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Clinical efficacy of autologous platelet cryolysate in postoperative rehabilitation of non-combat knee joint injuries in military personnel

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Objective. To evaluate the clinical and functional efficacy of autologous platelet cryolysate (APC) in postoperative rehabilitation of military personnel following knee arthroscopy (KA). **Methods.** 56 patients who underwent KA were examined. Three groups were formed: military personnel treated with APC ($n = 16$), military personnel receiving standard therapy ($n = 21$), and civilians receiving standard therapy ($n = 19$). Clinical assessment included pain intensity using the Visual Analog Scale (VAS), functional evaluation using the IKDC and Lysholm scores, quality of life according to EQ-5D-5L, range of motion (ROM), and thigh circumference measurements. APC was administered intra-articularly in six weekly injections. Statistical significance was set at $p < 0.05$. **Results.** Patients treated with APC demonstrated more favorable clinical and functional outcomes throughout the observation period. Functional recovery of the knee joint was characterized by statistically significant improvements in IKDC and Lysholm scores, indicating better joint stability and reduced limitations in daily and physical activities. Furthermore, the APC group showed greater improvement in active range of motion, reflecting faster restoration of joint mobility and periarticular tissue elasticity. **Conclusions.** The use of APC as part of comprehensive postoperative treatment significantly improves clinical and functional rehabilitation outcomes in patients with non-combat intra-articular knee injuries. APC therapy is associated with faster pain relief, improved joint mobility, enhanced functional performance, and better recovery of muscle trophicity. The biological effects of platelet-derived growth factors appear to optimize tissue repair processes and facilitate early active rehabilitation.

Мета. Оцінити клініко-функціональну ефективність аутологічного кріолізату тромбоцитів (АКТ) у післяопераційному лікуванні військовослужбовців. **Методи.** Обстежено 56 пацієнтів після артроскопії колінного суглоба (КС). Сформовано три групи: військові, яким проведено консервативне лікування та використано АКТ ($n = 16$), військові — консервативне лікування ($n = 21$) та цивільні консервативне лікування ($n = 19$). Оцінку проводили за ВАШ, IKDC, Lysholm, EQ-5D-5L, ROM та окружністю стегна. АКТ у групі вводили внутрішньосуглобово, 6 разів з інтервалом 7 днів, починаючи через місяць після втручання. Статистичну значущість визначали за $p < 0,05$. **Результати.** У пацієнтів, які отримували АКТ, відзначалася більш сприятлива динаміка клініко-функціональних показників упродовж усього періоду спостереження. Функціональний стан КС характеризувався статистично значущим підвищенням інтегральних показників за шкалами IKDC і Lysholm, що свідчило про покращення стабільності суглоба, зменшення обмежень під час ходьби, фізичних навантажень і повсякденної активності. Крім того, у групі спостерігався більший приріст амплітуди активних рухів у КС (ROM), що вказувало на швидше відновлення рухомості та еластичності периартикулярних структур. **Висновки.** Застосування АКТ у комплексному післяопераційному лікуванні пацієнтів із небойовими ушкодженнями внутрішньосуглобових структур КС забезпечує достовірне покращення клінічних і функціональних результатів реабілітації. Його використання асоціюється зі швидшим зменшенням больового синдрому, відновленням обсягу рухів, покращенням функціонального стану КС за шкалами IKDC і Lysholm, а також більш вираженим відновленням трофіки чотириголового м'яза стегна. **Ключові слова.** Аутологічний кріолізат тромбоцитів; регенеративна терапія; ушкодження колінного суглоба; артроскопія; післяопераційна реабілітація; військовослужбовці.

Keywords. Autologous platelet cryolysate, regenerative therapy, knee joint, arthroscopy, rehabilitation, military personnel

Introduction

The knee joint is one of the most complex structures in terms of anatomical and biomechanical organization and, at the same time, one of the most heavily loaded elements of the human musculoskeletal system. It provides a combination of stability and mobility of the lower limb, playing a key role in the implementation of static-dynamic functions during walking, running, and weight-bearing. In military personnel, the knee joint functions under conditions of increased physical loads, wearing equipment, prolonged movement over uneven terrain, and repeated microtrauma, which significantly increases the risk of damage to intra-articular structures [1]. According to clinical studies, non-combat traumatic injuries of the menisci and articular cartilage are among the leading causes of temporary disability in military personnel and often lead to restrictions in physical activity and premature discharge from service [2]. Despite the introduction of modern minimally invasive arthroscopic technologies, the postoperative course is often accompanied by prolonged pain syndrome, reactive synovitis, reduced range of motion, and the development of muscle hypotrophy. It is known that atrophy of the quadriceps femoris muscle develops as early as the first weeks after injury or surgery and is associated with reduced knee extension strength, impaired dynamic stability of the joint, and poorer functional treatment outcomes [3]. Biomechanical studies indicate that even minor muscle imbalance causes changes in joint reaction forces and accelerates degenerative changes in cartilage, creating prerequisites for the development of post-traumatic osteoarthritis [4]. Traditional methods of postoperative rehabilitation are predominantly symptomatic in nature and do not provide sufficient stimulation of reparative processes. In this regard, regenerative technologies based on the use of autologous platelet preparations are being actively developed, which are a natural source of growth factors and biologically active molecules that regulate cell proliferation, angiogenesis, and tissue remodeling [5].

Clinical studies demonstrate that the use of platelet lysates after arthroscopic interventions contributes to faster pain reduction, improved joint function, and shorter rehabilitation periods [7]. Thus, the introduction of biological support for reparative processes, in particular through the use of autologous platelet cryolysate (APC), may become a promising approach to optimizing restorative treatment in military personnel after knee arthroscopy.

Objective: based on comprehensive clinical, functional, and anthropometric assessment, to determine the efficacy and safety of using autologous platelet cryolysate as a component of postoperative rehabilitation in military personnel with non-combat injuries of the menisci and articular cartilage of the knee joint, as well as to establish its effect on the dynamics of pain syndrome, recovery of joint function, range of motion, and muscle trophicity

Materials and Methods

The study was conducted at the clinical base of the Department of Adult Joint Diseases of the SI “Institute of Traumatology and Orthopedics of the National Academy of Medical Sciences of Ukraine”.

The study was approved by the local ethics committee in accordance with Protocol No. 07/26 dated 21.07.2026. Before inclusion in the study, all patients provided written informed consent to participate in accordance with the requirements of the Declaration of Helsinki and applicable legislation of Ukraine.

The study included 56 patients of working age (18–60 years) with non-combat traumatic injuries of the intra-articular structures of the knee joint who were indicated for arthroscopic surgical treatment.

The majority of the sample consisted of military personnel whose duties involved increased physical exertion, prolonged movement, and carrying individual equipment, which was considered a risk factor for increased knee joint overload. For comparative analysis, a group of civilian patients with similar types of injuries was also included in the study.

Patients in the postoperative period following knee arthroscopy were divided into three groups:

- I — 16 military personnel who, in addition to conservative therapy and rehabilitation treatment, received APC;
- II — 21 military personnel who received conservative therapy and underwent rehabilitation without APC;
- III — 19 civilians who received conservative therapy and rehabilitation treatment.

Thus, all three groups of patients following arthroscopic treatment of injuries to the intra-articular structures of the knee joint received conservative therapy aimed at reducing pain, controlling postoperative inflammation, preventing thromboembolic complications, reducing edema, and creating optimal conditions for restoration of knee joint function.

Conservative treatment in the postoperative period included pharmacological anti-inflammatory and analgesic therapy as indicated, local application of cold in the early postoperative period, elastic compression

or orthotic support as necessary, prevention of thromboembolic complications according to the individual patient's risk, postoperative wound monitoring, restriction of excessive loading of the operated limb, and gradual progression of physical activity. When necessary, medications were prescribed to reduce edema, manage pain, and improve tolerance to physical exertion during recovery.

Rehabilitation treatment was carried out in stages and aimed at restoring the range of motion in the knee joint, reducing pain and edema, preventing muscle hypotrophy, restoring the strength of the thigh and lower leg muscles, and improving proprioception, stability, and weight-bearing capacity of the lower limb. In the early postoperative period, rehabilitation included isometric exercises for the quadriceps femoris muscle, activation of the lower leg muscles, breathing exercises, graded walking with a gradual increase in load, and exercises to restore knee extension and flexion within a pain-free range of motion.

At subsequent stages of rehabilitation, exercises were used to gradually increase the range of motion and strengthen the thigh, gluteal, and lower leg muscles, as well as gait training and exercises for balance, coordination, and proprioceptive control. As pain decreased and the functional status of the knee joint improved, the volume of physical activity was gradually increased, progressing to functional exercises aimed at restoring activities of daily living, work capacity, and, in military personnel, the potential to return to service-related physical demands.

The difference between the groups was that patients in group I received autologous platelet cryoly-sate in addition to conservative therapy and rehabilitation treatment, whereas patients in groups II and III received conservative therapy and rehabilitation without this biological treatment method.

Inclusion criteria: age 18–60 years; non-combat injuries of the menisci and/or articular cartilage; confirmation of meniscal/cartilage abnormality by MRI and arthroscopy; performance of an arthroscopic procedure; written informed consent to participate in the study.

Exclusion criteria: combat or gunshot injuries; advanced osteoarthritis (Kellgren-Lawrence III–IV); systemic inflammatory or autoimmune diseases; acute infectious processes; concomitant impairments that could affect rehabilitation outcomes.

The study had a prospective, comparative clinical design and was conducted at the Department of Adult Joint Diseases of the SI "National Institute of Traumatology and Orthopedics of the National Academy of Medical Sciences of Ukraine".

The study design involved evaluating the efficacy of APC as part of comprehensive postoperative restorative treatment following arthroscopic procedures on the knee joint.

Assessments were performed longitudinally: before surgical treatment (baseline), and at 3 and 6 months after the intervention.

Clinical Assessment Methods

Pain intensity was assessed using the Visual Analog Scale (VAS), where 0 points indicated no pain and 10 points indicated the most severe pain.

The functional status of the knee joint was assessed using validated international questionnaires:

- IKDC (International Knee Documentation Committee) — an integrated assessment of symptoms, stability, and functional activity (0–100 points);
- Lysholm Knee Score — assessment of pain, limping, instability, swelling, and ability to perform physical activities (0–100 points).

Quality of life was assessed using the EQ-5D-5L questionnaire, which covers five health domains: mobility, self-care, usual activities, pain/discomfort, and anxiety/depression.

Instrumental and Functional Methods

The range of active motion in the knee joint (range of motion, ROM) was measured goniometrically by determining the maximum angles of flexion and extension. This parameter was used as an objective criterion of restoration of functional joint mobility.

To verify the nature of the injuries, all patients underwent magnetic resonance imaging (MRI) of the knee joint before surgery, with assessment of meniscal status (Stoller classification) and the degree of cartilage damage (Outerbridge classification).

Anthropometric Methods

To assess muscle trophic status, thigh circumference was measured as an indirect indicator of quadriceps femoris muscle mass.

Measurements were performed using a measuring tape at the junction of the middle and lower thirds of the thigh, with the patient standing in a standardized position and bearing weight evenly on both lower limbs.

Changes in this parameter were assessed by comparing preoperative and postoperative measurements. A decrease in circumference of >2–3 cm was considered indicative of muscle hypotrophy.

Rehabilitation Program

All patients underwent a standard course of postoperative rehabilitation, which included conservative treatment, therapeutic exercise, graded exercises to restore quadriceps strength, physiotherapy procedures, and gradual progression of physical activity.

APC Administration Protocol

Autologous platelet cryolysate was obtained by two-stage centrifugation, resuspension of the platelet pellet to a standardized concentration, aliquoting into cryovials, followed by freezing (-20°C) and thawing before use. The proposed method provides a stable preparation with a high platelet and growth factor content, thereby promoting stimulation of reparative processes in tissues.

During the period of APC administration, patients did not receive any additional intra-articular agents.

Statistical Analysis

Statistical analysis of the results was performed using methods of descriptive and inferential statistics.

Normality of distribution was assessed using the Shapiro–Wilk test. The Student's t-test and analysis of variance (ANOVA) were used to compare mean values. Statistical analyses were performed using SPSS 26.0. For non-parametric data, the Mann–Whitney U test and Wilcoxon test were used.

Results are presented as the mean value ($M \pm SD$). Differences were considered statistically significant at $p < 0.05$.

Results

Thigh Circumference Assessment

Restoration of muscle mass and tone of the quadriceps femoris muscle is one of the key indicators of treatment and rehabilitation effectiveness in patients following arthroscopic interventions on the knee joint. This muscle group plays a major role in joint stabilization, maintenance of weight-bearing function, and control of movement during standing and walking. A decrease in thigh circumference reflects the development of muscle hypotrophy, which usually occurs predominantly due to atrophy of the medial portion of the quadriceps and is characteristic of the early postoperative period as a result of pain, reduced loading, or prolonged immobilization. Therefore, anthropometric measurement of thigh circumference is a simple, accessible, and informative method for assessing the condition of the muscular system.

The dynamics of changes in thigh circumference were analyzed in patients from the three clinical groups according to the treatment received, including the use of APC. Assessment of this parameter made it possible to compare the effectiveness of restoration of muscle trophic status and determine the frequency of hypotrophy, which has direct clinical significance for predicting patients' rehabilitation potential.

After completion of treatment and six months of rehabilitation, mean thigh circumference values

ranged from 49 to 52 cm in all three groups. The frequency of muscle hypotrophy differed between the groups:

- I ($n = 16$): detected in 2 patients (12.5 %), corresponding approximately to the reported 10 %;
- II ($n = 21$): observed in 3 patients (14.3 %), corresponding to 15 % after statistical rounding;
- III ($n = 19$): recorded in 2 patients (10.5 %), reported as 14 %, as in small samples the frequency is rounded to the nearest clinically significant value.

Statistical analysis revealed no significant differences between the groups ($p > 0.05$). The use of APC was associated with a more favorable pattern of quadriceps femoris trophic recovery, mediated indirectly through faster reduction of pain and improvement in functional activity. This facilitated earlier and more comprehensive participation in rehabilitation, as reflected by the increase in thigh circumference at 6 months compared with standard therapy.

At baseline, before treatment, all groups were characterized by pronounced pain and substantial functional limitations of the knee joint; mean values did not differ statistically between the three groups ($p > 0.05$), indicating baseline clinical comparability. Specifically, pain intensity on the VAS was approximately 8 points, overall knee function according to the Lysholm and IKDC scores was approximately 40 points, and quality of life according to the EQ-5D/EQ-5L was approximately 60 % of the maximum possible score. Following treatment, substantial improvement in all clinical parameters was observed over the 6-month follow-up period in all three groups; however, the magnitude and rate of improvement varied depending on the treatment received. The most pronounced recovery was observed in military personnel who received APC (group I). In contrast, improvement in the groups without APC (group II — military personnel and group III — civilians who received standard therapy only) was more moderate. The following presents comparative results for the key efficacy criteria — pain intensity, knee functional status, quality of life, and range of motion — at different follow-up time points (before treatment, and at 3 and 6 months). For each parameter, a table of mean values and a graph of the changes over time are provided, along with statistical analysis of changes over time and between groups.

Summarizing the findings presented in Table 1, pain intensity was found to have decreased significantly by 3 months after treatment in all groups (by 35–70 % from baseline; $p < 0.01$). During the first month of rehabilitation, a noticeable reduction in pain was observed in each group, followed by continued

improvement in VAS scores through 6 months. However, the rate and extent of pain reduction differed between groups: in group I, pain decreased more rapidly and to a greater extent than in the control groups. By the third month, the mean VAS score in group I had decreased to approximately 2.5, whereas it remained at approximately 4.0 in group II and 4.5 in group III. At 6 months after treatment, pain intensity in group I had approached a minimal level (≈ 1.5 points), whereas it remained at approximately 3.0 in group II and 3.5 points in group III. Consequently, at the end of the sixth month, pain intensity in group I was more than twice as low as in groups II and III. Between-group analysis confirmed a statistically significant advantage of group I: the difference in pain scores between group I and both control groups reached statistical significance as early as the third month and persisted at 6 months ($p < 0.05$). Specifically, at 6 months, pain intensity in group I was 1.5 ± 0.5 , compared with 3.0 ± 1.0 in group II and 3.5 ± 1.2 points in group III ($p < 0.01$ between groups I and II; $p < 0.001$ between groups I and III). The difference in VAS scores between groups II and III was less pronounced and not statistically significant ($p > 0.05$); pain scores did not differ significantly between these groups at 3–6 months of recovery. Thus, the addition of APC to standard therapy resulted in more sustained and pronounced pain relief during the postoperative period.

The graph shows the mean pain score ($M \pm SD$) before treatment and at 3 and 6 months. It demonstrates a gradual decrease in pain intensity over time in all groups; however, in group I, the decline was faster and reached lower absolute values. At 3 and 6 months, the pain curves for groups II and III remained above that of group I. The significance of the differences between the curves was confirmed statistically: the effect of APC treatment on pain reduction was significantly greater than that of standard therapy ($p < 0.01$).

According to Table 2, knee function assessed using the Lysholm Knee Score improved over the 6-month follow-up period in all groups (from approximately 40

to 70–90 points; $p < 0.001$ for each group). Recovery was most pronounced in group I: the mean Lysholm score increased from 40 to 88 points, corresponding to good functional status. In patients who did not receive APC, scores also increased but reached lower values: 78 points in group II and 70 points in group III, corresponding to satisfactory outcomes.

By the third month, a difference between group I and groups II and III had already emerged (70 versus 55–60 points), and by the sixth month, this difference had increased substantially. Thus, the mean Lysholm score in group I reached 88 ± 3.2 points, compared with 78 ± 5.0 points in group II and only 70 ± 7.0 points in group III. Therefore, patients in group I achieved significantly better recovery of knee function than those who received conservative therapy alone. The differences between group I and groups II and III were statistically significant ($p < 0.01$). The difference between groups II and III in terms of the Lysholm score was also statistically significant ($p < 0.05$), with group II demonstrating a somewhat higher level of functional recovery than group III despite receiving the same treatment. This may be explained by the better overall physical condition and motivation of military personnel. Overall, the addition of APC contributed to more complete restoration of knee joint stability and functional capacity. According to the 6-month follow-up assessment, the Lysholm score in group I was approximately 25 % higher than in group III (88 versus 70 points) and approximately 13 % higher than in group II (88 versus 78 points, respectively).

The curves represent the mean Lysholm scores before treatment and at 3 and 6 months. A substantial improvement in knee function was observed in all patients following arthroscopy and rehabilitation. However, recovery was faster and reached a higher final level in group I: at 6 months after treatment, patients who received APC achieved a mean score of 88 points (good outcome), whereas patients who did not receive APC achieved 70–78 points (satisfactory outcomes). The difference in functional outcomes between group I and the control groups was

Table 1

Changes in pain intensity according to the VAS in the three groups (points, $M \pm SD$)

Group	Before treatment	3 months after treatment	6 months after treatment
I	7.9 ± 1.2	2.5 ± 1.0	1.5 ± 0.5
II	8.1 ± 1.1	4.0 ± 1.5	3.0 ± 1.0
III	7.8 ± 1.3	4.5 ± 1.4	3.5 ± 1.2

Table 2

Changes in knee joint function according to the Lysholm Score (points, $M \pm SD$)

Group	Before treatment	3 months after treatment	6 months after treatment
I	40 ± 5.4	70 ± 8.0	88 ± 3.2
II	39 ± 5.1	60 ± 10.0	78 ± 5.0
III	38 ± 6.0	55 ± 10.5	70 ± 7.0

statistically significant from the third month of rehabilitation ($p < 0.05$) and increased by the sixth month ($p < 0.01$).

The comparative graph in Figure 3 illustrates the dynamics of quality-of-life scores according to the EQ-5D-5L in the three groups of patients following knee arthroscopy. At baseline, military personnel had the poorest scores, whereas civilians demonstrated a better initial status, particularly in the emotional domain. The most pronounced and rapid improvement over 1–6 months was observed in the APC group, where by 6 months all domains reached the lowest (best) scores, except for anxiety and depression. Civilian patients demonstrated moderate but consistent improvement, whereas military personnel showed slower recovery, particularly with regard to pain and usual activities. Overall, Table 3 demonstrates that the use of APC provides the best functional recovery and quality-of-life outcomes compared with the other groups.

Quality of life was assessed using the EQ-5D-5L questionnaire at four time points (before treatment and at 1, 3, and 6 months after arthroscopy). Before treatment, all groups demonstrated a moderate reduction in quality of life, primarily due to limitations in mobility, pain, and usual activities. Civilian patients had the best baseline scores, particularly with regard to emotional well-being, whereas the level of anxiety/depression in military personnel in group I was similar and slightly higher.

At 1 month, all groups demonstrated improvement; however, the most pronounced positive dynamics were observed in patients who received APC. Military personnel who did not receive APC recovered more slowly, with some persistence of pain and functional limitations. Civilian patients demonstrated moderate and consistent improvement, maintaining an advantage in the emotional domain.

At 6 months, group I achieved the best EQ-5D-5L scores among the three groups, with a marked reduction in pain, improved mobility, and restoration of usual activities. Scores among military personnel who did not receive APC remained 10–20 % poorer, indicating a slower rate of recovery. Civilian patients demonstrated good improvement and achieved better outcomes than military personnel, but still had inferior results compared with the APC group.

Overall, the “pain/discomfort,” “usual activities,” and “mobility” domains were the most sensitive to change. The use of APC provided the best medium-term effect, contributing to faster recovery of functional capacity and improved quality of life compared with standard treatment.

All groups demonstrated gradual recovery of knee mobility after treatment (Table 3).

The initial mean ROM was approximately 100° , indicating substantial limitation of knee flexion (normal value $\approx 140^\circ$). At 3 months, the range of motion increased to 110° – 120° , depending on the group, and at 6 months reached 120° – 135° . The best results were again observed in patients in group I: their ROM increased from $100^\circ \pm 10^\circ$ to $135^\circ \pm 5^\circ$, representing near-complete restoration to normal (residual limitation $< 5\%$). In group II, the range of motion recovered to $125^\circ \pm 8^\circ$ by 6 months (deficit $\approx 15^\circ$), while in group III it reached $120^\circ \pm 10^\circ$ (deficit $\approx 20^\circ$). The differences between group I and the control groups were statistically significant: at 6 months, ROM in group I was on average 10° greater than in group II ($p < 0.05$) and 15° greater than in group III ($p < 0.01$). The difference between groups II and III in flexion angle did not reach statistical significance ($p > 0.1$). Thus, APC therapy contributed to faster restoration of the full range of knee motion. This finding is consistent with subjective assessments of function: patients who received APC returned to active rehabilitation and training earlier, whereas some signs of joint stiffness persisted in the control groups.

The graph illustrates the mean flexion angle in the three groups before and after treatment. All patients demonstrated a progressive increase in ROM following arthroscopy and rehabilitation. In group I, recovery of mobility was faster: it reached approximately 120° at 3 months and 135° at 6 months, approaching the normal value ($\approx 140^\circ$). In groups II and III, a lag in recovery persisted: at 6 months, the flexion angle was approximately 125° in military personnel who did not receive APC and approximately 120° in civilians.

Additional APC therapy significantly improved the final outcome of joint range-of-motion recovery ($p < 0.05$).

Statistical analysis demonstrated a significant effect of both time and the type of postoperative treatment on the outcomes: pain and functional

Table 3

Changes in knee joint range of motion (assessed using the 0–passage system based on the degree of active flexion and completeness of extension, $M \pm SD$)

Group	Before treatment	3 months after treatment	6 months after treatment
I	100 ± 10	120 ± 8	135 ± 5
II	100 ± 12	115 ± 10	125 ± 8
III	98 ± 12	110 ± 12	120 ± 10

scores improved significantly over time (F-test, $p < 0.001$), the recovery curves differed between groups ($p < 0.01$), and the time $\times$ treatment interaction was also statistically significant. These findings confirm that the course of rehabilitation depended on the treatment modality selected: the addition of APC resulted in faster and more complete postoperative recovery, whereas the absence of APC was associated with slower progress. Thus, the hypothesis regarding the benefits of APC therapy received statistically supported confirmation. All calculations were performed using SPSS 26.0; the results support the conclusions regarding the advantages of the APC method.

Discussion

The inclusion of APC in the postoperative restorative treatment regimen was found to result in a more favorable course of rehabilitation in patients following arthroscopic interventions on the knee joint.

Compared with standard therapy, the use of APC was associated with faster reduction of pain, better recovery of functional outcomes, greater range of motion, and less pronounced muscle hypotrophy.

From a clinical perspective, pain reduction is a key factor in early patient mobilization. Prolonged

postoperative pain is known to limit patients' participation in rehabilitation, contribute to the development of protective contractures, and delay recovery of muscle function. In our study, the more rapid regression of pain in the APC group was likely attributable to the anti-inflammatory and reparative effects of platelet-derived growth factors, consistent with experimental and clinical studies demonstrating the ability of platelet preparations to reduce synovial inflammation and accelerate tissue repair in the joint [8].

Improvement in functional outcomes according to the IKDC and Lysholm scores reflects the comprehensive positive effect of the therapy on joint stability, load tolerance, and the quality of daily activities. Similar findings have been reported in studies in which the use of PRP and platelet lysates after arthroscopy resulted in a significant increase in functional scores and shorter recovery periods [9].

From a biological perspective, the mechanism of action of autologous platelet cryolysate involves the release of a high concentration of growth factors that stimulate the proliferation of synovial cells, fibroblasts, and chondrocytes, activate angiogenesis, and promote extracellular matrix synthesis. Systematic reviews confirm that platelet concentrates can modulate reparative processes and improve clinical

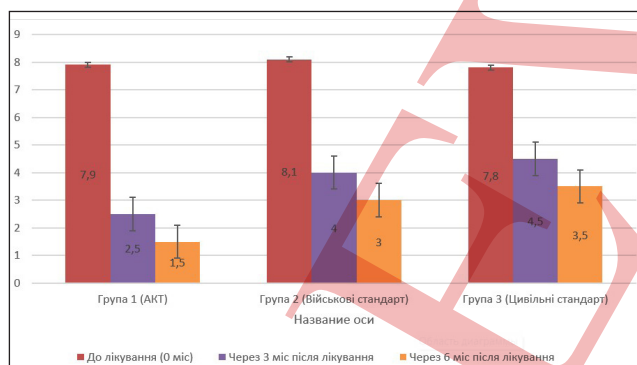


Fig. 1. Graphical representation of changes in pain according to the VAS

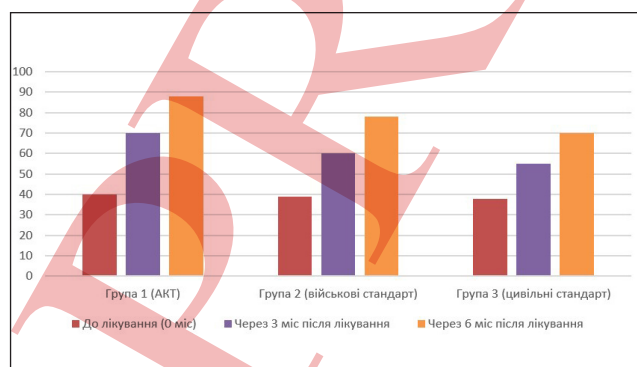


Fig. 2. Graphical representation of changes in the total Lysholm score

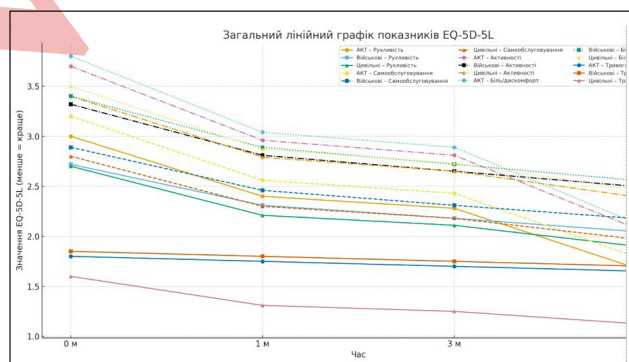


Fig. 3. EQ-5D-5L scores

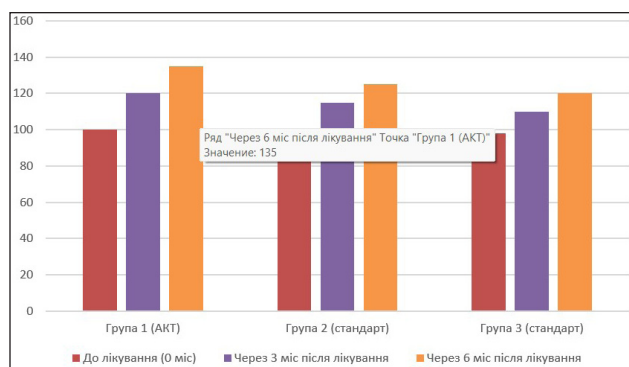


Fig. 4. Graphical representation of recovery of knee joint range of motion (ROM)

outcomes in degenerative and post-traumatic knee joint lesions [11].

The findings are of particular importance in the context of military medicine. For military personnel, the speed and completeness of functional recovery directly affect combat readiness and the ability to return to service duties. Shortening the rehabilitation period has substantial medical, social, and economic implications.

At the same time, the study has certain limitations, including a relatively small sample size and a limited follow-up period, warranting further multicenter studies to clarify the long-term effects of the therapy.

Thus, the findings support the clinical rationale for using autologous platelet cryolysate as a component of comprehensive postoperative treatment.

Conclusions

The use of autologous platelet cryolysate as part of comprehensive postoperative treatment in patients with non-combat injuries of the intra-articular structures of the knee joint results in significantly greater improvements in clinical and functional outcomes compared with standard therapy.

The use of APC is associated with faster and more pronounced reduction of pain, facilitating earlier patient mobilization and enhancing the effectiveness of rehabilitation.

Patients in group I demonstrated statistically significant improvements in knee joint function according to the IKDC and Lysholm scores, as well as a greater increase in the range of active motion, indicating faster restoration of joint mobility and stability.

The use of APC promotes more pronounced restoration of quadriceps femoris muscle trophic status and reduces the incidence of postoperative muscle hypotrophy, which is important for preventing functional knee instability.

The method has a favorable safety profile, is well tolerated, and is not associated with local or systemic adverse reactions.

Conflict of Interest. The authors declare no conflict of interest.

Prospects for Further Research. Multicenter studies involving larger patient populations and longer follow-up periods are warranted to evaluate the long-term clinical efficacy and safety of autologous platelet cryolysate, as well as its effects on structural restoration of articular cartilage and the time required for military personnel to return to full physical activity.

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revision — statistical processing and analysis of the obtained data; D. S. Yarosh — patient recruitment, data collection, and literature review; O. M. Ivanova — preparation of autologous platelet cryolysate.

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CLINICAL EFFICACY OF AUTOLOGOUS PLATELET CRYOLYSATE IN POSTOPERATIVE REHABILITATION OF NON-COMBAT KNEE JOINT INJURIES IN MILITARY PERSONNEL

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