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PRELIMINARY FINDINGS OF THE KNEE ANTERIOR CRUCIATE LIGAMENT ONE-STAGE RECONSTRUCTION

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Introduction. Anterior cruciate ligament (ACL) injury is the most common injury to the stabilizing ligaments of the knee. Despite the technical and rehabilitative advances in primary ACL repair, the frequency of ACL re-rupture remains high.

The study is aimed to analyze the long-term outcomes of the two types of ACL revision surgery to restore knee joint function (BTB vs. ST+GT+PLT).

Methods. We performed a prospective survey using commonly accepted questionnaires: Lysholm Knee Functioning Scale, and Subjective Knee Evaluation Form, 2000 IKDC. After the two kinds of reconstruction, BTB and ST+GT+PLT, patients of the two groups were interviewed at baseline, 16-17 weeks, and 44-46 weeks after surgery. Nonparametric tests were used: Wilcoxon for checking the differences between the two samples of paired measurements and Wald-Wolfowitz for small unrelated samples. For all tests, a two-sided type I error ($p \leq 0.05$) was assumed statistically significant with a 95% confidence interval.

Results. In 2020-2021, we performed fourteen reconstructive operations with autografts, eight with BTB autografts, and six using combined ST+GT+PLT one. Pain syndrome duration (days): 28 ± 5.5 vs. 21.2 ± 5.9 (p=0.044). There were no differences between the two groups on the Lysholm scale at baseline (p 0.56); after 16-17 weeks (p=0.83); after 44-46 weeks (p=0.83); on the IKDC scale at baseline (p=0.17). Differences were revealed on the IKDC scale after 16-17 weeks - Me 75 scores vs. 81 (p=0.0028); after 44-46 weeks - Me 76 scores vs. 81 (p=0.0008).

Conclusion. In general, the ST+GT+PLT technique is found to be more promising for athletes, as it better meets the requirements of patients with an active lifestyle due to the following advantages: performing the surgery in one stage, which accelerates the knee function restoration; establishing a more massive and, at the same time elastic autograft (> 8.5 mm); reducing the duration of pain after surgery and decreasing the risk of developing osteoarthritis of the patellofemoral joint.

Keywords: *revision arthroscopy, cruciate ligament reconstruction, sports injury, knee joint.*

Резюме

ПРЕДВАРИТЕЛЬНЫЕ РЕЗУЛЬТАТЫОДНОЭТАПНОЙ РЕВИЗИОННОЙ ПЛАСТИКИ ПЕРЕДНЕЙ КРЕСТООБРАЗНОЙ СВЯЗКИ КОЛЕННОГО СУСТАВА

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Введение. Повреждение передней крестообразной связки (ПКС) является самой частой травмой стабилизирующих связок колена. Несмотря на технические и реабилитационные достижения в области первичной пластики ПКС, частота ее повторного разрыва остается высокой.

Цель работы: выполнение сравнительного анализа отдаленных результатов двух типов ревизионной пластики крестообразной связки для восстановления функции коленного сустава (BTB и ST+GT+PLT).

Материалы и методы. Выполнен анализ результатов проспективного анкетирования пациентов по официальным опросникам: Шкала функционирования коленного сустава Лисхольма и Subjective Knee Evaluation Form, 2000 IKDC. Пациенты двух групп - после пластики BTB и после пластики ST+GT+PLT, опрошены исходно; через 16-17 недель после операции; через 44-46 недель после операции. Использованы непараметрические тесты: Уилкоксона для проверки различий между двумя выборками парных измерений, и Вальда-Вольфовица для малых несвязанных выборок. Для всех тестов статистически значимой принята двусторонняя ошибка типа I ($p \leq 0.05$) при 95% доверительном интервале.

Результаты. В 2020-2021 годах было выполнено 14 ревизионных пластик с аутотрансплантатами, из них 8 с использованием аутотрансплантата BTB, и 6 с использованием комбинированного аутотрансплантата (ST+GT+PLT). Длительность болевого синдрома (в днях): 28±5.5 vs. 21.2±5.9 (p=0.044). Не выявлено различий между двумя группами по шкале Лисхольма исходно (p=0.56); через 16-17 недель (p 0.83); через 44-46 недель (p=0.83); по шкале IKDC исходно (p=0.17). Различия выявлены по шкале IKDC через 16-17 недель - Me 75 баллов vs. 81 (p=0.0028); через 44-46 недель - Me 76 баллов vs. 81 (p=0.0008).

Заключение. Методика ST+GT+PLT в целом более перспективна для спортсменов и лучше отвечает необходимым требованиям пациентов, ведущих активный образ жизни, в силу следующих преимуществ: выполнение операции в 1 этап, что ускоряет восстановление функции коленного состава; установление более массивного, и в то же время, эластичного аутотрансплантата (>8.5 мм); уменьшение длительности болевого синдрома после операции и снижение риска развития остеоартрозапателлофеморального сочленения.

***Ключевые слова**: ревизионная артроскопия, пластика крестообразной связки, спортивная травма, коленный сустав.*

Түйіндеме

ТІЗЕ БУЫНЫНЫҢ АЛДЫҢҒЫ КРЕСТТӘРІЗДІ БАЙЛАМЫНЫҢ БІРСАТЫЛЫ ТЕКСЕРУ ПЛАСТИКАСЫНЫҢ АЛДЫНАЛА НӘТИЖЕЛЕРІ

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Кіріспе. Зақымдануы алдыңғы крест тәрізді байламы (АКБ) тізе буынының тұрақтандыратын байланыс тырғыштар ішінде ең жиі жарақат болып табылады. АКБ бастапқы пластикасы саласындағы техникалық және оңалту жетістіктеріне қарамастан, оның қайта жыртылу жиілігі жоғары болып қала береді.

Жұмыстың мақсаты: тізе функциясын қалпына келтіру үшін кресттәрізді байламды тексеру пластикасының екі түрінің ұзақ мерзімді нәтижелеріне салыстырмалы талдау жасау (BTB және ST+GT+PLT).

Әдістері. Ресми сауалнамалар бойынша пациенттерге проспективті сауалнама нәтижелерін талдау жүргізілді: Лисхольм тізе буынының жұмыс істеуш каласы және Subjective Knee Evaluation Form, 2000 IKDC. Екі топтағы пациенттерден - BTB пластикасынан кейін және ST+GT+PLT пластикасынан кейін бастапқыда; операциядан 16-17 аптадан кейін; операциядан 44-46 аптадан кейін жауап алынды. Параметрлік емес сынақтар қолданылды: екі жұптық өлшеулердің арасындағы айырмашылықты тексеру үшін Уилкоксон және Вальд-Вольфовиц кішкентай байланыссыз жұптықтар үшін. Статистикалық маңызы бар барлық сынақтар үшін 95% сенімділік интервалында I типті (P≤0.05) екі жақты қате қабылданды.

Нәтижелері. 2020-2021 жылдары 14 тексеру пластикасы жасалды, олардың сегізі BTB аутотрансплантатпен, ал науқастардың алтысына аралас (ST+GT+PLT) аутотрансплантат қолданды**.** Ауырсыну синдромының ұзақтығы (күнмен): 28±5.5 vs. 21.2±5.9 (p 0.044). Лисхольм шкаласы бойынша бастапқы (p=0.56); 16-17 аптаданкейін (p=0.83); 44-46 аптаданкейін (p=0.83); IKDC шкаласы бойынша бастапқы (p=0.17) екі топ арасында айырмашылықтар анықталған жоқ. Айырмашылықтар IKDC шкаласы бойынша 16-17 аптадан кейінан ықталды - Me 75 балл vs. 81 (p=0.0028); 44-46 аптадан кейін - Me 76 балл vs. 81 (p=0.0008).

Қорытынды. ST+GT+PLT әдісі спортшылар үшін тиімді және белсенді өмірсалтын жүргізетін пациенттердің қажетті талаптарына сәйкес келеді, өйткені келесі артықшылықтарға байланысты: операцияны 1 кезеңде орындау, бұл тізе функциясының қалпына келуін тездетеді; неғұрлым массивті және сонымен бірге серпімді аутотрансплантатты орнату (>8.5 мм); операциядан кейін ауырсыну синдромының ұзақтығын азайту және пателлофеморальды мүшелеуның остеоартроз қаупі назайту.

***Түйінді сөздер:** ревизиялық артроскопия, крест тәріздібайлам пластикасы, спорттық жарақат, тізе буыны.*

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Introduction

According to American and British orthopedists, annually in North America and the UK alone, about 200,000 operations are performed to restore the cruciate ligament of the knee joint [13, 27]. This operation's satisfactory postoperative outcomes range from 75% to 97% [4, 6, 7].

Various reasons can cause unsatisfactory results after primary reconstruction of the cruciate ligament: recurrent instability (pathological laxity of the joint), severe pain, limitation of movement or arthrofibrosis, progression of arthrosis, undetected or unrepaired during the operation associated injuries (damages of the meniscus, medial collateral ligament, posterior oblique ligament, and posterolateral angle) [33].

Despite technical and rehabilitation advances in the field of primary anterior cruciate ligament (ACL) repair, the frequency of its re-rupture remains high [37, 8, 28, 17, 36]. One of the main risk factors for recurrent ACL rupture is age. As shown by a cohort study by Maletis GB et al., patients aged 21 years were 8 times more likely to have re-injured ACL compared with persons over 40 years of age [23]. In fact, not only the operated joint is at risk of rupture after ACL reconstruction, many studies have shown a similar or even higher risk of ACL rupture on the contralateral side. The timing of the return to sports after revising ACL reconstruction with such ruptures takes longer than with the primary operation [38, 30].

The factors leading to the need for ACL revision intervention include 1) traumatic rupture of the cruciate ligament graft, which occurs in young patients actively involved in sports; 2) incorrect position of intraosseous tunnels. According to the calculations of Battaglia et al., graft failure in 70-80% of cases occurred due to the non-anatomical location of the tunnels [5, 35]. Based on data reported by Morgan et al., malposition of the femoral canal was a contributing factor to ligament failure in 47% of cases and rupture in 25% of cases [25].

The choice of ACL graft also plays an essential role in its reconstruction. Numerous studies have shown an extremely high failure rate in young patients using an allograft. Engelman et al. reported a hazard ratio of 1:4.4 in allograft versus autograft patients (age 11–18 years) [12]. The diameter of the graft also influences the risk of recurrent ligament rupture. Magnussen et al. retrospectively reviewed outcomes in patients with autologous hamstring (semitendinosus and tender muscles) grafts. They reported that a graft diameter of 8 mm or less in active young patients was associated with an increased risk of re-rupture [22]. A systematic review by Conte et al. confirmed that hamstring autograft sizes of 8 mm or more reduced the incidence of ruptures [10]. Spragg et al. reported a 0.82-fold reduction in the risk of ACL re-reconstruction for every 0.5 mm increase in hamstring graft diameter in patients with a mean age of 17 years [32]. However, the graft size must be selected individually for each patient, as increasing the graft size in patients with a small condyle or less bone morphology increases the risk of re-rupture [11, 14].

The conventional choice of ACL revision reconstruction for active, young patients under 30 years of age is usually a type of bone-tendon-bone (BTB) operation using the tendon of the patellar ligament [7]. This is due to the patient's lack of the hamstring used in the first ACL repair. The BTB is valuable because of the bone blocks at both ends of the graft, which creates additional stability and healing of the ligament in the bone tunnels. However, the BTB graft causes some limitations in the early postoperative period - due to the increase in the postoperative wound, pain in the anterior part of the knee persists for a long time [24, 26]. In the long term, patients develop arthrosis of the patellofemoral joint [18, 29].

Consequently, the type of surgery ST+GT+PLT (using a combined autograft of the semitendinosus muscle' tendon - ST, gracilis muscle' tendon - GT, and tendon of the peroneus longus muscle - PLT) was recognized to be more relevant to the goal of returning the athlete to the sport despite some limitations. At first, this surgical technique is more complicated. Besides, two conditions must be present - the correct position of the intraosseous tunnels and the absence of anatomical obstacles to surgery [33].

Considering the Center for Arthroscopy and Sports Injury specialization, mastering the ST + GT + PLT technique seemed crucial, and we started practicing this method in 2020. Currently, we perform both types of revision reconstructions at the Center.

The **presented study is aimed** to analyze the long-term outcomes of the two kinds of ACL reconstruction to restore knee joint function (BTB and ST+GT+PLT).

Methods

The work was performed at the Center for Arthroscopy and Sports Injury of the Academician N.D. Batpenov National Scientific Center for Traumatology and Orthopedics. The research was approved by the IRB of the Academician N.D. Batpenov National Scientific Center for Traumatology and Orthopedics (meeting No. 5 dated May 13, 2021) and performed following the principles of the Helsinki Declaration and the STROBE checklist.

We designed the study as an analysis of a prospective survey using official questionnaires: the Lysholm Knee Joint Functioning Scale and the Questionnaire "Subjective Knee Evaluation Form" (2000 IKDC (International Knee Documentation Committee)). The examples of both questionnaires are available on the Internet and constitute working tools in the practice of traumatologists [21, 34]. Both questionnaires were translated into Kazakh and Russian languages to provide the patient's choice.

Patients enrolled consecutively as they were admitted to the division for surgical intervention. The inclusion and exclusion criteria strictly depended on the trauma type and surgery indicated. We did not use the visual analog scale (VAS) to assess pain intensity, as patients evaluated the pain intensity by themselves. The study participants provided written informed consent to publish the questionnaire results and MRI images without mentioning personal data. Their informed consent forms are available on reasonable request. The privacy rights of patients were observed.

The Lysholm Knee Score was developed to assess the results of knee joint diseases treatment, including the reconstruction of ligaments, bones of the knee joint, etc. The Lysholm scale consists of the following parameters: lameness, use of additional support, joint blockage, joint instability, pain, joint swelling, stair climbing, and squatting. The following interpretation of the results is applied:

<64 points - unsatisfactory; 65-83 points - satisfactory;

84-94 points - good; 95-100 points - excellent [20].

The Subjective Assessment of Knee Function Questionnaire (IKDC, 2000) is completed by patients themselves. It assesses the intensity of symptoms, the ability to play sports, and the knee joint functionality.

Interpreting survey results by summing the points awarded for each response is performed along with more sophisticated scoring methods. Responses to each item on the questionnaire are scored by assigning a serial number: one point is assigned to responses representing the lowest level of functionality or the highest level of symptom expression. For example, question №1 – "highest level of physical activity without severe knee pain" is scored by assigning 1 for "Unable to do any of the activities listed because of knee pain" and scoring 5 for the answer "Very difficult, strenuous activity, such as jumping or turning in basketball, football." One point is assigned to the answer "Constantly" to question No. 2, related to the frequency of pain, but eleven points for the answer "Never." For the questionnaire "Subjective assessment of the knee joint function," the scores for individual questions are summed up and converted into a standard scale of 0 to 100 points. The answer to question №10, "Functionality before the injury," is not included in the total score.

The following steps are being applied to scoring the IKDC form:

1) assigning a score to each response to the question so that the lowest score indicates the lowest level of functionality or the highest level of symptoms;

2) calculating the preliminary results by summing up the answers to all questions, except for the answer to question No.10: "The volume of functions performed before the injury";

3) transforming the preliminary results into a scale from 0 to 100 according to a particular formula, where the lowest possible score is 18, and the range of possible scores is 87.

The converted results are interpreted as a degree of functionality: higher scores correspond to its high level. One hundred points correspond to the absence of restrictions in daily activities and sports, as well as the absence of symptoms. The questionnaire can be considered completed if the patient answers at least 90% of the questions. If there are missing answers, the calculation of preliminary results is carried out by substituting the arithmetic mean of the available answers. We practiced the methodology for calculating points taken from the methodological manual of Russian scientists [1].

Patients were allocated into two groups - after BTB reconstruction and ST+GT+PLT one. The indications for the ST+GT+PLT technique were: young age of patients up to 27 years maximum; active sports; traumatic nature of damage to the primary graft. BTB repair was performed in patients who needed knee stabilization, but there were no plans to return to the sport. The presence of additional damage to the intra-articular structures, revealed during the revision, was not a contraindication to the operation unless it caused obstacles to its implementation. Patients were interviewed at baseline; 16-17 weeks after surgery; 44-46 weeks after surgery. The survey findings were processed statistically.

Statistical analysis

We used the software package Statistica.10 (StatSoft - Russia, version 10) and SPSS modeler (IBM, version 25) in the statistical processing. The distribution of the quantitative variables was checked through the Kolmogorov-Smirnov test. Variables were presented as M(SD), where M is the mean, SD is the standard deviation, and the median and 25/75 percentile, Me (25;75). Quantitative variables were compared using the nonparametric Wilcoxon test to analyze for differences between two samples of paired measurements. For small unrelated samples, the Wald-Wolfowitz criterion was applied. For all tests, a two-sided type I error ($p \leq 0.05$) was assumed statistically significant with a 95% confidence interval.

Results.

On average, our Center performs about 250-260 surgeries for primary ACL reconstructions per year, of which about 10-12 individuals return for revision plastic surgery (4-5%). In 2020-2021, we performed fourteen reconstructions with autografts, eight with a BTB autograft, and six using a combined autograft (ST+GT+PLT).Of the concomitant injuries of intra-articular structures, two patients had meniscus injury; one patient had grade II chondromalacia of the medial tibial condyle and damage of the medial meniscus. All concomitant operations were performed simultaneously and did not affect the quality of revision surgery. One patient with an incorrectly performed primary reconstruction was included in the list of patients for ST+GT+PLT due to the preserved bone integrity and the possibility of performing a bone canal. The pathology of this patient is presented graphically on the MRI image (Figure 1).

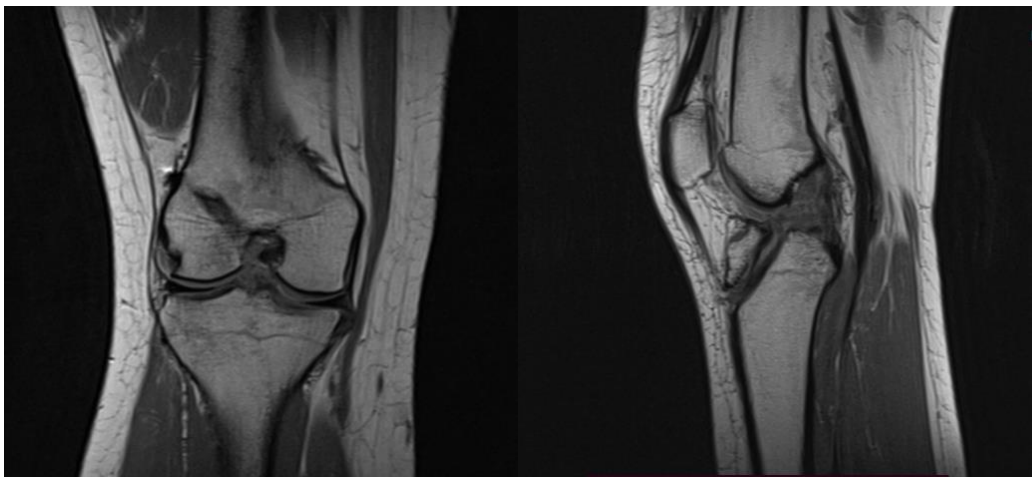

Fig. 1.MRI image of the damaged graft*.
(*A ligament is missed as a result of repeated injury. Bone canal diameter 7.5 mm.)

Figure 2 presents another case illustrating the indications for patient selection for ST+GT+PLT revision plastic surgery.

Fig. 2.MRI image of an incorrectly performed primary ACL repair*.
(*The patient had an incorrectly installed ligament fixed with a tibial screw projecting onto the articular surface, which led to ligament failure and persistent joint dysfunction.)

Description of the technique of one-stage ACL reconstruction using a combined ST+GT+PLT graft

In the first step, the ST and GT tendons are being taken from the patient's contralateral side. Then, PLT is being taken from the side of the injured joint. As a rule, these tendon grafts are obtained with at least 8.5 mm diameter. After a preliminary revision of the joint, processingthe attachment site, and removal of the old ACL graft remnants, the formation of tunnels is performed. They are carried out precisely along the same primary course of the tunnels, and the diameter must be at least 1.5 mm larger than the diameter of the previous tunnel. This is a vital detail of the operation, which allows decortication of the bone canal, avoiding the risk of non-closure of the graft, and doing plastic surgery in one step.

All patients before and after surgery at 16-17 and 44-46 weeks of outpatient follow-up in the recovery period were asked to fill out questionnaires: the Lisholm Knee Joint Functioning Scale and the IKDC 2000 Subjective Assessment Knee Joint Function Questionnaire. Questionnaire scores were summed up according to the previously described method and then subjected to statistical analysis. Descriptive statistics is presented in Table 1 - age, duration of pain syndrome, results in the form of summed scores of both scales.

Table 1.

Descriptive statistics of the studied parameters.

№	Evaluation parameters: (M±SD); Me (25;75), min-max	Typeofsurgery BTB	Type of surgery ST+GT+PLT
1	*N*	8	6
2	Averageageofpatients:	28±5.5, Me 28.5 (23;31.5); min-max (21-37)	24±3.22, Me 24.5 (22;27); min-max (19-27)
3	Painduration (days):	31±3.5, Me 31.0 (28.5;33.5); (26-36)	21.2±5.9, Me 18.5 (17;27); (16-30)
4	Assessment of the knee joint function by the Lysholm scale:		
	At baseline:	51.1±1.46, Me 51 (50;52.5); (49-53)	53.5±1.76, Me 53 (52;55); (52-56)
	16-17 weeks after surgery	84±7.13, Me 83 (78.5;91); (74-93)	84.3±2.33, Me 85 (82;86); (81-87)
	44-46 weeks after surgery	93.7±2.43, Me 94 (92;95); (88-96)	92.5±4.7, Me 94.5 (91;95); (84-96)
5	Subjective evaluation of the knee joint function by IKDC:		
	At baseline:	49.12±6.1, Me 46.5 (44.5;53); (44-61)	51.33±1.36, Me 51.5 (51;52); (49-53)
	16-17 weeks after surgery	75±3.38, Me 75 (72;77); (71-81)	81.2±1.72, Me 81 (80-82); (79-84)
	44-46 weeks after surgery	75.5±3.5, Me 76 (72.5;77); (71-82)	89.6±1.9, Me 89 (88;91); (88-93)

In the postoperative period, in patients with BTB autografts, the pain syndrome persisted longer than in patients after a combined ST + GT + PLT technique (Me 31.0 vs. 18.5). After ten months of follow-up (44-46 weeks), the assessment of motion range showed no significant differences in both groups of patients (p 0.39). In the subjective evaluation of knee joint function according to the IKDC scale, the most remarkable differences we revealed by the end of the 10th month of follow-up, Me 76 points vs. 89 points. Analysis of the Wald-Wolfowitz series confirmed the statistical significance of differences in the subjective assessment of knee joint function. The results of the Wald-Wolfowitz test are summarized in Table 2.

It follows from Table 2 that both groups were pretty similar in terms of functionality (degree of damage) of the knee joint before surgery (p 0.56 and 0.17), and significant differences in the subjective assessment of the surgery results we revealed using a more detailed IKDC questionnaire.

We analyzed dynamic changes in the knee joint function in two groups, and the results are shown in Table 3.

Table 2.

Comparing both groups to identify significant differences.

№	Comparedparameters	p
1	The pain syndrome duration	0.044
2	Baseline Lysholm scores (before surgery)	0.56
3	Lysholm scores 16-17 weeks after surgery	0.83
4	Lysholm scores 44-46 weeks after surgery	0.83
5	Baseline IKDC scores (before surgery)	0.17
6	IKDC scores 16-17 weeks after surgery	0.028
7	IKDC scores 44-46 weeks after surgery	0.0008

Table 3.

The analysis of both groups to identify differences in the dynamics of knee joint healing.

№	Comparedparameters	pvalue (BTB group)	p value (ST+GT+PLT group)	pvalue (total)
1	Baseline scores on the Lysholm scale vs. 16-17 weeks; and after 16-17 weeks vs. 44-46 weeks	0.011	0.027	0.0009
2	Baseline IKDC scores and after 16-17 weeks	0.011	0.027	0.0009
3	IKDC scores 16-17 weeks and 44-46 weeks	0.067	0.027	0.005

We detected significant differences in the dynamics of postoperative results, both within the group, for a specific time interval, and in both groups, respectively. Our patients currently continue rehabilitation. The approximate term for returning to the previous physical activity is one year, as the protocol of restorative rehabilitation after surgery is designed for 12 months [2].

Discussion

Revision ACL reconstruction constitutes a severe clinical problem for orthopedic and rehabilitation specialists. A favorable clinical outcome is highly dependent on the recognition of all predisposing factors for graft failure [35].

Leo Pinczewski et al.'s comparative analysis of both methods, hamstring tendon surgery (a ligament graft formed from the two tendons - of semitendinosus and gracilis muscles) and the BTB technique, showed no difference in knee function (97% in both groups). However, in the BTB group, more patients reported pain in the knees during exercise requiring increased exertion (p = 0.05) [29]. Radiographically, arthrosis of the knee joint, in particular the patellofemoral joint, was also more common in the BTB group (p = 0,04) [18, 29]. *Salmon et al.* obtained the same data during a 13-year follow-up of 67 patients who underwent ACL repair using a BTB graft - 75% of them had radiographic evidence of cartilage degeneration [31]. There were no patellofemoral joint fibrosis development cases in the BTB group in our study. Nonetheless, we confirmed the apparent disadvantage of the BTB graft in terms of the pain syndrome duration.

The great advantage of both methods is the possibility of using an autograft. First of all, the choice of graft for re-revision is determined by the ACL primary reconstruction and depends on the previously used graft [19]. The MARS Group, which conducted a cohort study of 1,205 patients with ACL revisions, found that patients with an allograft were 2.78 times more likely to have a second rupture than those who received an autograft [24].

Concerning the return to sports of those athletes operated on using the ST+GT+PLT method at our Center, we can predict favorable long-term results of the surgery with a certain degree of caution, based on follow-up data and the data available in the literature sources. At the same time, in international practice, the overall rate of return to sports in patients after ACL revision is lower than after primary ACL reconstruction [15, 3, 16]. This statistical difference occurs owing to several factors - concomitant damage to the intra-articular structures of the knee (menisci, collateral ligaments) - 69%, fear of re-injury - 22%, and other, unvoiced reasons - 9% [3].

The study had a lot of limitations. We consider it necessary to note the following drawbacks: a small sample of patients; the subjective nature of the information provided by participants during surveys; the presence of a certain number of confounding factors in the form of simultaneous operations performed in some patients. Nevertheless, even preliminary findings of a comparative analysis of both approaches to ACL revision repair indicate that the ST+GT+PLT technique is promising, especially in professional athletes. At the same time, we cannot assert the unequivocal superiority of the ST+GT+PLT method in terms of knee joint functionality. Our study did not reveal any difference in the Lysholm scale scores in patients of both groups. However, we found significant differences in the subjective assessment of the surgery outcomes using a more detailed IKDC questionnaire. Perhaps a larger sample of patients would have yielded a more convincing result.

Conclusion

In general, the ST+GT+PLT technique meets the requirements of patients leading an active lifestyle. Its advantages include: performing the surgery in one stage,

which accelerates restoring the knee function; the establishing of a more massive and, at the same time, elastic autograft (>8.5 mm), which allows it to withstand increased active loads in later life; a decrease in the duration of pain syndrome after surgery and a reduction in the risk of developing osteoarthritis of the patellofemoral joint, due to the absence of the need to use a BTB graft.

For a more scrutinized analysis concerning the efficacy of the one-stage combined ST + GT + PLT technique practiced at the Arthroscopy Center since 2020, further observations with a larger number of participants are needed.

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Conflict of interest
The authors declare no conflict of interest.

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