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UDC 616.8-07
DOI – https://doi.org/10.14300/mnnc.2024.19030
ISSN – 2073-8137

FEATURES OF FORMATION OF PSYCHOPHYSIOLOGICAL DISORDERS IN MINE EXPLOSION INJURY

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ОСОБЕННОСТИ ФОРМИРОВАНИЯ ПСИХОФИЗИОЛОГИЧЕСКИХ НАРУШЕНИЙ ПРИ МИННО-ВЗРЫВНОЙ ТРАВМЕ

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The article discusses issues related to cognitive impairment in patients who have suffered mine blast trauma (MBT). The main group comprised 61 patients (58 men and three women). The average age was 45.5±4.7 years. The patients were divided into two groups: the first group – 31 (50.8 %) patients with a history of isolated traumatic brain injury (TBI) of mild to moderate severity; the second group – 30 (49.2 %) patients with a combination of mild and moderate TBI with somatic complications (amputation of the lower limb at different levels). The control group consisted of 30 healthy individuals. In the main group, sharply reduced levels of cognitive wave amplitude were noted. This was based on the difficulty in perceiving and processing incoming signals. As a result of the study, it can be argued that after MBT, patients perceive complex external perceptual events, objects, and phenomena worse. At the same time, there was a decrease in the communicative activity of patients with the onset of depression, which, in terms of level and severity, dominated in patients of the second group due to limited movement and difficulties in self-care.

Keywords: mine blast injury, traumatic brain injury, cognitive impairment, evoked potentials

Рассмотрены вопросы, связанные с когнитивными нарушениями у пациентов, перенесших минно-взрывную травму (МВТ). Основную группу составил 61 пациент (58 мужчин и 3 женщины). Средний возраст 45,5±4,7 лет. Пациенты были разделены на 2 группы: первая группа – 31 (50,8 %) пациент с изолированной черепно-мозговой травмой (ЧМТ) легкой и средней степени тяжести в анамнезе; вторая группа – 30 (49,2 %) больных с сочетанием нейротравмы легкой и средней степени тяжести с соматическими осложнениями (ампутация нижней конечности на разных уровнях). Контрольную группу составили 30 здоровых лиц. В основной группе отмечены резко сниженные показатели амплитуды когнитивной волны, что, вероятно, определяло сложности в восприятии и переработке поступающих сигналов. По результатам исследования можно утверждать, что после МВТ сложные внешние перцептивные события, объекты и явления хуже воспринимаются пациентами. При этом происходило снижение коммуни-

кативной деятельности с возникновением депрессии, которая по уровню и степени выраженности доминировала у пациентов второй группы, что явилось следствием ограничения передвижения и сложностей в самообслуживании.

Ключевые слова: минно-взрывная травма, черепно-мозговая травма, когнитивные нарушения, вызванные потенциалы

For citation: Karpov S. M., Barkinkhoeva A. B., Vyshlova I. A., Soboleva O. A., Akhtarudzhaman M., Azoidis I., Iskra D. A. Features of formation of psychophysiological disorders in mine explosion injury. *Medical News of North Caucasus.* 2024;19(2):131-134. DOI – https://doi.org/10.14300/mnnc.2024.19030

Для цитирования: Карпов С. М., Баркинхоева А. Б., Вышлова И. А., Соболева О. А., Акхтарудджаман М., Азоидис И., Искра Д. А. Особенности формирования психофизиологических нарушений при минно-взрывной травме. *Медицинский вестник Северного Кавказа*. 2024;19(2):131-134. DOI – https://doi.org/10.14300/mnnc.2024.19030

CNS – central nervous system
CTE – chronic traumatic encephalopathy
EP – evoked potentials
LP – latent period
MBT – mine blast injury
TBI – traumatic brain injury

Undoubtedly, military conflicts that have taken place over the past decade have led to a large number of casualties due to explosive injuries [1–4]. It is worth noting that anthropogenic disasters also potentially cause injuries, mainly similar to mine blast injuries (MBI) in clinical manifestations and mechanisms of action. This problem becomes socially crucial due to significant economic losses and severe medical consequences [5–7]. MBI is characterized by both general damaging effects on the body and complex impact on the brain in the form of neurotrauma, leading to a more severe outcome in the remote period after MBI [8], as well as damage to the organ of vision [9] and limbs in both adults and children [10]. There are various systems for assessing injuries in MBI [11]. Imaging methods play a significant role in diagnosis [12]. Prehospital triage for mass casualty cases is essential for early surgical assessment [13].

The study aimed to study psychophysiological disorders and the presence of depression after MBI.

Material and Methods. Patients in the remote period after MBI were examined. The main group consisted of 61 patients (58 men and three women), averaging 45.5±4.7 years. Patients were divided into 2 groups: the first group included 31 (50.8 %) patients with isolated traumatic brain injury (TBI) of mild and moderate severity in the medical history; the second group included 30 (49.2 %) patients with a combination of TBI of mild and moderate severity with somatic complications (lower limb amputation at different levels). The remote period after MBI for the examined patients was 10.1±1.2 years. The control group consisted of 30 relatively healthy individuals.

All participants underwent a thorough collection of medical history, clinical examination using standard techniques, and neurophysiological studies using evoked potentials (EP). The endogenous P300 wave was analyzed, which allowed for an indirect assessment of cognitive potential, and the cortical auditory wave «V» was examined to study the integrative functions of the CNS in the remote period after BI.

The study used the computer processing device «Encephalan 131–03» (Medikom MTD, Taganrog, Russian Federation). This study is based on the presentation of insignificant and significant stimuli in random order followed by differentiation by the subjects. The stimulation conditions for the P300 wave were standard: binaural stimulation with a stimulus duration of no more than 50 ms and an intensity of no more than 60 dB with an interstimulus interval of 2 seconds. Five insignificant stimuli were pseudo-randomly presented in a series of stimuli, and 1–2 significant stimuli appeared – the number of presented significant stimuli needed to be counted. Auditory EPs were evaluated using the «V» wave to identify long-latency auditory EPs. For both methods, the response's latent period (LP) and amplitude (A) were analyzed.

The state of depression was assessed using the Beck's Depression Inventory (BDI) (Beck & Beck, 1961). The scale consists of 21 categories of symptoms and complaints, with 4–5 statements reflecting the specifics of depression manifestations. The statements are ranked in order of increasing contribution of the symptom to the overall severity of depression and have gradation levels of depression (normal, mild, moderate, severe, and very severe).

Mean arithmetic values (M) and their errors (m), as well as standard deviation (δ), were calculated. Statistically significant differences in mean values were evaluated using the Student's t-test. The computer software package StatTech 2.5.8 (Stattech LLC, Russian Federation) was used.

Results and Discussion. Analysis of cognitive EPs of the P300 wave based on LP parameters revealed a statistically significant ($p<0.01$) increase in patients of the 1st and 2nd groups (335.4±5.81 ms and 331.4±4.29 ms, respectively) compared to the control group (311.5±2.93 ms). We found no statistically significant changes in LP between 1st and 2nd groups patients. An increase in LP of the P300 wave above reference values in the 2nd group was noted in 25 (84.3 %) cases, with the remaining five instances showing changes in amplitude despite average LP values.

The study of response amplitude to the presented stimulus in all cases indicated a statistically significant ($p<0.01$) decrease to 3.8±1.21 μV and 2.9±2.03 μV respectively, in the 1st and 2nd groups, compared to the control group (7.91±2.02 μV). This indicates reduced «neuronal resources» in processing incoming signals and their recognition due to previous MBI (Figure).

Analysis of EPs to auditory stimuli with an assessment of LP and amplitude of the «V» wave allowed for the evaluation of the auditory zones of the cortex. In the 1st group, the LP of the «V» wave was 106.8±4.67 ms; in the 2nd group – 105.8±4.41 ms, which was statistically significant ($p<0.01$) compared to the control group (91.2±2.41 ms). The amplitude of the «V» wave in patients of the 1st group was 3.2±1.23 μV; in the 2nd group – 3.7±1.79 μV, and in the control group – 7.3±1.39 μV.

The obtained results for the cognitive P300 wave and the cortical auditory wave were comparable.

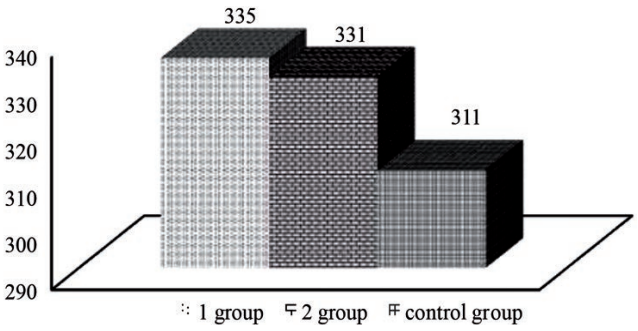

Fig. Comparative characteristics of the P300 wave in TBI survivors according to the parameters of the latent period (ms)

Depression, as a critical component of any traumatic factor, was assessed using the Beck's scale, and the results obtained are presented in the Table. The data showed the distribution of depression levels among the patients in the main group and the control group. The numbers represent the absolute count of patients and the percentage within each subgroup. The indicators of depression severity, according to Beck's scale, point to different levels of psychopathological states in the studied groups. In the 2nd group, manifestations of moderate depression were observed in 20 (66.7 %) of the examined individuals, while in the 1st group (16 (51.6 %) patients). Severe depression was more frequently observed in patients of the second group.

Table

Beck's depression indicators in examined patients in the remote period after MBI

Depression Level	Main group (n=61)				Control group (n=30)	
	1st group (n=31)		2nd group (n=30)			
	Abs.	%	Abs.	%	Abs.	%
Normal	3	9,7	–	–	26	86,7
Mild	11	35,4	5	16,7	4	13,3
Moderate	16	51,6	20	66,7	–	–
Severe	1	3,2	4	13,3	–	–
Very Severe	–	–	1	3,3	–	–
Total	31	100	30	100	30	100

The results obtained for the parameters of the endogenous P300 wave and the «V» cortical auditory response to stimuli demonstrate a decrease in neuronal activity in response reactions, leading to prolonged decision-making time, indicating dysfunction of cortical «reactions», which were sharply reduced in patients of both the 1st and 2nd groups. The parameters of the P300 amplitude reflect the organization of cognitive and perceptual-motor functioning as a complex evaluation of incoming information in the CNS. The generation of the P300 amplitude is formed by the interaction of thalamic-hippocampal structures with the involvement of temporoparietal and frontal areas of the cerebral cortex [14], which allows for assessing the mechanisms of recognition of incoming information. In both main groups, significantly reduced indicators of cognitive wave amplitude were noted, which determines difficulties in perceiving and processing incoming signals. According to the research results, it can be argued that after MBI, complex external perceptual events, objects, and phenomena are perceived worse by patients, leading to a reduction in the patient's communicative activity and the onset of depression, which dominated in terms of level and severity among patients of the second group, resulting from movement limitations and difficulties in self-care [15–17].

Assessing the results of other studies, it was noted that repetitive brain injury is associated with progressive neurological deterioration characterized as chronic traumatic encephalopathy (CTE). The authors noted that most cases of CTE occur in association with sports but also in association with blast injuries, where symptoms of CTE include behavioral and mood changes, memory loss, cognitive impairment, and dementia [18].

The authors of another publication [19] express grave concern about the consequences for military personnel caused by an explosion and draw attention to the fact that the stressful context in which this injury occurs, with psychiatric manifestations often happening, should be taken into account. The authors point to the emergence of cognitive consequences caused by MBT.

Conclusion. Assessing the cognitive potential and depressive state of a patient after TBI is necessary to solve the problem of an integrated approach in the treatment of injury to reduce its consequences. Reorienting medical research will improve the treatment of MBT, which will positively impact both civilian and military healthcare systems.

Disclosures: The authors declare no conflict of interest.

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Received 30.07.2023

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