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Routine daily activities and pain intensity according to the results of the initial examination of patients with polystructural injuries of the upper extremities

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Abstract

Purpose. This article analyzes the structure of the total sample of patients with polystructural injuries of the upper extremities depending on the severity of injuries and the type of reconstructive interventions and evaluates the results of the initial examination according to the indicators of activity of daily life and intensity of pain syndrome with the determination of the most severe clinical group.

Material & Methods. The study involved 56 patients with gunshot wounds of the upper extremities after reconstructive interventions. Patients were divided into groups according to the severity of the polystructural injury (I-IV grade). All study participants underwent an initial examination using the DASH questionnaire, the modified Frenchay scale (MFS), and the visual analogue pain scale (VAS). Mathematical statistical methods were used to analyze the structure of the total sample and identify the most severe clinical group.

Results. The initial examination of 56 patients after gunshot wounds of the upper extremities in the post-acute period revealed the prevalence of grade IV severity (55%), in terms of distribution by segments, the most common injuries were in the shoulder-elbow segment (37%). Initial condition in the group as a whole (n=56): VAS = 7 points, DASH = 61.5, MFS = 72.5 – pronounced pain syndrome and functional deficit. The Kruskal-Wallis test did not reveal significant differences between groups I, II, combined III-IV for pain, MFS and DASH before treatment (H=1.50; 3.57; 0.80; p>0.05). However, group II (nerve plastic surgery) tends to have the worst results: the highest pain (rank 31.04), the lowest MFS function (rank 26.31), the highest DASH disability (rank 31.38). Such results may be due to neuropathic pain, paresis and sensory deficits, which limit activity more than musculoskeletal defects in grade IV in the post-acute period. When comparing the performance of the four most difficult tasks of the modified Frenchay scale (MFS), statistically significant intergroup differences were found only in the task of "simulating cutting food" (H=6.96; p=0.031), where the worst results (the lowest mean rank 19.46) were recorded in group II (peripheral nerve plastic surgery).

Conclusions. Despite the lack of statistical significance, grade II polystructural injury was functionally the most severe according to the visual analogue scale, MFS and DASH scales, and one statistically significant task of the MFS scale. This partially contradicts the expectations that grade IV (muscle/bone defects) would have the worst prognosis, and indicates the key role of the nerve defect (grade II) as a limiting factor in functional recovery.

Keywords: Gunshot injury, physical therapy, occupational therapy, mine-blast injury, military rehabilitation, upper limbs.

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Introduction

Modern high-precision and high-kinetic firearms cause an increase in the number of combined and polystructural injuries, which are accompanied by primary and secondary tissue defects. According to the literature, gunshot wounds to the extremities account for up to 62% of all combat injuries (upper – 25.7%, lower – 36.9%), which is explained by their lower protection (Huriev et al., 2014, Strafun et al., 2017).

The publication by Moshkivskyi et al. (2023) states that in the structure of damaged tissues of the upper limb, soft tissue injuries prevailed – 52%, gunshot fractures of bones and joints were in 31.5% of cases, nerve injuries in 14% and injuries of major arteries in 2%.

As is known, peripheral nerve damage leads to motor, sensory and trophic disorders, the formation of persistent contractures, impaired fine motor skills and a significant decrease in the functional capacity of the limb. Gunshot fractures with a bone tissue defect require staged reconstructive interventions using bone grafting and prolonged immobilization, which additionally contributes to the development of joint stiffness, muscle atrophy and slowing down the restoration of function. According to leading scientists, bone defects are observed in 11.6% of patients. The number of injured people who subsequently need to undergo reconstructive surgery is 35-40% (Strafun et al., 2022). Often, such injuries are accompanied by significant skin defects, which requires the use of various plastic methods (local, regional or free flaps) to close the wounds and protect the reconstructed structures. The complexity of the lesion leads to a high risk of unsatisfactory results and determines the need to improve surgical treatment and rehabilitation tactics aimed at restoring the anatomical integrity and functional activity of the limb (Moshkivskyi, 2023; Trutiak, 2021).

At the rehabilitation stage, a multidisciplinary team should provide a detailed clinical examination, set realistic short- and long-term goals (according to the SMART format), and assess the rehabilitation potential to prevent disability of the victims (Kruk & Hryhus, 2022).

The development of a modern rehabilitation program for patients with polystructural gunshot wounds of the upper extremities should be based on evidence-based methods of physical therapy and occupational therapy, using the latest technologies, a differentiated approach taking into account the severity of injuries, the level of damage, and the patient's functional capabilities.

After primary and intermediate reconstructive surgeries, it is advisable to start physical therapy and occupational therapy as early as possible to prevent complications, ensure early recovery of movements, and stabilize the psychoemotional state of the victims (Klapchuk YV, 2020).

The aim is to analyze the structure of the total sample of patients with polystructural injuries of the upper extremities depending on the severity of injuries and the type of reconstructive interventions and to evaluate the results of the primary examination according to the indicators of daily life activity and pain intensity with the determination of the most severe clinical group.

Material and methods

Participants. The research sample consisted of 56 military personnel with polystructural gunshot wounds of the upper extremities who were hospitalized in the rehabilitation department of the State Institution "Institute of Traumatology and Orthopedics of the National Academy of Medical Sciences of Ukraine" from January to September 2025.

Inclusion criteria: patients aged 18-60 years with polystructural gunshot wounds of the upper extremities after surgical treatment, in stable condition, who gave informed consent to participate in the study.

Exclusion criteria: multiple injuries of other anatomical areas that require priority surgical or intensive treatment (injuries to the brain, spinal cord, chest, pelvis, etc.); amputation of the upper limb (except for amputation of 2-5 fingers); severe systemic complications; oncological pathology or acute infections.

Analysis of the age structure of the study group showed that the average age was 40.95 ± 9.67 years. The patients represented heterogeneous postoperative stages, encompassing both post-acute and long-term recovery periods. The vast majority of them arrived after reconstructive surgical treatment performed at the State Institution "Institute of Traumatology and Orthopedics of the National Academy of Medical Sciences".

The study was conducted in accordance with the ethical principles of the Declaration of Helsinki (1964–2013), the International Conference on Harmonisation Good Clinical Practice guidelines (ICH GCP, 1996), Council of Europe Convention Directive No. 609 (1986), and the orders of the Ministry of Health of Ukraine No. 690 (September 23, 2009), No. 944 (December 14, 2009), and No. 616 (August 3, 2012). The study protocol No. 8 was approved by the Commission on Bioethics of the State Institution "Institute of Traumatology and Orthopedics of the National Academy of Medical Sciences of Ukraine" (Minutes dated November 25, 2025). All patients provided written informed consent after being fully informed about the study objectives, procedures, rights, respon-

sibilities, and the possibility of withdrawing from the study at any time without consequences.

Material and methods

Our study and development of the FT and ET program were based on the modified classification of the consequences of polystructural trauma of the upper limb by I.M. Kurinny (2009) and the supplemented classification by N.O. Borzykh (2019). This classification determines the severity of gunshot wounds. This facilitates the determination of the rehabilitation potential of patients, taking into account the limitations between staged reconstructive interventions. The modified classification is described in more detail in the authors' previous work (Borzykh, 2025).

In accordance with the purpose of the study, during the initial examination of patients before the start of rehabilitation treatment, quantitative indicators were obtained on the DASH scale, the Modified Frenchay Scale (MFS) and pain intensity according to VAS.

By choosing evidence-based methods of examination and assessment, according to the results of several systematic reviews, we have data that in the therapy of diseases of the musculoskeletal system of the upper extremities, the Disability of the Arm, Shoulder and Hand (DASH) Questionnaire should be used (Huang et al., 2015; Sigirtmac, 2021). According to Gummesson (2003), the Disability of the Arm, Shoulder and Hand (DASH) questionnaire has the potential to develop patient-centered treatment programs after surgical interventions that are adapted to their individual needs and daily activities, and can also detect and differentiate small and large changes in disability in both the early postoperative and long-term periods. The interpretation of the questionnaire results is as follows: an excellent result is considered to be a sum of up to 25 points, from 26 to 50 – good, from 51 to 75 – satisfactory and from 76 to 100 points – unsatisfactory.

Based on several MCD (Laclergue, 2023; Wendel, 2013) on the determination of motor control and dexterity of the upper extremities when performing everyday tasks, the Modified Frenchay Scale (MFS) was selected, which is based on the original Frenchay Arm test.

According to this scale, the patient performed 10 standardized household tasks, where each task was evaluated from 0 to 10 points with the maximum possible number of points – 100. Moreover, high scores indicate better function of the upper limb, low – pronounced disorders (Heller, 1987). When performing MFS, the patient indicated the significance of a particular task when determining SMART goals (Radajewska, 2013).

Pain syndrome was assessed using a generally accepted Visual Analogue Scale (VAS) (Hlynyana, 2020).

The study was carried out in accordance with the research plan of the rehabilitation department of the State Institution "Institute of Traumatology and Orthopedics of the National Academy of Sciences of Ukraine" for 2025-2027 on the topic "Rehabilitation of patients with polystructural gunshot wounds of the upper extremities", state registration number 0125U000201.

The issues of the work correspond to the plan of scientific and research work carried out at the National University of Physical Education and Sports of Ukraine for 2021–2025 on the topic: 4.1. "Increasing the level of functional independence and occupational participation of individuals of different nosological groups using occupational therapy intervention programs", state registration number 0121U107532 and/or 4.2 "Restoration of functional capabilities, activity and participation of individuals of different nosological, professional and age groups using physical therapy", state registration number 0121U107926.

Study organization

After reconstructive surgery, patients underwent a standardized postoperative route. 4-5 days after staged surgical treatment, patients were discharged from the hospital with recommendations for an orthopedic regimen that included maintaining mobility in joints not involved in immobilization.

Approximately six weeks after surgery, based on control diagnostic examinations, a decision was made to begin active rehabilitation. If necessary, the immobilization period was extended to 7-8 weeks. After receiving a referral from the military unit commander or family doctor (for military personnel who were discharged from service), patients were hospitalized for comprehensive rehabilitation measures.

After a detailed history and functional examination, patients were distributed according to the modified classification of polystructural injuries, which has I-IV degrees of severity. All 56 patients were distributed in this way (Fig. 1). The I severity group included 9 patients (16%), who underwent surgical interventions, including suture or plastic of tendons, muscles; dismantling of the external fixation device with possible subsequent conversion of the fixation method; nerve revision, neurolysis. The II severity group included 13 patients (23%), who underwent suture or plastic of peripheral nerves, tendon-muscular transpositions with irreversible nerve damage (as well as possible interventions that are characteristic of the I severity). The III severity group, for which plastic of the skin defect is characteristic, included

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3 patients (6%). The IV severity group included 31 patients (55%), who underwent plastic of the bone and/or muscle defect, joint replacement, as well as possible previous surgical interventions that are characteristic of the I-III degrees of severity.

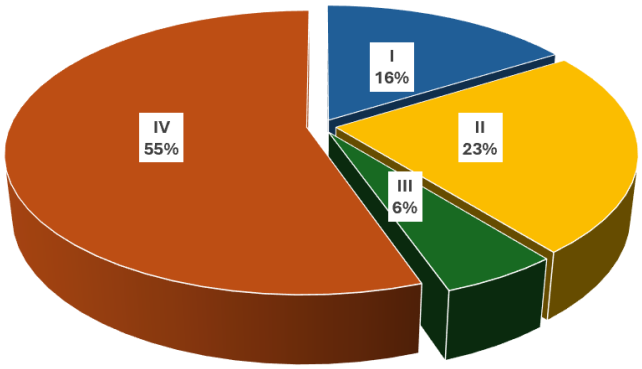

Figure 1. Distribution of the study population between I-IV degrees of severity of polystructural injury of the upper limb.

Due to the limited number of patients in Group III, Groups III and IV were merged for subsequent statistical analysis. This methodological decision was justified by the similarity of the clinical profiles of these groups, particularly with respect to the high level of surgical complexity. In both groups, the reconstruction of skin defects involved advanced plastic and reconstructive soft tissue procedures, consistent with a Grade IV level of injury complexity. Combining the groups allowed to increase the statistical power of the analysis and conduct a comparative assessment in order to determine the clinical group with the most unsatisfactory functional indicators.

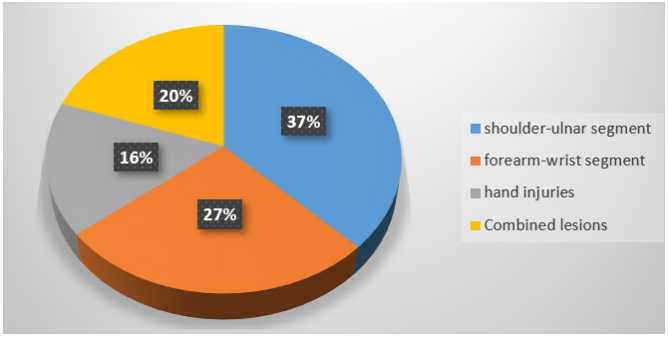

Figure 2. Distribution of the contingent of subjects with polystructural injuries by segment of gunshot wound of the upper limb.

Analysis of the distribution of patients by segment of gunshot wound showed (Fig. 2) that the most common injuries were at the level of the shoulder-ulnar segment – 21 cases (37%), then at the level of the forearm-wrist segment – 15 cases (27%), hand injuries – 9 cases (16%).

Combined lesions – 11 cases (20%) indicate a significant energy of the traumatic factor and the need for a comprehensive surgical and rehabilitation approach.

Statistical analysis

Mathematical data processing was performed using the TIBCO Statistica 14.0.0.15 program (TIBCO Software Inc.). Since the distribution of most indicators did not correspond to the law of normal distribution (checked by the Shapiro–Wilk criterion), the median (Me) and interquartile range (IQR) — 25th and 75th percentiles — were used to describe the samples. In order to identify statistically significant differences in functional indicators between three independent groups (I, II and combined III–IV) depending on the severity of the injury, a nonparametric Kruskal–Wallis ANOVA by Ranks analysis of variance was performed with the calculation of the H statistic. The level of statistical significance was set at $p<0.05$.

Results

The analysis revealed a statistically significant deviation from normal distribution ($p<0.05$) for all three questionnaires, which justifies the presentation of descriptive statistics in the form of median (Me) and interquartile range (Q1; Q3) (Table 1). Most patients had moderately pronounced or significant impairment of upper limb function, which is confirmed by high DASH values – Me=61.45(50.5;73.3), (according to the Shapiro–Wilk test (W=0.954; p=0.033<0.05) a statistically significant deviation from normality was established.

Table 1. Indicators of daily life activity and pain intensity according to the results of the initial examination

Indicators	n=56 (Me [Q1; Q3])	Shapiro–Wilk W	p
DASH before treatment	61,45(50,5;73,3)	0,954	0,033
MFS before treatment	72,5(62;83)	0,873	0,001
Pain intensity before treatment	7(5;8)	0,934	0,004

According to the results of the modified MFS scale before treatment, the preservation of movements in most patients was relatively satisfactory, while individual cases were characterized by pronounced functional limitations – Me=72.5 (62;83, W=0.873; p<0.001), which indicates the variability of the functional state of the upper extremities:

The median pain intensity according to VAS before the start of treatment was 7 points (5;8,

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Table 2. Results of the analysis of functional indices before treatment using the Kruskal-Wallis test

Indicator	Severity	N	Sum of ranks	Average rank	H	p-value
Pain during movement	I	9	205,00	22,78	1,5	0,472
	II	13	403,500	31,04		
	IV	34	987,500	29,04		
Frenchay (MFS)	I	9	341,00	37,89	3,568	0,168
	II	13	342,00	26,31		
	IV	34	913,00	26,85		
DASH	I	9	226,00	25,11	0,8	0,670
	II	13	408,00	31,38		
	IV	34	962,00	28,29		

Note: *H is the Kruskal-Wallis test statistic*; all p values are >0.05, indicating no statistically significant differences between groups at the time of examination

W=0.934; p=0.004), which reflects the high initial severity of the pain syndrome in most patients before the start of treatment, which significantly limits daily activity and movements in the affected upper limb.

Also, a nonparametric Kruskal-Wallis ANOVA by Ranks (H) was performed for three independent groups (I, II, combined III-IV) to determine whether there were statistically significant differences in the functional states of patients depending on the severity of the injury. The analysis was performed on the VAS pain index during limb movement, the results of the modified MFS and DASH scales (Table 2).

Analysis of the indicator "Pain during limb movement before treatment" according to the results of the Kruskal-Wallis test had the following values – H=1.50, p=0.47. Statistically significant differences in pain levels between groups with different degrees of injury severity were not found (p>0.05). The average rank is highest in group II (31.04), which may indicate a tendency towards more severe pain in this group compared to groups I (22.78) and IV (29.04), however, this difference is not statistically significant (Fig. 3).

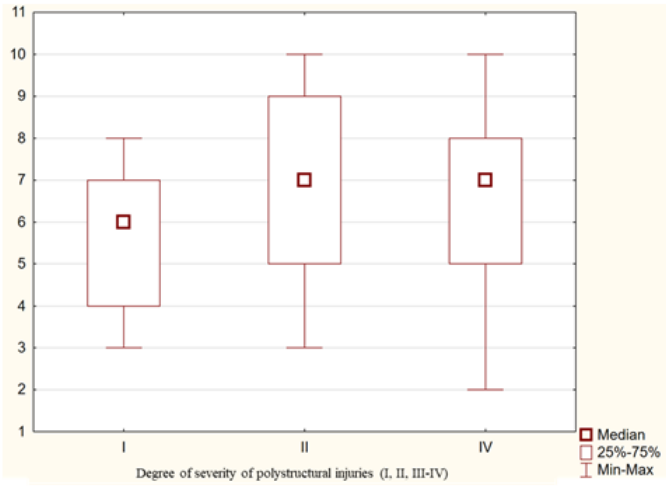

Figure 3. Distribution of pain intensity in patients with different degrees of polystructural injury severity (I, II, III-IV) before treatment.

According to the Modified Frenchay Scale (MFS) (MFS) before treatment, no statistically significant intergroup differences were found (Kruskal–Wallis H=3.57; p=0.17). The worst indicators (lowest mean ranks) were registered in group II – 26.31 and combined group III–IV – 26.85, while group I had a significantly better mean rank of 37.89 (Fig. 4). Thus, the most severe functional state before treatment was observed in group II and combined groups III–IV.

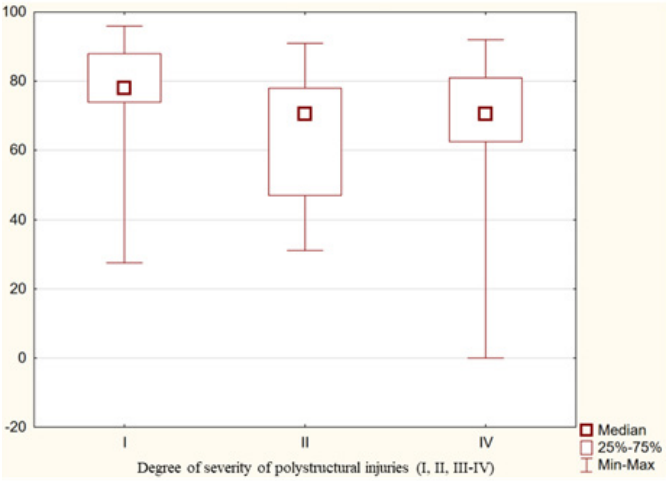

Figure 4. Distribution of indicators according to the Modified Frenchay Scale in patients with different degrees of severity of polystructural injury (I, II, III-IV) before the start of treatment.

According to DASH, no statistically significant intergroup differences were found (H=0.8; p=0.670). The worst indicators (the highest average rank 31.38) were registered in group II, while the combined group III-IV – 28.29, group I – 25.11. Thus, the most severe impairment of daily activities was observed in patients after nerve plastic surgery (group II).

Therefore, despite the lack of statistical significance, the clinical interpretation of the mean ranks indicates potentially worse functional outcomes in groups with higher severity, which requires attention when planning rehabilitation programs and choosing surgical tactics.

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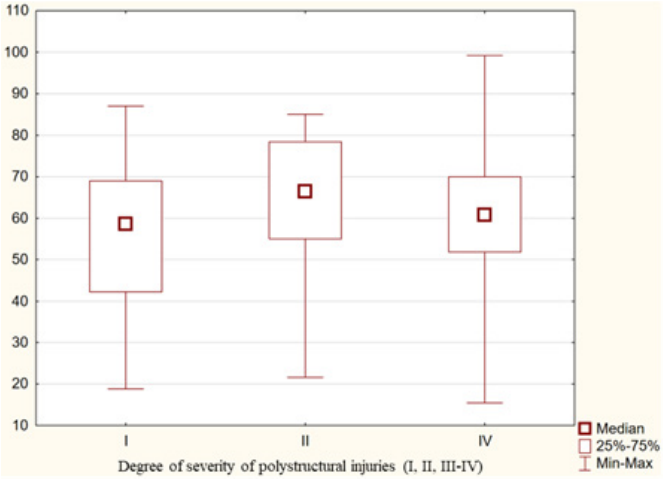

Figure 5. Distribution of DASH scores in patients with different degrees of polystructural injury severity (I, II, combined III-IV) before the start of treatment.

In order to more closely analyze the functional state of the upper limb in patients with gunshot wounds and identify specific components that most affect the overall outcome on the MFS scale, a separate analysis of the responses was conducted for each item of the questionnaire. Moreover, for each item, a corresponding code was determined according to the International Classification of Functioning, Disability and Health (ICF) in the "Activity and Participation" domain (Table 3), which made it possible to integrate the assessment results into the process of forming individual rehabilitation goals.

Since the distribution of all MFS questionnaire scores was significantly non-normal (Shapiro–Wilk W=0.71–0.92; p<0.05 in all cases), the results are presented as median [Q1; Q3].

According to the results obtained (Table 3), the performance indicators of tasks on the Modified Frenchay Scale (MFS) in patients with gunshot wounds of the upper limb before the start of rehabilitation treatment varied from 4.0 to 9.0 points on a ten-point scale.

Thus, the highest indicators were observed when holding a ruler and drawing a line (Me=9 [8; 10]) and opening/closing a can (Me=8 [6; 9]), which indicates the preservation of basic grasping movements and the ability of the proximal segments of the upper limb to their stable position. Average results were when lifting and carrying a large and small bottle, drinking, using a fork and knife (Me=7–8 points), which indicates a moderate limitation of the range of motion in the joints and grip strength. The lowest score was obtained when performing the task "reach, take a comb and comb your hair" (Me=4 [2.5; 8]), which demonstrates the greatest complexity in movements involving the shoulder and elbow joints, as well as pincer grip. Performing this task requires precise spatial control, a significant amplitude of movement in the joints of the upper limb, including rotational movements. To identify the group with the most severe functional outcome, four tasks of the Modified Frenchay Scale were selected for detailed intergroup comparison (Kruskal–Wallis), which in the general sample demonstrated the lowest medians – they turned out to be the most

Table 3. MFS scores in patients after gunshot wound of the UL according to the results of the initial examination

MFS question/ICF code	n=56 (Me [Q1; Q3])
Open and close a jar with a screw-top lid: the affected hand holds the jar. d4401 Grasping	8(6;9)
Hold a ruler and use it to draw a straight line on a piece of paper while holding a pencil in the other (unaffected) hand. The affected hand holds the ruler. d440 Fine motor skills	9(8;10)
Reach out, pick up and put down a large bottle with the affected hand. d4301 Transferring	7(5;8)
Reach out, pick up and put down a small bottle with the affected hand. d4301 Transferring	8(6;9)
Reach out, pick up and bring a glass to mouth with the affected hand. Drinking d560	7(3;8)
Attach three clothespins to a notebook. The unaffected hand holds the notebook. d4402 Manipulating	8(6;9)
Reach out, pick up a comb with the affected hand and comb the hair. The task involves running the hand over the top of the head and both sides from the face to the back of the head, from the right and left sides. d5202 Hair care	4(2,5;8)
Apply toothpaste to a toothbrush. The affected hand holds a tube of toothpaste. d5201 Dental care	8(6;9)
Pick up a fork and knife and imitate cutting food. d550 Eating	7,5(4,5;9)
Pick up a broom and imitate sweeping the floor with both hands. d6402 Cleaning the living area	8(5;9)

Table 4. Results of the analysis of the 4 Frenchay tasks (FMS) before treatment using the Kruskal-Wallis test

Indicator	Severity	Sum of ranks	Average rank	H	p-value
With the affected hand, reach, lift and put back a large bottle	I	256,50	28,50	0,16	0,92
	II	350,50	26,96		
With the affected hand, reach, lift and bring a glass to the mouth.	III-IV	989,00	29,09		
With the affected hand, reach, lift and bring a glass to the mouth.	I	327,50	36,39	3,02	0,22
	II	384,00	29,54		
	III-IV	884,50	26,01		
With the affected hand, take a comb and comb the hair (imitation of combing)	I	343,00	38,11	5,27	0,07
	II	405,50	31,19		
	III-IV	847,50	24,93		
Take a fork and knife and imitate cutting food.	I	335,50	37,28	6,96	0,03
	II	253,00	19,46		
	III-IV	1007,50	29,63		

difficult to perform (Table 4).

Among the four most difficult tasks of the modified Frenchay scale, statistically significant intergroup differences were found only for one – "Take a fork and knife and imitate cutting food" (Kruskal–Wallis H=6.96; p=0.03).

Detailed distribution of average ranks for this task:

Severity group I (n=9) – average rank 37.28 – the best result

Combined severity group III–IV (n=34) – average rank 29.63 – intermediate result

Severity group II (n=13) – average rank 19.46 – the worst result than in groups I and combined groups III–IV

No statistically significant differences were found for the other three MFS tasks (p=0.072–0.921). The lowest average ranks were registered:

- "lift a large bottle" – group II (26.96);
- "bring a glass to your mouth" and "comb your hair" — groups III–IV (26.01 and 24.93, respectively).

Thus, tasks that depend on fine motor skills, coordination, and nerve conduction were performed worst by patients in group II, and tasks with large amplitude and proximal segment strength — by the combined groups III–IV.

Discussion

The data of the initial examination indicate that in a sample of 56 patients after a gunshot wound to the upper limb, in 55% of cases, patients after complex reconstructive interventions prevailed, who have the most severe IV degree of polystructural damage. By localization, isolated damage to the shoulder-elbow segment was most common (37%). Patients had severe pain syndrome (7 points according to VAS), a significant decrease in upper limb function (61.5 according to DASH) and a low motor index according to the modified MFS scale (72.5 points). In this regard, to optimize treatment results, it is extremely important to assess the rehabilitation potential of patients in order to predict the functional outcome and determine adequate differentiated tactics. The need for such a differentiated approach is confirmed by the data of scientists Klapchuk. et al (2020).

The nonparametric Kruskal–Wallis analysis of variance did not reveal statistically significant intergroup differences in any of the studied indicators: VAS during movement (H=1.5; p=0.472), MFS (H=3.568; p=0.168) and DASH (H=0.8; p=0.670).

The lack of statistical significance between the groups is consistent with current literature data and indicates that the final functional outcome after polystructural gunshot wounds of the upper limb is determined not only by the initial severity of the injury, but primarily by the quality and timeliness of reconstructive interventions, adequate intermediate rehabilitation and the patient's individual compensatory capabilities (Naumenko, 2017; Girard, 2017). It is the action of these factors that probably smoothed out potential intergroup differences, ensuring a comparable level of functional adaptation even in groups with more pronounced structural defects.

However, the trend analysis of mean ranks demonstrates that the group of severity II (with nerve defect plastic surgery) has the most pronounced functional deficit: the highest level of pain according to VAS (mean rank 31.04), the lowest function according to the modified MFS scale (26.31) and the highest DASH score (31.38).

When comparing the performance of the four most difficult tasks of the modified French-ay scale (MFS), statistically significant intergroup differences were found only in the task of "simulating cutting food" (H=6.96; p=0.031), where the worst results (the lowest mean rank 19.46) were recorded in group II (plasticity of peripheral nerves).

Thus, the most severe functional impairments of fine and purposeful motor skills (especially bimanual actions) are observed in patients after nerve plastic surgery (group II), while tasks requiring significant amplitude and strength of proximal segments were performed worst by patients with massive musculoskeletal defects (combined groups III–IV). This confirms the different profile of functional limitations depending on the dominant component of the polystructural injury.

It can also be assumed that a peripheral nerve defect of grade II severity significantly limits functional activity, especially in the early stage, due to neuropathic pain, paresis and sensory deficit, than musculoskeletal defects of grade III-IV. In particular, in patients with grade IV severity, despite significant muscle and bone defects, adequate plastic reconstruction can provide better functional indicators, compared with less severe injuries. These findings are consistent with the data of Tsymbaliuk et al. (2015), who claim that the functional results of surgical treatment of gunshot wounds of peripheral nerves are generally worse than other types of damaged structures.

Moreover, the results of our interim analysis are confirmed in the scientific work of Strafun et al. (2018), which proves that it is the trauma of peripheral nerves that determines the severity of the injury.

Therefore, based on the available data, it is impossible to unambiguously identify one of the analyzed groups (I, II, or combined groups III–IV) as the statistically significant "most severe" in terms of functional indicators before treatment, however, the clinically least favorable indicators are observed in the II severity group.

The obtained data give us grounds for the following steps:

1. Continuation of the collection of primary data. The current sample size (N=56) may be insufficient to detect existing clinically significant differences between the groups. Presumably, the effect of the severity of the injury on the functional state is smaller than expected, and a larger sample is required to detect it, which will provide a higher statistical power of the study.

2. Analysis of the dynamics of treatment. The planned rehabilitation intervention program with an assessment of its effectiveness in dynamics (after 2 weeks, 3 months and 6 months) is a key stage in achieving the main goal of the study. It is in the dynamics that we can expect differences in functional recovery between groups. Patients with more severe injuries (grades II and IV) may demonstrate slower dynamics of improvement according to the MFS and DASH questionnaires or higher levels of pain that persist at later follow-up, in contrast to the group with less severe injuries (grade I).

Conclusions

The obtained data do not allow us to assert a statistically significant advantage of any of the groups in most functional indicators. However, the clinically least favorable results (the lowest average ranks) in key scales (FSM, DASH, VAS) and in the only statistically significant MFS task – "simulate cutting food", were registered in group II (after peripheral nerve plasticity).

This partially refutes the expectation that the worst functional prognosis will be for patients with grade IV severity (musculoskeletal defects), and emphasizes the leading role of the peripheral nerve defect as a limiting factor in the restoration of upper limb motor skills.

Thus, the achieved goal allows us to conclude that the most unsatisfactory functional results are associated not only with the volume of the tissue and bone defect, but primarily with the involvement of peripheral nerves and the complexity of their reconstruction. This conclusion should be taken into account when identifying risk groups, planning treatment phases, and developing rehabilitation protocols, especially for patients with grade II injuries.

Further research will focus on two main areas: increasing the sample size to increase the statistical power of the analysis of the baseline condition of the subjects and conducting an analysis of the effectiveness of the rehabilitation program, which will allow not only to identify differences between groups, but also to assess their dynamics depending on the severity of the injury.

Author's contribution

Natalia Borzykh: Conceptualization, Methodology, Clinical Supervision, Preparation of the Final Version of the Article; **Svitlana Barabash:** Clinical Supervision, Writing of the Text, Software, Statistical Calculations; **Iryna Roy:** Data Curation, Study Design, Peer Review and Validation; **Kudrin Anton:** Study Visualization, Access to Clinical Databases, Equipment, Clinical Supervision and Organization of the Rehabilitation Process; **Kravchuk Lyudmila:** Peer Review, Validation. All authors have read and agreed with the published version of the manuscript.

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Conflict of Interest
The authors declare that there is no conflict of interest.

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