

Experience in the comprehensive management of gunshot shrapnel wounds of soft tissues at various locations

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Aim. To develop a comprehensive strategy for the treatment of isolated gunshot shrapnel wounds of soft tissues at various locations.

Materials and methods. This study analyzed outcomes in 5,000 patients of working age (18–49 years) treated for isolated gunshot and shrapnel soft-tissue wounds at hospitals in Zaporizhzhia and the Zaporizhzhia Military Hospital between March 2022 and June 2025. The injuries were predominantly localized in the lower extremities (67.06 %), less frequently in the upper extremities (25.14 %) and trunk (7.78 %). Different treatment approaches were applied: platelet-rich plasma (PRP) in combination with delayed primary sutures (DPS) or early secondary closure (ESC), modified autodermoplasty, and local or free flap reconstructions.

Results. PRP combined with suturing was applied in 3851 cases (77.02 %): DPC in 2394 (47.88 %) and ESC in 1457 (29.14 %). The complication rates were 7.81 % with DPC and 8.86 % with ESC, while the average hospital stay was 16.0 ± 3.1 and 22.0 ± 2.2 days, respectively. In 1149 cases (22.98 %), plastic techniques were required: modified autodermoplasty in 953 (19.06 %) and flap reconstructions in 196 (3.92 %). These methods enabled the closure of extensive defects but were associated with higher complication rates (25.6–67.9 %) and longer hospital stays (23.0–36.8 days).

Conclusions. The use of PRP in combination with delayed primary or early secondary closure is the most effective and safe treatment strategy for small, isolated gunshot shrapnel wounds of soft tissues, ensuring low complication rates and faster functional recovery. Autodermoplasty and flap techniques remain the methods of choice for large and deep defects but require advanced surgical expertise and are associated with longer rehabilitation.

Ключові слова:

вогнепальні осколкові поранення, PRP-терапія, первинно відтерміновані шви, ранні вторинні шви, аутодермопластика, клаптеві пластики.

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Досвід комплексного лікування вогнепальних осколкових поранень м'яких тканин різної локалізації

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Мета роботи – розробити стратегію комплексного лікування вогнепальних осколкових поранень м'яких тканин різної локалізації.

Матеріали і методи. Дослідження ґрунтується на результатах лікування 5000 пацієнтів працездатного віку (18–49 років) з ізольованими вогнепальними пораненнями м'яких тканин, що перебували на лікуванні в 2022–2025 рр. на базі міських лікарень м. Запоріжжя та Запорізького військового госпіталю. Поранення локалізувалися переважно на нижніх кінцівках (67,06 %), рідше – на верхніх кінцівках (25,14 %) та тулубі (7,78 %). Під час лікування застосовували різні методи: збагачену тромбоцитами плазму (PRP) у поєднанні з первинно відтермінованими (ПВШ) або ранніми вторинними швами (РВШ), модифіковану аутодермопластику, локальні та вільні клаптеві пластики.

Результати. PRP у комбінації з ушиванням застосовано у 3851 (77,02 %) випадку: ПВШ – у 2394 (47,88 %), РВШ – у 1457 (29,14 %). Частота ускладнень становила 7,81 % при ПВШ і 8,86 % при РВШ, середня тривалість госпіталізації – $16,0 \pm 3,1$ та $22,0 \pm 2,2$ доби відповідно. У 1149 (22,98 %) пацієнтів використано пластичні методики: модифіковану аутодермопластику – у 953 (19,06 %), клаптеві пластики – у 196 (3,92 %). Ці методи дали змогу закрити великі дефекти, проте асоційовані з вищим рівнем ускладнень (25,6–67,9 %) та тривалішою госпіталізацією (23,0–36,8 доби).

Висновки. Використання PRP у поєднанні з первинно відтермінованими або ранніми вторинними швами – найефективніша тактика лікування ізольованих вогнепальних осколкових поранень невеликих розмірів, оскільки асоційована з низькою частотою ускладнень і сприяє швидкому відновленню працездатності. Аутодермопластика та клаптеві пластики залишаються методом вибору у разі великих і глибоких дефектів, але потребують високої кваліфікації хірургів, а пацієнтам потрібна триваліша реабілітація.

Introduction

In the context of the armed aggression against Ukraine, where hostilities result in a significant number of injuries among both military personnel and the civilian population, the selection of an effective treatment strategy for gunshot wounds of soft tissues has become particularly relevant [1,2,3,4].

Isolated blind and shrapnel wounds are the most common combat injuries; they are often accompanied by pronounced microbial contamination, tissue destruction, impaired regional blood circulation, and a high risk of developing purulent-septic complications. In this regard, the search for the optimal method of closing such wounds is not only a clinical challenge but also a strategic necessity [5,6].

At present, various approaches are used in clinical practice for wound closure – open management with secondary healing of the defect, vacuum-assisted closure (VAC), delayed suturing, different options of plastic surgery with local tissues, as well as more complex techniques involving skin flap transposition. Each of these methods has its advantages, however, none of them is universal [7,8,9].

The development of an optimal strategy for the management of gunshot soft tissue wounds depending on their characteristics is a rather complex task, the solution of which depends on a whole range of factors. In our work, we would like to share our experience in this regard and the results of treating patients with gunshot soft tissue wounds of various locations.

Aim

To develop a comprehensive strategy for the treatment of isolated gunshot shrapnel wounds of soft tissues at various locations.

Materials and methods

This study is based on the results of surgical treatment of patients with gunshot wounds of soft tissues of various localizations who were treated from March 2022 to June 2025 at the surgical departments of the Municipal Non-Profit Enterprise "City Hospital of Emergency and Urgent Medical Care" of Zaporizhzhia City Council, Municipal Non-Profit Enterprise "City Hospital No. 7" of Zaporizhzhia City Council, Municipal Non-Profit Enterprise "City Hospital No. 8" of Zaporizhzhia City Council, Zaporizhzhia Military Hospital and includes a sample of more than 10,000 patients with isolated and combined gunshot wounds of soft tissues.

Considering the complexity in the treatment of patients with polytrauma, only patients with isolated gunshot wounds of soft tissues of various locations, non-penetrating abdominal or thoracic cavities, without traumatic injuries of neurovascular bundles and bone structures, were enrolled in the study.

These strict inclusion criteria allowed us to evaluate the treatment results of 5,000 (100.0 %) patients. The mean age of the injured was 39.7 ± 9.6 years. All patients were of working age (18–49 years), which was due to the characteristics of the combat contingent and the specificity of the studied injuries.

All 5,000 (100.00 %) patients were transferred to the third stage of medical evacuation on an urgent basis after receiving emergency medical care at the pre-hospital stage.

The patients included in the study had isolated gunshot wounds localized within three main anatomical zones: lower limbs, upper limbs, and trunk.

The most common were injuries of the lower limbs – 3,354 (67.08 %) patients. Such a high frequency is explained by the anatomical vulnerability of this area during explosive action near the ground surface, especially in the standing position or during movements. The thigh and shin were most often affected – 2,884 (85.99 %). Injuries of the upper limbs were observed in 1,257 patients (25.14 %) being mainly located in the forearm and shoulder areas – 903 (71.84 %). Trunk localization (including the chest, anterior abdominal wall, and back without cavity penetration) occurred much less frequently, only in 389 (7.78 %) wounded.

Despite the different frequencies, the distribution by anatomical zones was statistically homogeneous, indicating the sample representativeness and the correspondence to the typical clinical structure of combat injuries in the context of modern military conflicts.

All procedures conducted in studies involving participants adhered to the ethical principles outlined in the 1964 Helsinki Declaration and its subsequent revisions or equivalent ethical guidelines. The study protocol and informed consent forms were approved by the Bioethics Committee of Zaporizhzhia State Medical and Pharmaceutical University (Protocol No. 9, dated 29 August 2025).

Statistical analysis of the obtained results was carried out using Statistica 13.0, TIBCO Software Inc. (license No. JPZ804I382130ARCN10-J) and Microsoft Excel 2013. Text and table-based data were presented as arithmetic mean $\pm$ standard deviation ($M \pm SD$) in the case of a normal distribution, and as Me (Q1; Q3) (median with the indication of the upper (75 %) and lower (25 %) quartiles) in case of a non-normal distribution. Comparison of variables between study groups was performed using the Mann–Whitney U test to determine statistical significance. Results were considered significant at $p < 0.05$.

Results

Taking into account wound localization, morphometric characteristics, and time to hospitalization, different treatment strategies were applied. In 3,851 patients (77.02 %), a comprehensive treatment approach was implemented, which included the use of platelet-rich plasma (PRP) in combination with either delayed primary closure (DPC) or early secondary closure (ESC).

PRP was prepared from 18.0–36.0 ml of fasting venous blood collected from the cubital vein into 9.0 ml tubes containing sodium heparin (15.0 IU/ml) and separation gel (0.5 ml). Centrifugation was performed using a Spin Plus XC-3000 device. Following centrifugation, three layers were obtained: erythrocyte mass, PRP, and platelet-poor plasma. Only the PRP fraction was aspirated using a sterile syringe for therapeutic use.

Prior to application, wounds were irrigated with 10 % povidone-iodine and anesthetized with 0.5 % novocaine 10.0 (5.0; 20.0) ml. PRP was injected into the wound bed



Fig. 1. Macroscopic appearance of the perforated epidermal flap at the time of the first dressing. Small foci of ischemia and partial graft necrosis (dark-cyanotic zones) are evident, whereas signs of inflammation or seroma formation are absent.

6.5 (5.0; 7.0) ml and edges 0.5 ml every 0.5 cm according to defect size in a total volume of 12.0 (9.0; 18.0) ml [10].

DPC was performed in patients admitted within 3 days of injury (median 2.0 (1.0; 3.0) days). These wounds demonstrated several favorable characteristics: sharply defined edges without undermining, absence of necrotic areas, a minimal infiltration with a volume of serous exudate of 7.0 (5.0; 10.0) ml/day, and limited depth of 1.5 (1.0; 2.5) cm. Morphometrically, the average wound area was 6.8 (3.1; 10.0) cm² and volume 22.8 (9.3; 40.0) cm³. Injuries were restricted to skin, subcutaneous tissue, or superficial muscle without fascial or intermuscular space involvement, providing optimal conditions for DPC with PRP and ensuring rapid and uncomplicated epithelialization.

In cases when a patient was admitted later, on the 6.0 (4.0; 9.0) day after injuries, and a wound required delayed closure until the stage of active granulation, ESC was applied in combination with PRP.

Closure was performed under strict criteria: stable wound edges, absence of necrosis or infection, and presence of mature granulation. These wounds were larger and deeper (depth 3.2 (2.7; 3.8) cm); area (12.9 (10.1; 18.0) cm²); volume (37.5 (29.0; 52.4) cm³). This approach facilitated successful closure under the biostimulatory effect of PRP even in delayed repair scenarios.

All suturing was performed using the classical Donati technique with USP 3/0 polyamide sutures, achieving stable approximation of the wound edges under minimal tension.

Passive strip drainage was maintained for 24.0 (20.0; 48.0) hours to prevent seromas or hematomas. Daily postoperative assessment and ultrasonographic monitoring allowed objective evaluation of wound healing and early identification of morphometric changes or complications.

DPC was performed in 2,394 patients (47.88 %), while ESC was applied in 1,457 patients (29.14 %). The overall complication rate in patients who received PRP combined with suturing was low. Among DPC + PRP cases, 187 patients (7.81 %) developed minor seromas or superficial hematomas, none requiring reoperation. In the ESC group with PRP, complications occurred in 129 (8.86 %) patients, that was a favorable result in terms of preventing secondary infection and maintaining wound edge stability.

The length of hospital stay is a valuable clinical measure, directly indicating the pace of recovery and the therapeutic effectiveness. In patients treated with DPC + PRP, the mean hospital stay was 16.0 ± 3.1 days, whereas in ESC + PRP cases it extended to 22.00 ± 2.20 days, $U = 12.5$, $p = 0.0024$.

These findings confirm the feasibility of early but controlled wound closure after PRP preparation, as it accelerates healing and restores combat or work capacity.

This method can be recommended as an effective and rational approach for treating relatively small shallow wounds in conditions of modern warfare, mobile surgical practice, and resource-limited healthcare settings.

In 1,149 patients (22.98 %), the wound dimensions, characteristics, and anatomical localization precluded the application of DPC or ESC. In these cases, various plastic surgical techniques were utilized to achieve closure of the soft tissue defect.

For wound bed preparation prior to closure, negative pressure wound therapy was used, which effectively drained exudate, reduced interstitial edema, improved microcirculation, and stimulated the formation of healthy granulation tissue. This approach served as an ideal "bridge" between wound cleansing and final closure, thereby significantly shortening the time for plastic surgery.

In cases of large wound surfaces (>10.0 cm²), localization on the anterior tibial surface, lateral and posterior thigh surfaces, forearm, lateral arm surface, and when the wound depth was within the subcutaneous tissue without muscle damage, modified perforated split-thickness skin grafting was applied in 953 (19.06 %) patients.

Wounds were distributed by localization as follows: 405 (42.5 %) on the anterior tibial surface, 239 (24.97 %) on the posterior thigh, 167 (17.52 %) on the inner forearm, and 143 (15.01 %) on the outer arm.

In this subgroup, on hospital day 6.0 ± 1.2 after wound cleansing, PRP injections were administered under infiltration novocaine anesthesia (0.5 %) in a volume of 12.0 (8.0; 20.0) ml into the wound bed in a chessboard pattern (1.0 ml per 1.0 cm² of defect plus 1.0 ml into wound edges every 2.0 cm) [10].

After wound preparation, donor split-thickness skin grafts were harvested from the anterior thigh under infiltration anesthesia with 0.5 % novocaine (25.0–30.0 ml), using a linear electric dermatome (model DK-717) at an optimal thickness of 0.7 mm. Then, grafts were rinsed in 0.9 % saline and perforated with a scalpel. Wounds were treated with antiseptic solutions, and the prepared perforated autograft was applied. To prevent graft displacement, it was additionally fixed to wound edges with USP 4/0 prolene interrupted sutures. Paraffin mesh and 5.0 % betadine-soaked gauze pads provided additional stabilization.

The first dressing was performed on postoperative day 4.0 ± 1.3 to evaluate graft viability based on fixation to the wound bed, absence of exudate or fluid accumulation, appropriate graft coloration, and inflammatory reactions in surrounding tissues (hyperemia, edema). Graft adhesion to the recipient area was completed at 80.0 % by days 4–5, so delaying the first dressing reduced the risk of graft displacement and necrosis [10] (Fig. 1).

Analyzing the structure of postoperative complications, it was found that in this subgroup (953 patients), seromas

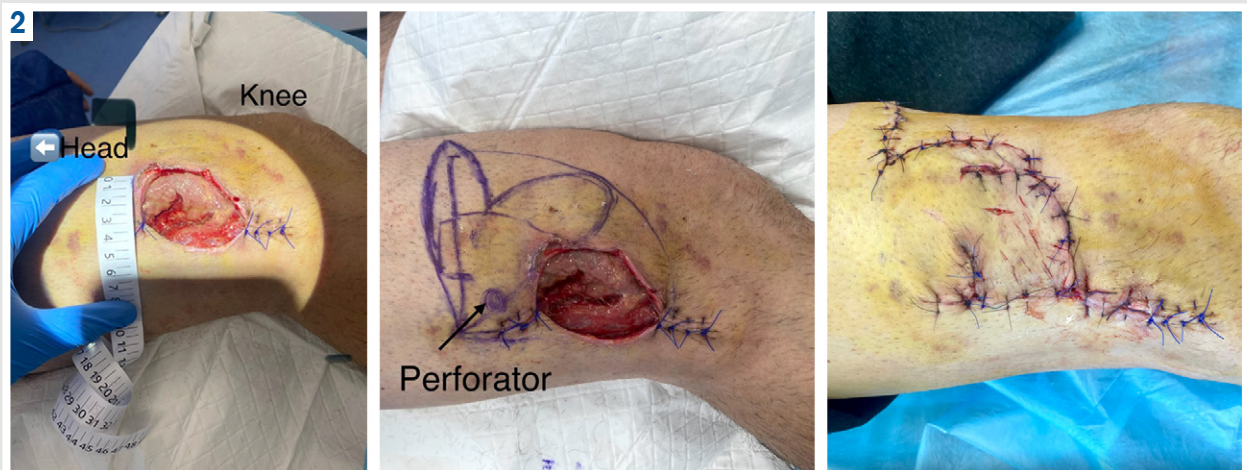


Fig. 2. Reconstruction of a wound defect in the distal third of the lateral thigh using the propeller flap technique.



Fig. 3. Perioperative assessment of the wound and postoperative outcomes in a patient undergoing V-Y advancement flap reconstruction.

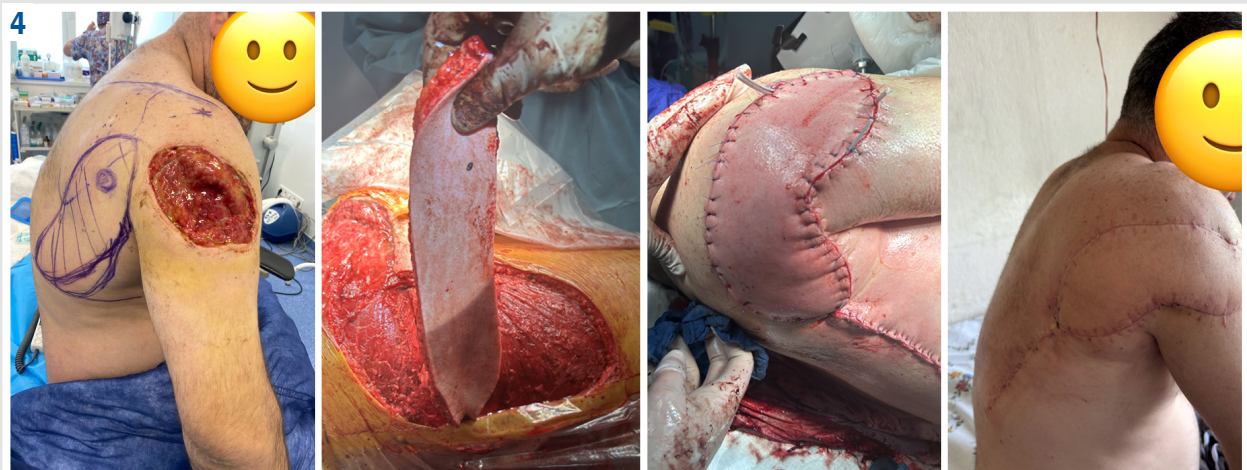


Fig. 4. Closure of the defect in the right deltoid region with a parascapular flap on a vascular pedicle.

Table 1. Key outcome indicators of treatment in patients with gunshot soft-tissue wounds using tissue flap plastics (n = 196)

Indicator	Local skin flap plastics, n = 168	Free skin flap plastics, n = 28	p-value
Duration of preoperative wound preparation, days	7.0 (6.0; 9.0)	9.0 (7.0; 11.0)	0.1278
Number of complications, abs. (%)	44 (26.19 %)	19 (67.86 %)	0.0078
Length of hospital stay, days	29.4 ± 9.2	36.8 ± 10.1	0.0432

were diagnosed in 126 (13.22 %) cases and flap necrosis in 67 (7.03 %) patients, while inflammation in the graft zone was detected in 51 (5.35 %) individuals. The overall complication rate was 244 (25.60 %). Repeat surgical intervention was performed in 84 (8.81 %) patients of this subgroup.

The mean hospital stay following modified autoder-moplasty was 23.0 ± 5.3 days. After discharge, all patients in this subgroup were prescribed a 30-day convalescent leave, thereby extending the overall recovery period before regaining combat readiness in cases of gunshot and shrapnel-induced soft-tissue injuries.

Therefore, the use of modified autoder-moplasty cannot be considered an alternative to wound suturing and should be applied only in the presence of clear indications.

In cases where the wound defect exceeded 10.0 cm² and was accompanied by muscle damage with exposure of bone and neurovascular structures, reconstruction with vascularized flaps was necessary, as these provided an independent blood supply to the affected area.

This subgroup comprised 196 (3.92 %) patients who underwent complex reconstructive procedures using rotational, advancement, or free flaps based on a vascular pedicle.

Propeller rotational flaps became a breakthrough in the reconstruction of small- and medium-sized defects, particularly in the leg and forearm regions. This technique consists of mobilizing an island of skin and subcutaneous tissue supplied by a single perforator vessel and rotating it into the defect at an angle of 90–180°. Such an approach enables closure of the wound with tissues of optimal color and texture match, while minimizing trauma at the donor site (*Fig. 2*).

For soft tissue reconstruction in injuries of the proximal third of the lower leg, coverage was achieved using a gastrocnemius muscle flap. In defects located in the distal third and ankle region, a sural fasciocutaneous flap based on retrograde blood flow (sural flap) was utilized. In cases of extensive tissue loss, V-Y advancement flaps were applied (*Fig. 3*).

A total of 168 (85.71 %) patients underwent this procedure. The mean duration of preoperative wound preparation before flap surgery was 7.0 (6.0; 9.0) days. In the postoperative period, 19 (11.31 %) patients developed inflammatory wound changes, 7 (4.17 %) had partial necrosis, and 2 (1.19 %) had complete necrosis in the area of the free flap. Postoperative hematoma occurred in 5 (2.98 %) patients, and seroma of the surgical wound in 11 (6.55 %) cases. The overall complication rate was 44 (26.19 %) cases. No lethal outcomes were recorded. The average length of hospital stay was 29.4 ± 9.2 days.

In cases of massive composite defects, when local tissues were destroyed, the only option for limb salvage was the use of free flaps on a vascular pedicle. This technique involved harvesting a complex of tissues (skin, subcutaneous tissue, muscle) from a remote donor site

(e. g., thigh, back) and transplanting it into the wound with microsurgical vascular anastomosis. Most commonly used were the anterolateral thigh flap (ALT flap) and the latissimus dorsi flap (*Fig. 4*).

This technique was used in 28 (14.29 %) patients. The average duration of preoperative wound preparation was 9.0 (7.0; 11.0) days, U = 95.0, p = 0.1278. In the postoperative period, 5 (17.86 %) patients developed inflammatory wound changes, 6 (21.43 %) experienced partial necrosis, and 1 (3.57 %) developed complete necrosis of the flap. Postoperative hematoma occurred in 2 (7.14 %) patients, and seroma in 5 (17.86 %). The overall complication rate was 19 (67.86 %) cases, U = 25.0, p = 0.0078. No lethal outcomes were documented.

The use of these techniques was carried out without PRP therapy or modifications, as at this stage we performed statistical analysis of the classical method results. A more detailed analysis, improvements in existing techniques, and the development of new complex reconstructive methods will be done in the future. The average duration of inpatient treatment was 36.8 ± 10.1 days, U = 23.5, p = 0.0432 (*Table 1*).

Thus, these wound defect closure techniques are technically demanding, and their application is associated with a high rate of complications and, consequently, prolonged hospitalization and certain difficulties in the rapid recovery of working and combat capacity in the injured.

Discussion

The results obtained in our study are of particular importance in the context of modern military surgical care, which seeks effective methods to accelerate wound healing and ensure a faster return of combat readiness in injured personnel.

International experience in the treatment of combat-related gunshot injuries, particularly during armed conflicts in Iraq, Afghanistan, Syria, Libya, and Central Africa, confirms the high incidence of soft tissue injuries with severe contamination, significant wound depth, and the need for repeated necrosectomy. According to data from US Army field hospitals, the rate of infection in such wounds without adequate local therapy may reach 25.0–30.0 %, even under conditions of intensive systemic treatment.

In a randomized trial, P. Martin & D. B. Gurevich have shown a twofold higher rate of complete healing in patients treated with PRP compared to normal saline. These findings are correlated with our observations and confirm the feasibility of using PRP in situations where other methods are either less effective or technically demanding. PRP in combination with DPC or ESC is not only an effective means of accelerating healing in small gunshot wounds but also a strategically justified method of casualty management in combat conditions. It enables rapid wound closure without the need for complex equipment or aggressive surgical interventions and can be integrated into military surgical standards with minimal resource consumption [10].

The use of split-thickness perforated skin grafts was indicated for large-area defects ($>10.0 \text{ cm}^2$) with wound depth limited to the subcutaneous fat layer. Certain wound localizations require special consideration: for example, injuries on the posterior thigh surface, where high functional activity increases the risk of wound dehiscence due to strong tension, as reported in the literature. Likewise, wounds on the anterior tibial surface are characterized by minimal muscular and subcutaneous tissue coverage, which reduces wound edge mobility and favors the choice of autodermoplasty [11].

The use of PRP injections enhances reparative processes through the action of biologically active substances, growth factors, and neoangiogenesis, allowing a significant reduction in the duration of preoperative preparation before autodermoplasty – 15.6 (12.9; 17.7) days, $p = 0.00113$, as compared with both published data and our control analysis [12].

The application of rotational and free vascularized skin flaps in our practice was considerably less frequent, accounting for only 196 (3.92 %) patients in the present cohort, which corresponds to frequencies reported in the literature [13,14]. This limited use is explained by the technical complexity of these procedures, the requirement for highly specialized surgical training, and not only the characteristics of the wound defect itself but also the injury anatomical localization. Such localization may necessitate the use of one of the various options, including rotational flaps, V-Y advancement flaps, or free flaps on a vascular pedicle [15].

Conclusions

1. The use of platelet-rich plasma in combination with wound closure is an effective and safe treatment strategy for small, isolated gunshot soft-tissue injuries. It is associated with a low rate of postoperative complications and allows patients to regain working and combat readiness within relatively short timeframes.

2. The method of autodermoplasty with a perforated split-thickness skin graft has proven its value in the management of large-area defects ($>10.0 \text{ cm}^2$) with wound depth limited to the subcutaneous fat layer, particularly in highly mobile anatomical zones where pronounced scar formation may result in contractures and restricted joint mobility.

3. Rotational and free full-thickness flaps are an important reconstructive option for massive defects involving not only superficial soft tissues but also deep muscular, vascular, and neural structures. However, their application requires significant surgical expertise and microsurgical skills in handling vascular grafts.

Prospects for further research. Future scientific investigations should focus on improving approaches to the personalization of treatment strategies, taking into account the wound morphometric characteristics, location, and the functional significance of the affected area. A promising direction is the study on the effectiveness of combining PRP therapy with other modern methods, such as negative pressure wound therapy and bioengineered materials, which may accelerate reparative processes and reduce the frequency of complications in patients with large or complicated defects. Particular attention should be given

to conducting multicenter randomized clinical trials, the results of which will not only confirm the effectiveness of the proposed approaches but also facilitate their integration into national and international treatment standards.

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References

- Balazh MS, Shestopal NO. [Modern approaches to physical therapy measures in individuals with gunshot injuries of the upper limb]. *Sportyvna medytsyna, fizychna terapiia ta erhoterapiia*. 2028;(2):68-74. Ukrainian. doi: [10.32652/spmed.2018.2.68-74](https://doi.org/10.32652/spmed.2018.2.68-74)
- Gybalo RV, Batiuk AI. [Features of the up-to-date approach to diagnosis and treatment of patients with postoperative ventral hernias after multi-stage surgical treatment of open gunshot wounds]. *Suchasni aspekty viiskovoi medytsyny*. 2020;27(2):321-31. Ukrainian. doi: [10.32751/2310-4910-2020-27-54](https://doi.org/10.32751/2310-4910-2020-27-54)
- Zavhorodnii SM, Kotenko OI, Danyliuk MB, Kubrak MA. [Surgical treatment of isolated gunshot shrapnel wounds of soft tissues using delayed primary sutures combined with platelet-rich plasma injections in mine-explosive injuries]. *Zaporizhzhia Medical Journal*. 2023;25(4):339-45. Ukrainian. doi: [10.14739/2310-1210.2023.4.269875](https://doi.org/10.14739/2310-1210.2023.4.269875)
- Kukuruz YS, Slychko IY, Yalovenko VA. [Peculiarities of teaching for reserve officers of surgical tactics at fire and open injury of extremities]. *Medychna osvita*. 2013;(4):94-6. Ukrainian. doi: [10.11603/me.v0i4.1095](https://doi.org/10.11603/me.v0i4.1095)
- Neroba V. [The role of mining weapons in the modern wars and border conflicts]. Collection of scientific works of the National Academy of the State Border Guard Service of Ukraine. Series: Military and Technical Sciences. 2019;(3):155-71. Ukrainian. doi: [10.32453/3.v8i1i3.444](https://doi.org/10.32453/3.v8i1i3.444)
- Chernyak VA, Rogovsky VM, Nahaliuk YV, Sivash YY, Shchepetov MV, Karpenko KK. [Results of the treatment of major vacuum wounds in the united kingdom's operation in the eastern ukraine for the period from 2014 to and quarter of 2019]. *Scientific Bulletin of Uzhhorod University. Series: Medicine*. 2020;61(1):130-9. Ukrainian. doi: [10.24144/2415-8127.2020.61.130-139](https://doi.org/10.24144/2415-8127.2020.61.130-139)
- Ahmad S, Agrawal P, Anwer A, Khurana S, Adil M, Ibran M. Gunshot Injury to Distal Tibial Physis and Talus: A Case Report. *J Orthop Case Rep*. 2024;14(4):134-9. doi: [10.13107/jocr.2024.v14.i04.4388](https://doi.org/10.13107/jocr.2024.v14.i04.4388)
- Zavhorodnii SM, Kotenko OI. [Effectiveness of the use of early secondary sutures and injections of platelet-rich autoplasm in isolated gunshot shrapnel wounds of soft tissues]. *Reports of Vinnytsia National Medical University*. 2024;28(2):287-93. Ukrainian. doi: [10.31393/reports-vnmedical-2024-28\(2\)-18](https://doi.org/10.31393/reports-vnmedical-2024-28(2)-18)
- Feliciano DV. Gunshot wound to big red. *Trauma Surg Acute Care Open*. 2020;5(1):e000506. doi: [10.1136/tsaco-2020-000506](https://doi.org/10.1136/tsaco-2020-000506)
- Martin P, Gurevich DB. Macrophage regulation of angiogenesis in health and disease. *Semin Cell Dev Biol*. 2021;119:101-10. doi: [10.1016/j.semcdb.2021.06.010](https://doi.org/10.1016/j.semcdb.2021.06.010)
- Liashevych AM, Lupaina IS, Hryshchuk SM. *Dynamichna anatomiia [Dynamic Anatomy]*. Zhytomyr: Zhytomyr State University Press; 2022. Ukrainian.
- Pykaliuk VS, Lavryniuk VY, Shevchuk TY, Aponchuk LS. *Anatomiia oporno-rukhovoho aparatu [Anatomy of the Musculoskeletal System]*. Lutsk: FOP Ivaniuk V. P.; 2022. Ukrainian.
- Mishra JK, Sahu SA, Bodhey NK, Sindhuja A, V A. Perforator-based propeller flap with additional venous pedicle for lower limb reconstruction. *Indian J Plast Surg [Internet]*. 2023;56(4):373-7. doi: [10.1055/s-0043-1769113](https://doi.org/10.1055/s-0043-1769113)
- Yu JL, Tolley PD, Kneib C, Miller EA, Crowe CS. Current concepts in microsurgical soft tissue reconstruction of lower extremity trauma in a single-vessel extremity. *Plast Aesthet Res*. 2022;9(5):37. doi: [10.20517/2347-9264.2021.124](https://doi.org/10.20517/2347-9264.2021.124)
- List EB, Hahn BA, Qiu SS, de Jong T, Rakhorst HA, Verheul EM, et al. Free Fasciocutaneous versus Muscle Flaps in Lower Extremity Reconstruction: Implications for Functionality and Quality of Life. *J Reconstr Microsurg*. 2024 Dec 20. doi: [10.1055/a-2483-5388](https://doi.org/10.1055/a-2483-5388)