rehabilitation, and splint immobilization were administered according to the standard protocol followed after anterior cruciate ligament reconstruction.

During the examination, the VAS, IKDS, Tegner, Lysholm, and KOOS scales were determined in both groups, and the time course of osteoarthritis progression was assessed using the Kellgren and Lawrence classification.

Previous surgeries

Two patients in the first group (7.69 %) had previously undergone surgery on the damaged joint: 1 had undergone ACL reconstruction due to a tear; the second had previously undergone ACL refixation.

In the second group, only 1 patient (3.7 %) had previously undergone ACL reconstruction.

Concomitant interventions

Patients of the first group (16 (61.54 %)) underwent additional operations along with reconstruction of the ACL and the structures of the posterolateral angle: 5 (19.23 %) individuals underwent a suture of the lateral meniscus, in 3 (11.54 %) cases a suture of the medial meniscus, in 1 (3.85 %) meniscus, in 7 (26.92 %) patients partial removal of the damaged meniscus was performed.

Patients of the second group (17 (62.96 %)) underwent additional operations along with reconstruction of the posterior cruciate ligament: 4 (14.81 %) — suture of the lateral meniscus, 3 (11.11 %) — suture of the medial meniscus, 4 (14.81 %) — partial removal of the damaged meniscus, 5 (18.52 %) — partial removal of both damaged meniscuses, 1 (3.71 %) — removal of the metal structure.

Statistical processing of the obtained results was carried out using computer variational, nonparametric analysis of variance (Excel and Statistica 7.0 software).

Results

First group

The age of patients at the time of surgery was 13–57 years, average age 32.89 years. In 10 (38.46 %) cases, there was acute and in 16 (61.54 %) cases, there was chronic instability of the knee joint. The time interval between the injury and the provision of first aid was on average (1.38 ± 3.91) (0–20.18) years, and between the date of injury and reconstructive intervention was (1.95 ± 4.24) (0.03–20.27) years. The assessment of the condition of 12 out of 26 patients (46.15 %) was possible using a questionnaire, personal clinical examination and MRI. The status of 14 out of 26 (53.85 %) could only be determined by subjective questionnaires and MRI. All operations were performed by a single traumatologist. On average, the VAS index was (2.46 ± 1.65) (0–7), Tegner 5 (1–9), Lysholm (88.67 ± 18.98) (34–100), IKDC index (87.34 ± 18.53) (35.63–100), KOOS for pain 91–100), KOOS for function (87.3 ± 16.32) (53.57–100), KOOS for activities of daily living (90.16 ± 13.09) (51.47–100), KOOS for sports and leisure (87.74 ± 29.94) (0–10). The total score of the IKDS scale was: A19, B5, C2, D0. Most patients (87.50%) were very or moderately satisfied with the treatment results. They would agree to undergo the same amount of surgery again, knowing the results (Table 1–3).

A subjective satisfaction assessment was obtained from all 26 (100 %) patients. It indicates that 17 (65.38 %) subjects were very satisfied, 5 (19.23 %) were satisfied, 3 (11.54 %) were moderately satisfied, and 1 (3.85 %) was not satisfied.

Complications after the QT-graft removal on the knee joint were minor. Only one patient presented with pain at the site of the graft removal, as well as a painful sensation due to impaired wound healing. One patient was bothered by a crunching sound in the area of graft fixation for reconstruction of the posterolateral angle structures in the area of the external condyle of the femur.

The second group

The age of the patients was between 23 and 46 years, the average age was 28.92. The time interval between the injury and the provision of first aid was on average (2.18 ± 2.01) (0–14.21) years, and between the date of the injury and the reconstructive intervention was (1.47 ± 4.24) (0.03).

The assessment of the condition of 17 out of 27 patients (62.96 %) was possible using a questionnaire, personal clinical examination and magnetic resonance imaging.

On average, the VAS index was (2.75 ± 1.27) (0–7), Tegner 5 (1–9), Lysholm (76.75 ± 17.18) (38–100), IKDC index (75.42 ± 19.35) (34.36–100), KOOS for pain (80.92 ± 19.75) (25.83–100), KOOS for function (79.34 ± 15.26) (52.71–100), KOOS for activities of daily living (81.62 ± 15.56) (52.45–100), KOOS for sports and leisure (75.68 ± 28). IKDS was A18, B5, C4, D0. Most patients 22 (81.48 %) were very or just satisfied with the treatment results.

Subjective satisfaction was obtained from all 27 (100 %) patients.

Complications after the QT-graft harvest in the knee joint were insignificant.

Radiological evaluation of the results was carried out by comparing the Kellgren and Lawrence osteoarthritis scale before and after the operation.

All patients in the first group (26 people) underwent MRI control. Before the intervention, 19 patients (73.08 %) had doubtful osteoarthritis of stage 0, and 7 (26.92 %) had osteoarthritis of stage I. None were diagnosed with stages II or III (Table 4).

After the operation, magnetic resonance imaging was performed. The following stages of osteoarthritis were detected in the patients: 12 (46.15 %) — 0; 10 (38.47 %) — I; 4 (15.38 %) — II with slightly pronounced osteoarthritis. None of the patients were diagnosed with stage III with severe osteoarthritis (Table 4).

Table 1

Comparative subjective assessment by VAS, IKDC, activity level by Tenger

Scale	First group	Second group	P
VAS	2.46 ± 1.65 (0–7)	2.75 ± 1.27 (0–7)	> 0.05
IKDC	87.34 ± 18.58 (35.63–100)	75.42 ± 19.35 (34.36–100)	< 0.01
Lysholm	88.67 ± 18.98 (34–100)	76.75 ± 17.18 (38–100)	> 0.05
Tegner	5 (1–9)	5 (1–9)	< 0.01

Таблиця 2

Оцінка результатів за шкалою KOOS

Показник	First group	Second group	P
Pain	91.22 ± 18.15 (27.78–100)	80.92 ± 19.75 (25.83–100)	> 0.05
Symptom	87.30 ± 16.32 (53.57–100)	79.34 ± 15.26 (52.71–100)	< 0.01
Activity in daily life	90.16 ± 13.09 (51.47–100)	81.62 ± 15.56 (52.45–100)	> 0.05
Sports and leisure	87.31 ± 29.94 (0–100)	75.68 ± 28.56 (0–100)	< 0.01

Таблиця 3

Оцінка за шкалою IKDC

Показник	First group	Second group
Mobility	A-20, B-6, C-0, D-0; 76.9 %, 23.1 %	A-20, B-5, C-2, D-0; 74.1 %, 18.5 %, 7.4 %
Stability	A-20, B-4, C-2, D-0; 67.9 %, 15.4 %, 7.7 %	A-20, B-4, C-3, D-0; 74.1 %, 14.8 %, 11.1 %
Function	A-16, B-8, C-2, D-0; 61.5 %, 38.8 %, 7.7 %,	A-16, B-7, C-4, D-0; 59.3 %, 25.9 %, 14.8 %
Overall outcome	A-19, B-5, C-2, D-0; 73.1 %, 19.2 %, 7.7 %,	A-18, B-5, C-4, D-2; 66.7 %, 18.5 %, 14.8 %

All 27 patients (100 %) of the second group underwent MRI. Before the intervention, 11 (40.74 %) of them had no signs of osteoarthritis, 14 (51.85 %) had stage I osteoarthritis, and 2 (7.41 %) had mild stage II osteoarthritis. No patient was diagnosed with stage III (Table 4).

After surgery, MRI revealed that 8 (29.63 %) had no signs of osteoarthritis, 13 (48.15 %) had stage I, 4 (14.81 %) had stage II, and 2 (7.41 %) had stage III. None of the patients were diagnosed with stage IV with severe osteoarthritis (Table 4).

Complications

In the first group, complications were recorded in 1 (3.85 %) case. The patient had a hematoma in the area of graft harvesting in the area of the quadriceps tendon, which did not require drainage, so local hypothermia was performed with a continuation of the antibiotic course.

In the second group, complications were observed in 2 patients (7.41 %). Both had superficial wound healing disorders in the area of the outer knee, which were treated conservatively with dressings and a continuation of the course of antibacterial therapy.

A possible complication of this operation is damage to the peroneal nerve, which is located in the area of the instrument (needle, drill) around the posterior edge of the lateral condyle of the tibia, so its protection is a priority during such an operation.

Recurrent injury

In the first group, one patient (3.85 %) out of 26 experienced a recurrent injury. Upon examination, it was found that the patient had damage to the internal meniscus, which was subsequently repaired with suturing.

In the second group, 3 (11.11 %) out of 27 patients were injured again. Two had damage to the internal meniscus after the suture, one had an injury to the internal meniscus (which was intact during the operation).

Comparative analysis of both groups

A comparative analysis of the treatment results of patients in both groups was performed by constructing comparative tables and determining the reliability of differences in numerical indicators between the groups (Tables 1–4).

In general, statistical processing showed that the results in both groups were similar. However, there was a tendency towards better indicators in the first group of patients after arthroscopic reconstruction of the posterolateral angle structures. Some values differed more significantly in favor of this group. For example, the IKDC index, KOOS symptoms, and the progression of osteoarthritis according to Kellgren and Lawrence (Table 3–4).

Subjective comparative assessment using the VAS, IKDC, KOOS, Lysholm, and Tegner scales also showed slightly better results in the first group (Table 1–2). Moreover, a significant difference was obtained only for the VAS and IKDC. That is, the KOOS and Lysholm scales, which are recommended for use in osteoarthritis, did not reveal a significant difference.

Tegner activity was practically the same. The main differences were determined by the IKDC scales, which characterizes knee stability, and the VAS, which subjectively assesses pain syndrome.

Some heterogeneity of the IKDC scale indicators is due to the fact that in the second group there were slightly more meniscal injuries. In addition, it should be noted that arthroscopic precise positioning of the graft fixation point during the reconstruction of the hamstring muscle [15], undoubtedly, provided better stability of the structures of the posterolateral corner, which was reflected in the assessment of the results according to this scale (Table 3). It is clearly seen that the stability indicators of the knee joint are better in the first group of patients.

The progression of osteoarthritis was greater in the second group. Also, the stability indicators of the knee joint according to the results of the assessment according to the IKDC scale were slightly worse.

It is important to note that, while the KOOS and Lysholm scale results showed only minor differences,

Таблиця 4

Результати оцінки динаміки остеоартрозу за Kellgren та Lawrence

Стадія	First group		Second group		
	before surgery	after surgery	before surgery	after surgery	P
0	19 (73.08 %)	12 (46.15 %)	11 (40.74 %)	8 (29.63 %)	> 0.05
I	7 (26.92 %)	10 (38.47 %)	14 (51.85 %)	13 (48.15 %)	> 0.05
II	—	4 (15.38 %)	2 (7.41 %)	4 (14.81 %)	< 0.01
III	—	—	—	2 (7.41 %)	< 0.05
IV	—	—	—	—	—

the IKDC scale assessments were significantly more favorable in the first group of patients, who underwent the arthroscopic technique for reconstructing the structures of the posterolateral corner.

Discussion

Reconstructions of the posterolateral angle of the knee joint result in only partial restoration of the intact relationships [2, 3, 12, 14, 16]. A significant factor influencing the functional outcome is the correct position (positioning) of the graft in the area of the posterior edge of the lateral condyle of the tibial bone. In addition, we reconstruct the hamstring muscle by augmenting it with a much stiffer tendon graft. The ideal drill channel in the area of the lateral condyle of the tibial bone is formed in an anterior-posterior direction through the tibia to the projection of the place where the hamstring tendon passes. Biomechanical studies have indicated that this results in early loss of graft tension, thinning, and possible failure [4, 15, 16].

The results of arthroscopically guided reconstruction of the posterolateral angle, combined with ACL reconstruction, were quite promising: the overall IKDS score was: A19, B5, C2, D0. The majority of patients (87.50 %) were very or fairly satisfied with the treatment results. A comparative analysis of functional and radiological results showed that the stability of the knee joint based on the IKDS score was better in the group with arthroscopically guided reconstruction of the posterolateral angle in combination with ACL reconstruction, and this group also had a lower rate of osteoarthritis progression. The wide variety of surgical techniques, with a wide selection of grafts, the small number of observations and the short periods of post-operative examination limit the reliability of the results. The ideal scope of care for injuries to the posterolateral angle of the knee has diametrically different approaches in terms of surgical technique and graft selection. Arthroscopic intervention using the original technology using a tendon graft is combined with the minimally invasive all-inside arthroscopic technique for reconstruction of the ACL. The goal of ACL reconstruction is to restore the function of the knee joint. At the same time, there are numerous treatment methods (conservative and surgical), experimental concepts and recommendations (ESSKA) for the optimal elimination of posterolateral rotational instability. The results of this study argue for the good stability of anatomical reconstruction by arthroscopic intervention technique, which can be recommended as a valuable alternative method of plastic surgery of the structures of the posterolateral angle of the knee joint. The average subjective and objective results over time are promising, as evidenced by patient satisfaction, restored stability, return to sports, and a low incidence of osteoarthritic degeneration. The rate of complications is also within an acceptable range. However, this study is based on a small and heterogeneous sample of patients, meaning that the results should be interpreted with caution.

Conclusion

Arthroscopic reconstruction of the posterolateral angle of the knee joint in case of combined injury with rupture of the anterior cruciate ligament can be recommended as an alternative method compared to open reconstruction. The number of complications is low; however, it is important to note the progression of osteoarthritis and the potential risk of iatrogenic injury to the common peroneal nerve, which must be carefully protected during surgery.

Conflict of interest. The authors declare the absence of a conflict of interest.

Prospects for further research. It is planned to determine the impact of restoration of the posterolateral angle of the knee joint structures on the development of secondary osteoarthritis of the knee joint and to evaluate the differential indications for partial restoration of the posterolateral angle structures at different degrees of their damage.

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Authors' contribution. Golovakha M. L. — drafting the afrticle; Bezverkhyi A. A. — assessment of the primary material and statistical analysis; Orlyansky V. — setting the goal and objectives of the study.

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RESULTS OF RECONSTRUCTION OF THE STRUCTURES OF THE POSTEROLATERAL CORNER IN COMBINATION WITH ANTERIOR CRUCIATE LIGAMENT SURGERY

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