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EFFECT OF TREATMENT ANESTHETIC TACTICS ON LONG-TERM PAIN MANAGEMENT OUTCOMES IN PATIENTS WITH GUNSHOT AND MINE BLAST WOUNDS

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The frequency of chronic pain in patients after gunshot or mine blast wounds can range from 66 to 91.7 % and depends on several factors. However, the effect of therapeutic anesthesia tactics on long-term pain management outcomes in this category of patients remains unexplored. The results of pain management in 2215 patients with gunshot and mine blast wounds were analyzed. Comparisons were made using the Mann-Whitney and chi-squared tests with allowance for continuity. Better long-term results of pain management were in group 2 ($p < 0.001$), $OR = 0.09$ (95 % CI 0.07-0.11) than in group 1, as well as when using regional anesthesia or regional anesthesia with sedation compared to patients who used general anesthesia. The tactics of pain management in patients after gunshot or mine blast wounds are of crucial importance and affect the long-term results of treatment. When standardized by the type of wound and the number of localizations of wounded anatomical parts of the body, the use of tactics that ensure high-quality control over pain can reduce ($p < 0.001$) the risk of ineffective treatment, $OR = 0.08$ (95 % CI 0.07–0.10).

Key words: pain treatment, therapeutic tactics of analgesia, gunshot and mine blast wounds, quality of life, military.

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ВПЛИВ ЛІКУВАЛЬНИХ ТАКТИК ЗНЕБОЛЕННЯ НА ВІДДАЛЕНІ РЕЗУЛЬТАТИ ЛІКУВАННЯ БОЛЮ У ПАЦІЄНТІВ З ВОГНЕПАЛЬНИМИ ТА МІННО-ВИБУХОВИМИ ПОРАНЕННЯМИ

Частота хронізації болю у пацієнтів після вогнепальних чи мінно-вибухових поранень може коливатись від 66 до 91,7 % та залежить від низки факторів. Проте не вивченим залишається вплив лікувальних тактик знеболення на віддалені результати лікування болю у такої категорії пацієнтів. Проаналізовано результати лікування болю у 2215 пацієнтів з вогнепальними та мінно-вибуховими пораненнями. Порівняння проводилося за критерієм Манна-Уїтні, хі-квадрат з урахуванням поправки на неперервність. Кращі віддалені результати лікування болю у групі 2 ($p < 0.001$), $ВШ = 0.09$ (95 % ВІ 0.07-0.11) ніж у групі 1, а також при використанні регіонарної анестезії чи регіонарної анестезії з седацією у порівнянні з пацієнтами, у яких використана загальна анестезія. Тактика лікування болю у пацієнтів після вогнепальних чи мінно-вибухових поранень має вирішальне значення та впливає на віддалені результати лікування. При стандартизації за типом поранення та кількістю локалізацій поранених анатомічних ділянок тіла використання тактики, яка забезпечує якісний контроль над болем дозволяє знизити ($p < 0.001$) ризик неефективного лікування, $ВШ = 0.08$ (95 % ВІ 0.07–0.10).

Ключові слова: лікування болю, лікувальні тактики знеболення, вогнепальні та мінно-вибухові поранення, якість життя, військові.

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A condition in which pain progresses from an acute state to a chronic state and persists after the healing process is completed characterizes the process of chronic pain. Chronic pain disrupts function and reduces patients' quality of life. In recent years, many efforts have been made to improve our understanding of chronic pain and to develop better treatments to alleviate chronic pain [15]. In particular, much attention is paid by clinicians to the comprehensive treatment of patients with mine blast wounds and sizeable soft tissue wounds, which are complex in terms of treatment and at the stages of rehabilitation [11]. To improve pain management, experts have recently introduced research subtypes of chronic pain based on proposed underlying mechanisms.

Nociplastic pain is one such subtype that may involve a more prominent etiological role for brain plasticity, painful emotions caused by life stress and trauma, and unhealthy emotion regulation. Specifically, correlational and behavioral data link anger and its regulation to the presence and severity of nociplastic pain. Functional neuroimaging studies also show that nociplastic pain and healthy anger regulation exhibit inverse activity patterns in the medial prefrontal cortex and amygdala; thus, improving anger regulation may normalize activity in these regions [14]. The International Association for the Study of Pain recently released clinical criteria and a classification system for nociplastic pain. However, clinicians and researchers can be confused by the multitude of terms and variety of clinical criteria available [9]. Other authors found no evidence that central sensitization can persist as an autonomous pain generator after wound healing [3, 7]. A deeper understanding of how the brain affects symptoms in recovering

patients may help guide rehabilitation strategies, develop new methods to counter these maladaptive brain changes, and ultimately improve pain outcomes [10].

Treating patients with chronic pain is an almost daily challenge. A unique syndrome is often included among the many causes of pain, usually called complex regional pain syndrome type. To make real progress in helping patients with pain, we will need new and different concepts [1, 6]. Several groups of researchers have described the presence of small fiber neuropathy in patients with fibromyalgia [8]. Thin fiber neuropathy is increasingly recognized. Knowledge of these disorders is essential in clinical practice, as increased awareness allows rapid diagnosis and comprehensive care for such patients after injury. In addition, these new developments may lead to a better understanding of pathophysiological mechanisms [5].

Despite numerous studies, there is still insufficient data on the effect of pain management tactics on long-term pain outcomes in patients with gunshot and mine blast wounds, as the frequency of chronic pain in such patients ranges from 66 to 91.7 %.

The purpose of the study was to investigate the influence of therapeutic tactics of analgesia on the long-term results of pain management in patients with gunshot and mine blast wounds.

Materials and methods. The study was carried out at the National Military Medical Clinical Center “Main Military Clinical Hospital”. Some of the patients were injured during the Operation of the United Forces, and the other part – during the defence of Kyiv in the period from February 24, 2022, to April 2, 2022. and received gunshot wounds during hostilities.

Studying the impact of pain management tactics on the long-term results of pain treatment in patients with gunshot and mine blast wounds, we selected 2215 patients after injuries received in combat while performing special combat tasks to protect the territorial integrity of Ukraine. 1049 patients were from a retrospective study (group 1), and 1166 patients – from a prospective study (group 2). The analysis used the treatment results of 1049 group 1 and 1166 patients of group 2.

In post-injury patients, long-term pain management outcomes were assessed using the Chaban Quality of Life Scale (CQLS): up to 56 inclusive – very low level, 57–66 – low, 67–75 – medium, 76–82 – high, 83–100 – very high. Understanding the connection between the beliefs and behavior of the wounded explains their attitude to treatment, and this is a personal experience that has an unconditional connection with treatment tactics. Perception is thought to be the balance that patients make between the advantages and disadvantages of their pain management experience [14]. Forecasting will allow you to predict the long-term outcome of a particular pain management tactic [9]. Some patients had general anesthesia with tracheal intubation and artificial ventilation, some had regional anesthesia (peripheral nerve blocks), and some had regional anesthesia with sedation.

Table 1

Coefficients of univariate logistic regression models predicting the risk of treatment failure

Factor designation		Model coefficient value, b±m	Significance level of difference from 0	Index OR (95 % CI)
Group	1		Reference	
	2	-2.43±0.10	<0.001	0.09 (0.07–0.11)
Type of wound	Gunshot wounds		Reference	
	Mine blast wounds	0.18±0.09	0.057	–
Types of anesthesia	General anesthesia		Reference	
	Regional anesthesia	-0.25±0.11	0.025	0.78 (0.62–0.97)
	Regional anesthesia+sedation	-0.53±0.11	<0.001	0.59 (0.48–0.73)
Age		-0.001±0.005	0.780	–
Height		-0.011±0.008	0.141	–
Weight		0.006±0.006	0.274	–
Number of localizations of wounded anatomical parts of the body		-0.10±0.03	0.002	0.90 (0.85–0.96)
Number of surgical operations		-0.055±0.023	0.017	0.95 (0.91–0.99)
ASA risk		0.00±0.11	0.986	–
Mean duration of anesthesia, per 100 minutes		-0.033±0.061	0.584	–
Mean duration of surgical operations, per 100 minutes		-0.033±0.060	0.586	–
Visual Analogue Scale upon hospitalization		0.72±0.06	<0.001	2.05 (1.82–2.30)

The study's results were analyzed in the EZR v. 1.35 package (R statistical software version 3.4.3, R Foundation for Statistical Computing, Vienna, Austria). Mean value and standard deviation (±SD) were

calculated to represent quantitative traits. The Kruskal-Wallis test was used to compare indicators in the three groups (the law of distribution differed from the normal one). Dunn's test was used for the posterior comparison. The Friedman test (for repeated measurements) was used to analyze changes in indicators over time. The odds ratio (OR) and its 95 % CI were used to assess the degree of influence factor quantitatively. When performing the analysis, the critical significance level is assumed to be 0.05 in all cases.

The study was carried out within the biotic examination protocol administered by the Ministry of Health of Ukraine, Bogomolets National Medical University Kyiv, Ukraine: Protocol No. 158, 23.05.2022.

Results of the study and their discussion. To analyze the risk of not achieving treatment success according to CQLS ($CQLS \leq 66$ after 12 months), the method of constructing and analyzing univariate and multivariate logistic regression models was used (Table 1).

As factor features, the analysis was performed for 12 Risk Factors: group, type of wound, patient's age, height, weight, number of surgical operations performed, type of anesthesia, number of localizations of wounded anatomical parts of the body, anesthetic risk according to ASA, the mean duration of surgical operations, the average duration of anesthesia, the intensity of pain according to VAS upon admission.

In the case when, after 12 months, the value of the CQLS index ≤ 66 , it was considered that the positive effect was not achieved (outcome variable $Y=1$, 1059 cases). If, after 12 months, the value of the CQLS index is >66 , a positive effect is considered to have been achieved (outcome variable $Y=0$, 1156 patients).

To identify a set of indices associated with the risk of treatment failure, significant features were selected (the method of stepwise rejection/inclusion of features was used, with the inclusion threshold $p < 0.075$ and the rejection threshold $p > 0.15$) in a multivariate logistic regression model (Table 2).

Table 2

Coefficients of a three-parameter logistic regression model predicting the risk of treatment failure

Factor designation	Model coefficient value, $b \pm m$	Significance level of difference from 0	Index OR (95 % CI)
Group	1	Reference	
	2	-2.52 ± 0.11	< 0.001 0.08 (0.07–0.10)
Type of wound	Gunshot wounds	Reference	
	Mine blast wounds	0.39 ± 0.12	0.001 1.47 (1.17–1.85)
Number of localizations of wounded anatomical parts of the body	≤ 2	Reference	
	> 2	0.36 ± 0.12	0.002 1.44 (1.14–1.82)

During the selection process, three characteristics were selected: group (pain treatment tactics), type of wound, and number of localizations of wounded anatomical body parts. A three-parameter logistic regression model for predicting the risk of chronic pain was built on the selected feature. The model is adequate ($\chi^2=708.9$ at $p < 0.001$).

Fig. 1 shows the operating characteristic curve for predicting the risk of treatment failure according to the model.

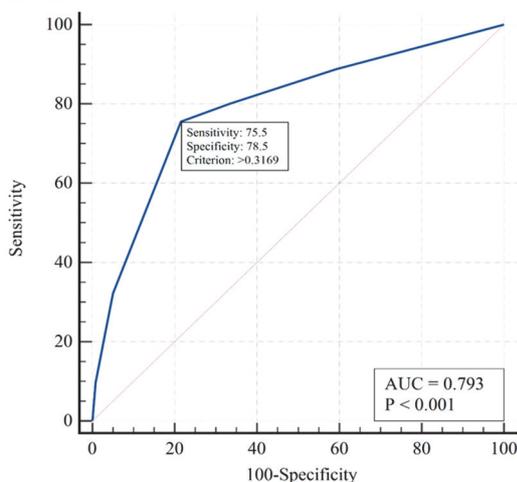


Fig. 1. Operating characteristics curve of the three-parameter model for predicting the risk of treatment failure. The model's critical threshold, sensitivity and specificity at the selected threshold are given.

The area under the operational characteristics curve, $AUC=0.79$ (95 % CI 0.78–0.81), indicates the presence of a connection between the group (pain management tactics), the type of wound, and the number of localizations of wounded anatomical parts of the body with the risk of treatment failure.

Authors of targeted studies pay attention to the problem of pain treatment in patients of various categories. In particular, a disorder of thin myelinated and unmyelinated fibers, the neuropathic component of pain and autonomic complaints are clinically dominant here, which leads to a significant decrease in the quality of life. The new assessments may contribute to a better understanding of the cellular and molecular substrates and enable improved diagnostic methods and designs in the future. Identification of the underlying mechanisms may contribute to the development of drugs that will more efficiently eliminate neuropathic

pain and autonomic symptoms. Small fiber neuropathy, which affects sensory fibers, is now a major diagnostic and therapeutic problem. Almost 7 % of the general population has chronic neuropathic pain, being responsible for serious impairment of quality of life. Therefore, it is necessary to increase clinicians'

awareness about the somatosensory and autonomic symptoms that can reveal small fiber neuropathy, the appropriate diagnostic tests, the most common causes and the best treatment options for each patient profile [12]. There is an evidence that clinicians' pain management is well-targeted at treating the underlying cause, but most patients will require pain control with multiple concurrent therapies [13]. Some authors argue that entrapment neuropathies are the most common type of peripheral neuropathy and are often difficult to diagnose and treat. Much of our current knowledge is based on empirical concepts and early (often biomechanical) research. This view will challenge some current beliefs due to recent advances in basic and clinical neuroscience [2]. Pain symptoms associated with constant activity develop in 17.7 % and are the main reason for appeals [4]. In developed countries, there is a large amount of research on pain and its treatment, but there is a lack of proper treatment. Patients with pain had an obvious economic burden, and their quality of life and psychology significantly deteriorated [15].

Our study proves that the improvement of the long-term results of pain management in patients with wounds depends on the tactics of pain treatment ($p < 0.001$), $OR = 0.09$ (95 % CI 0.07–0.11), as well as on the choice of anesthetic support: when using local anesthesia or regional anesthesia with sedation compared to patients in whom general anesthesia was used. Worse results ($p < 0.05$) were observed with an increase in the number of localizations of wounded anatomical parts of the body, the number of surgical operations and ineffective treatment of high-intensity pain ($p < 0.001$), $OR = 2.05$ (95 %, CI 1.82–2.30).

Conclusion

The tactics of pain management in patients after gunshot or mine blast wounds are of crucial importance and affect the long-term results of treatment. When standardized by the type of wound and the number of localizations of wounded anatomical parts of the body, the use of tactics that ensure high-quality control over pain can reduce ($p < 0.001$) the risk of inefficient treatment, $OR = 0.08$ (95 % CI 0.07–0.10). Such patients require many surgical operations, therefore giving preference to regional methods of anesthesia permits to reduce the frequency of chronic pain, as well as relieves the medical staff. Effective analgesia taking into account the localization of wounded anatomical parts of the body immediately after injury and at all stages of treatment can become one of the key components for improving the long-term treatment results of this category of patients.

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