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Neurological and neuropsychological characteristics of postconcussion syndrome following blast mild traumatic brain injury

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A common complication of blast mild traumatic brain injury (mTBI) is postconcussion syndrome (PCS), the diagnostic criteria of which are based on the patient's subjective complaints. Creation of reliable tools for clinical signs of blast mild TBI objectification is of great priority.

Objective: using a comprehensive neurological and neuropsychological examination to determine the characteristics of clinical signs of blast mild TBI in the long-term period to assess the correlation with the data of neurophysiological and radiological studies.

Materials and methods. The study involved 115 male participants of hostilities in the East of Ukraine (main group) with a diagnosis of " PCS after previous blast mTBI " and 30 healthy individuals (control group). Patients were in the long-term period of injury (from 6 months to 3 years). After collecting complaints and medical history data, the neurological status and the state of cognitive functions were examined. The latter were studied using the questionnaire "Cicerone". Neuropsychological testing according to the Montreal Cognitive Assessment score (MoCA) was carried out. The Hospital Anxiety and Depression Scale (HADS) was also used, and to objectify asthenic disorders - the Asthenic State Scale (ASS).

Results. Assessment of the severity of cognitive impairment using the questionnaire "Cicerone" allowed identifying three clinical variants of PCS: 1) with cognitive impairment in combination with affective disorders (44,3 ± 9,1) % of patients), 2) with a predominance of affective disorders (23,5 ± 7,7) % of patients), 3) moderate and mild disorders of the cognitive and affective spectrum in combination with moderate autonomic disorders ((32,2 ± 8,5) % of patients). In 43,5% of cases, according to the MoCA scale, a decrease in cognitive impairment was found for memorization (memory), attention, delayed recall, total score. According to the HADS scale, the distribution of patients was as follows: clinically significant anxiety was noted in (9,6%) patients, depression - in (11,3%) patients, combination of clinically significant anxiety with depression - in (5,2%) patients, subclinical symptoms of anxiety of various severity - in (55,7%) patients. The phenomena of asthenia due to fatigue with mood swings, loss of the ability to concentrate for a long time on mental and physical tasks occurred in all patients with PCS. Factors with a probably higher risk of cognitive impairment were identified: 1) complaints of extreme fatigue and headache, 2) neurological signs in the form of pyramidal insufficiency, brisk tendon reflexes, 3) anxiety level according to the HADS scale. They can be considered as predictors of detection of cognitive deficit in patients with PCS as a result of blast mild TBI.

Conclusions. Comprehensive neurological and neuropsychological examination is an effective tool for diagnosing cognitive changes in PCS as a result of blast mild TBI.

Key words: *blast mild traumatic brain injury; post-concussion syndrome; cognitive impairment; neuropsychological testing*

Introduction

In modern combat operations, blast mild (TBI) is a marker injury for military personnel. Given its prevalence, difficulty of diagnosis and social consequences, blast TBI is characterized as a "silent epidemic of an invisible injury" [1]. Of all injuries US military personnel received while serving in Iraq and Afghanistan, blast injuries accounted for 56-78% [2].

According to American researchers, the structure of blast injuries of the central nervous system (CNS) is dominated by mild blast TBI (mTBI). Severe injuries are diagnosed in only 2,8% of cases. The imaginary ease

of most cases of blast mTBI causes its incomplete and untimely diagnosis due to the vagueness of diagnostic criteria and imperfect tools for objectifying and visualizing the injury [3].

The symptoms of blast mTBI are extremely variable and are characterized by a tendency to long-term persistence of neurological and cognitive deficits. This became the basis for the allocation of a separate nosological unit - postconcussion syndrome (PCS). According to the diagnostic criteria, PCS occurs after a head injury leading to loss of consciousness and is characterized by at least three of the following: 1) complaints of discomfort and pain, such as headache, dizziness, general malaise, and excessive fatigue or noise intolerance; 2) emotional changes - irritability, emotional lability or a certain level of depression and / or anxiety, 3) subjective complaints of difficulty concentrating and performing mental tasks, as well as memory problems without clear objective evidence, 4) insomnia, 5) decreased alcohol tolerance, 6) concern about these symptoms and fear of permanent brain damage up to hypochondria and acceptance of the role of the patient [4].

The creation of reliable tools for objectifying the clinical signs of blast mTBI remains relevant. This publication is the part of the research work of the Romodanov Neurosurgery Institute "To determine neurophysiological criteria for predicting the development of cognitive impairment in patients with mild TBI in the long- term period of mine-blast trauma".

Objective: using a comprehensive neurological and neuropsychological examination to determine the characteristics of clinical signs of blast mild TBI in the long-term period to assess the correlation with the data of neurophysiological and radiological studies.

Material and methods

Study participants

The study involved 115 male participants of hostilities in the East of Ukraine (main group) and 30 healthy individuals (control group). All participants of the main group were diagnosed with PCS after previous blast mTBI by the special military medical commission of the Ukrainian Military Medical Academy based on the history and clinical data and accompanying medical documentation. Patients were in long term period of injury (from 6 months to 3 years).

Informed and voluntary written consent to participate in the research was obtained from all patients. The study was approved by the Committee on Ethics and Bioethics of the Institute of Neurosurgery named after acad. A. P. Romodanov, Ukraine (Minutes №1 dated 16.01. 2018).

Inclusion criteria:

1) participants of hostilities who suffered a mild TBI as a result of mine explosion;

2) age 18–45 years;

3) no history of previous TBI, cerebrovascular disorders, surgery on the central nervous system.

All subjects of the main and control groups gave written consent to conduct the study and further processing of the information obtained.

Exclusion criteria:

1) previous TBI;

2) any cerebrovascular accident;

3) alcohol abuse;

4) addictive substance abuse;

5) psychiatric observation.

Characteristics of the group

Of the 115 surveyed, 103 (89,6 ± 5,6%) had higher education, 11 (9,6 ± 5,4%) had incomplete higher education, and 1 (0,9 ± 1,7%) – had secondary education.

Study design

After collecting complaints and medical history data, the neurological status and the state of cognitive functions were studied using the questionnaire "Cicerone". Neuropsychological testing according to the Montreal Cognitive Assessment score (MoCA) was carried out. The Hospital Anxiety and Depression Scale (HADS) was also used and the Asthenic State Scale (ASS) - to objectify asthenic disorders.

K.D. Cicerone and K. Kalmar (1995) [5] identified 4 clusters of symptoms and signs in the structure of PCS: affective, cognitive, somatic and sensory. In contrast to these authors, based on the prevalence of clear and significant cognitive impairment and the severity of clinical manifestations of blast mild TBI, three main variants for PCS in combat CNS injuries have been identified. The frequency of detection of complaints, symptoms and signs of disorders in the studied patients is given in ***Table 1*** with the division into conditional degrees of severity. Assessment of symptoms (signs) according to items of questionnaire "Cicerone" was used to calculate scores in clusters: S - somatic disorders, C - cognitive disorders, A - affective disorders. Symptom (sign) was ranged from 0 to 3 points: 0 - rarely observed, does not affect working capacity, 1 - noted frequently, sometimes impairs working capacity, 2 - noted frequently, may impair working capacity, 4 - noted constantly, unable to work. In each cluster, according to the assessment of the questionnaire items and depending on the total score, the following gradations of impairments were established: 1-5 points – mild impairments, which do not affect working capacity, 6-10 points - moderate impairments, sometimes impair the ability to work, 11-15 points – significant impairments of working capacity, 16-20 points - significant impairments, the patient can not work and needs help.

The total number of points according to questionnaire "Cicerone" was assessed as follows: <23 points - does not affect working capacity, 23-44 points - disorders sometimes impair the ability to work, ≥45 points - impairments of working capacity,> 66 points - the patient can not work.

The MoCA scale is considered a quick tool for determining cognitive deficits [6]. It allows you to assess cognitive functions such as attention, concentration, performance, memory, speech, visual skills, abstract thinking, calculation and orientation. The test run time is about 10 minutes. The maximum possible score is 30 points. A score of ≥26 points is considered normal. One point is added if the duration of education is <12 years,

This article contains some figures that are displayed in color online but in black and white in the print edition

Table 1. Symptoms and signs of cognitive impairment in studied patients with postconcussion syndrome

№ *	Symptom, sign
1 C	Dizziness
2 C	Loss of balance
3 C	impaired motor coordination, clumsiness
4	Headaches
5 C	Nausea
6 C	Trouble seeing, blurred vision
7	High sensitivity to light
8	Hearing difficulty
9	High sensitivity to noise
10	Numbness or tingling in the body
11	Changes in taste or smell
12	Loss of appetite or its increase
13 K	Poor concentration
14 K	Forgetfulness, inability to remember certain things
15 K	Difficulty making decisions
16 K	Slowing down thoughts, inability to push the matter through
17 K	Exhaustion, decreased energy, rapid fatigability
18 A	Feeling of anxiety, nervous and psychic tension
19 A	Difficulty falling asleep, trouble sleeping
20 A	Feeling depressed or distress
21 A	High irritability
22 A	Feeling frustrated with little things

* –Item according to the questionnaire "Cicerone", used to calculate scores by clusters: S - somatic disorders; C - cognitive disorders; A - affective disorders.

and two points if its duration is <10 years. The subject is offered tests for: 1) alternative relationship (drawing a line from a number to a letter in ascending order), 2) visual-constructive skills (copying a cube drawing), 3) visual-constructive skills (drawing a clock), 4) names (the correctness of the names of drawn animals is assesed), 5) memory (memorizing a list of five words), 6) attention (repetition of words in the forward and reverse order), 7) vigilance (reaction by hitting the letter A with the palm of the hand on the table when reading a list of letters), 8) sequential counting (subtraction 7 from 100, then 7 from the answer until the examiner stops), 9) repetition of the phrase, 10) verbal speed (naming the maximum number of words starting with a certain letter of the alphabet, within a minute), 11) abstraction (explanation what is common between words), 12) memory (repetition of previously mentioned words), 13) orientation (to name the year, month, exact date and day of the week, location, city name).

The HADS scale is intended for screening detection of anxiety and depression in somatic hospital patients [7]. It was developed by A.S. Zigmond and R.P. Snaith in 1983. When forming the HADS scale, the authors excluded the symptoms of anxiety and depression, which can be interpreted as a manifestation of somatic disease (e.g., dizziness, headaches, etc.). Depression subscale items are selected from the list of the most common complaints and symptoms and reflect predominantly the anhedonic component of depressive disorder. Anxiety subscale items are selected based on the corresponding section of the standardized clinical interview. The subject is offered questions and answer options that are rated from 0 to 3: 1) I feel tension, I feel uncomfortable, 2) what used to bring me great pleasure, and now makes me feel the same, 3) I feel fear, it seems as if something terrible is about to happen, 4) I am able to laugh and see something funny in a certain event, 5) restless thoughts are my head, 6) I feel cheerful, 7) I can easily sit down and relax, 8) it seems to me that I started to do everything very slowly, 9) I feel internal tension or trembling, 10) I do not take care of my appearance, 11) I feel restless, as if I constantly need to move, 12) I believe that my activities (classes, hobbies) can give me a sense of satisfaction, 13) I have a sudden feeling of panic, 14) I can enjoy a good book, radio or television program.

The time to fill the scale is 20–30 minutes. If the patient missed individual items, interrupted the filling of the scale for a long time (several hours) or did not meet the allotted time,then it is recommended to retest.

Processing of results. The scale contains 14 statements, which are divided into two scales: "anxiety" (odd points - 1, 3, 5, 7, 9, 11, 13) and "depression" (even points - 2, 4, 6, 8, 10, 12, 14). Each statement is corresponded to four answer options reflecting the gradation of the severity of the symptom and are coded by the increase in the severity of the symptom from 0 (absence) to 3 (maximum severity). Processing of results consists in calculating the total indicator for each scale. Interpretation of results: 0–7 - norm (no significant symptoms of anxiety and depression), 8–10 - subclinically significant anxiety / depression, ≥11 - clinically significant anxiety / depression.

The Asthenic State Scale (ASS) (author L.D. Malkova, adaptation by T.G. Chertova) [8,9] was created on the basis of the results of clinical and psychological observations and a well-known MMPI questionnaire (Minnesota Multiphasic Personality Inventory) and is designed for diagnosing asthenic conditions (the disease state manifested by increased fatigue and exhaustion with extreme mood instability, weakening of self-control, impatience, restlessness, sleep disturbance, loss of the ability to prolonged mental and physical stress, intolerance of loud sounds, bright light, pungent odors). The scale contains 30 statements reflecting the characteristics of the asthenic condition: 1) I work with great stress, 2) I find it hard to focus on anything, 3) my sex life does not satisfy me, 4) waiting makes me nervous, 5) I feel muscular weakness, 6) I do not feel like going to the cinema or theater, 7) I am forgetful, 8) I feel tired, 9) my eyes get tired when reading for a long time, 10) my hands are shaking, 11) I have a poor appetite, 12) it's hard for me to be at a party or in a noisy company, 13) I don't understand what I read, 14) my hands and feet are cold, 15) I get hurt easily, 16) I have a headache, 17) I wake up in the morning tired and restless, 18) Sometimes I get dizzy, 19) I have muscle twitching, 20) I have tinnitus, 21) I have sexual problems, 22) I have sensation of heaviness in my head, 23) I feel general weakness, 24) I feel pain in darkness, 25) life for me is associated with stress, 26) my head seems to be tied by a hoop, 27) I easily wake up from the noise, 28) I get tired of people, 29) when I worry, I sweat, 30) restless thoughts do not let me fall asleep.

The subject evaluates each sentence-suggestion in points: "No, it's wrong" - 1 point, "Probably so" - 2 points, "True" - 3 points, "Absolutely true" - 4 points.

Asthenic manifestations on the ASS scale were assessed as follows: from 30 to 50 points - no asthenia, from 51 to 75 points - mild asthenia, from 76 to 100 points - moderate asthenia, from 101 to 120 points - severe asthenia.

Statistical analysis

Statistical data processing was performed using StatPlus software (version 7.0 Microsoft). The normality of data distribution in experimental groups was determined by the Kolmogorov-Smirnov test. Data are given as the arithmetic mean and the standard error of the arithmetic mean (M ± m). The results of neuropsychological testing of patients on scales were compared using the Mann–Whitney U-test. The results were considered statistically significant with a probability of null hypothesis $p < 0.05$.

Results and discussion

Data on the frequency of patients complaints are shown in **Fig. 1.** Complaints of increased fatigue, irritability, a significant loss in working capacity, family problems, misunderstandings with relatives (i.e. asthenic complaints), headaches of a different nature (localization, severity, persuasiveness of description), hearing loss, periodic dizziness (with very different descriptions)), fluctuations in blood pressure, heart rate, excessive sweating, gastrointestinal disorders, sleep disorders, etc.

The examination results of neurological status are presented in **Table 2.** According to the frequency detection, bilateral and unilateral brisk tendon reflexes, ataxia in the Romberg test, hyperhidrosis of the palms and feet prevailed. In 32 (27.8%) cases no pathological signs were found in the neurological status.

According to the results of the analysis of medical history data, complaints, neurological status, clinical syndromes were diagnosed: asthenic - in 68 (59,1%) patients, cognitive impairment - in 27 (23,5%) patients, autonomic dysregulation - in 40 (34,8%) patients, cerebrospinal fluid disorders - in 23 (20,0%) patients. No cerebral focal or epileptic syndrome was detected. Most of the examined subjects had signs of several syndromes of varying severity. The syndrome was considered to be the leading one, the clinical manifestations of which were the most significant at the time of the study.

During the neurological examination, the so-called symptoms associated with sensitivity ("sensory") were

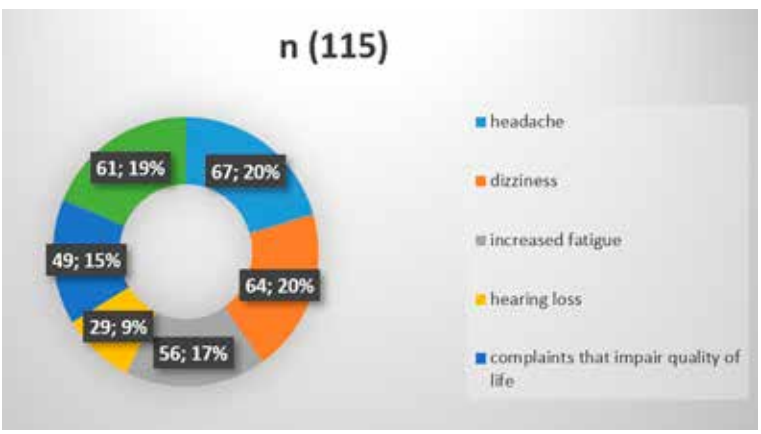

Fig. 1. Frequency detection of patient complaints with post-concussion syndrome in the result of mine-blast trauma (intermediate and long-term periods of mild traumatic brain injury)

detected: blurred vision, changes or decreases in taste and / or smell, discomfort when moving, tinnitus, etc. Findings on the detection of patients' complaints, symptoms and signs of disorders (according to the questionnaire "Cicerone" [5]) are given in ***Table 3*** with a division into conditional degrees of severity.

Cluster analysis, a multidimensional statistical procedure that allows objects to be combined into relatively homogeneous groups - clusters, that is, groups of elements characterized by a common property - is used to process the data obtained using the questionnaire "Cicerone". The main purpose of cluster analysis is to find groups of similar objects in a sample [10].

According to the questionnaire "Cicerone" criteria, the most severe symptoms were: headache, forgetfulness, poor concentration, rapid fatigue, impaired productivity, sleep problems, high irritability, feeling of opression or depression. Patients' complaints were dominated by cognitive impairment (attention, memory, difficulties with multi-step processes and decision-making), as well as autonomic complaints. Under the term "headache" patients often understood signs of a condition unfamiliar to them in the past, namely: "unclear head", dizziness, uncertainty while walking, etc. Quite often there were no clear explanations from patients about the complaint of "dizziness". Changes in the neurological status of patients and in the parietal system were determined, taking into account that "in case of a blast injury, the vestibular system suffers the most - the parietal cortex, this organ specifically perceives the action of the blast wave; its disease lasts for years "[11]. A detailed analysis of patient complaints revealed the following symptoms: dizziness, a kind of dizziness, imbalance, orthostatics. The severity of these symptoms in none of our patients exceeded the rating of "mild" or "moderately severe", which does not lead to disability.

As indicated in our previous publication [12], a differentiated assessment of the presence and severity of cognitive impairment by clusters of symptoms made it possible to identify three clinical variants of PCS. In 51 (44,3 ± 9.1)% of the sample) patients the first variant of PCS was identified with a predominance of cognitive impairment, which was characterized by significant (16-20 points) in (7,0 ± 4.6)% patients and severe (11 –15 points) - in (37,4 ± 8.8)% patients cognitive impairment in combination with significant and severe affective disorders. The second variant of PCS with a predominance of severe and significant affective disorders and moderate cognitive impairment was registered in 27 (23,5 ± 7,7%) patients. The third variant, which is characterized by moderate and mild cognitive and affective spectrum disorders in combination with predominantly moderate autonomic disorders (PCS variant with a predominance of psychosomatic disorders), was observed in 37 ((32,2 ± 8,5)%) patients. Only in 4 (3,5 ± 3,3%) patients somatic disorders ranked the first place among the causes that impair working capacity.

Neuropsychological testing of patients using special scales has significantly increased the accuracy of assessing cognitive and affective disorders. The results of neuropsychological testing of patients were compared with the indices of the control group according to the scales MoCA, HADS and ASS. All test parameters in patients with PCS as a result of blast mTBI differed statistically significantly from the results of the control group (***Table 4***).

According to the results of testing on the MoCA scale, the greatest decrease in cognitive impairment was found for memorization (memory), attention, delayed recall, total score. The frequency of non-dementia cognitive impairment was 43,5% (50 cases). The significance of the severity of cognitive impairment met the criteria of the International Classification (DSM-IV) - mild and moderate [4].

According to the HADS scale, the distribution of patients was as follows: clinically significant anxiety (> 11 points) - in 11 (9,6%) patients, depression - in 13 (11,3%) patients, a combination of clinically significant anxiety with depression - in 6 (5, 2%) patients, subclinical symptoms of anxiety of varying severity - in 64 (55,7%) patients. Normal values, that is, no signs of anxiety (<8 points on the HADS scale) were registered in 9 (7,8%) patients, no signs of depression (<8 points) - in 10 (8,7%) patients. Thus, according to the HADS scale, signs of anxiety were identified in 71 (61,7%) patients.

The phenomena of asthenia due to fatigue with mood swings, loss of the ability to concentrate for a long time on mental and physical tasks occurred in all patients with PCS.

Table 2. Clinical and neurological characteristics of patients (n = 115)

Neurological signs	Abs.	%
Facial asymmetry, cranial nerve dysfunction	3	2,6
Pyramidal insufficiency, unilateral, with brisk tendon reflexes	25	21,74
Uniform brisk tendon reflexes, bilateral	59	51,3
Ataxia in the Romberg test	49	42,6
Coordination disorders	13	11,3
Limb tremor	12	10,43
Hyperhidrosis of the hands and feet	35	30,43
Autonomic disfunction in the form of discoloration, moisture and temperature of the skin	26	22,6
Nothing abnormal detected	41	35,65

Analysis of the study data using the binary logistic regression method allowed to identify factors with a significantly higher risk of developing cognitive impairment, namely: 1) patients' complaints of extreme fatigue (and other asthenic complaints) and headache (of a different nature, localization, severity, persuasiveness of description), 2) neurological signs in the form of elements of pyramidal insufficiency, brisk tendon reflexes, 3) the level of anxiety according to the HADS scale. They can be considered as predictors of cognitive deficit in patients with PCS as a result of blast mTBI **(Table 5)**.

According to the research conducted at Romodanov Neurosurgery Institute [12–14], in-depth neuropsychological study is a reliable tool along with the neurophysiological method of cognitive evoked potentials for objectification of PCS following blast mTBI.

Conclusions

1. Comprehensive neurological and neuropsychological examination is an effective tool for diagnosing cognitive changes in postconcussion syndrome as a result of blast mild traumatic brain injury.

2. Objectification of these cognitive disorders after blast mild traumatic brain injury is possible in further research using neurophysiological and radiological methods.

Table 3. Detection rate and severity of symptoms and signs in patients with postconcussion syndrome

№ *	Symptom, sign	Detection rate							
		rarely,does not affect working capacity		frequently, sometimes impairs working capacity		very frequent, possible disability		constantly, unable to work	
		Abs.	%	Abs.	%	Abs.	%	Abs.	%
1 C	Dizziness	43	37,4	62	**53,9**	9	7,8	0	0
2 C	Loss of balance	74	64,3	21	18,3	3	2,6	1	0,9
3 C	Impaired motor coordination, clumsiness	72	62,6	12	10,4	10	8,7	1	0,9
4	Headaches	27	23,5	55	**47,8**	22	19,1	10	8,7
5 C	Nausea	75	65,2	17	14,8	3	2,6	1	0,9
6 C	Trouble seeing, blurred vision	66	57,4	15	13,0	10	8,7	5	4,3
7	High sensitivity to light	62	53,9	12	10,4	8	7,0	4	3,5
8	Hearing difficulty	41	35,7	50	**43,5**	11	9,6	9	7,8
9	High sensitivity to noise	73	**63,5**	20	17,4	8	7,0	7	6,1
10	Numbness or tingling in the body	62	53,9	13	11,3	7	6,1	6	5,2
11	Changes in taste or smell	31	27,0	7	6,1	6	5,2	2	1,7
12	Loss of appetite or its increase	39	33,9	15	13,0	4	3,5	6	5,2
13 K	Poor concentration	24	20,9	64	**55,7**	19	16,5	8	7,0
14 K	Forgetfulness, inability to remember certain things	31	27,0	55	**47,8**	23	20,0	6	5,2
15 K	Difficulty making decisions	48	41,7	55	**47,8**	11	9,6	1	0,9
16 K	Slowing down thoughts, inability to push the matter through	16	13,9	58	**50,4**	35	30,4	5	4,3
17 K	Exhaustion, decreased energy, rapid fatigability	12	10,4	50	**43,5**	37	32,2	16	13,9
18 A	Feeling of anxiety, nervous and psychic tension	21	18,3	59	**51,3**	29	25,2	6	5,2
19 A	Difficulty falling asleep, touble sleeping	6	5,2	34	29,6	44	38,3	31	27,0
20 A	Feeling depressed or distress	20	17,4	58	**50,4**	31	27,0	6	5,2
21 A	High irritability	22	19,1	62	**53,9**	24	20,9	6	5,2
22 A	Feeling frustrated with little things	35	30,4	62	**53,9**	13	11,3	3	2,6

Note: the most common disorders are highlighted; * - questionnaire item (according to "Cicerone"), used to calculate scores by clusters: S - somatic disorders; C - cognitive disorders; A - affective disorders.

Table 4. Results of neuropsychological testing on scales

Scale	Main group (n=115)			Control group (n=30)			Comparison
	Range	Me	IQR	Range	Me	IQR	U; p
MoCA, score	13–30	23	20–25	23–30	29	27–29	181,5; 0,001
HADS A, score	5–18	11	9–12	0–11	3	2–4	136,5; 0,001
HADS D, score	4–16	9	7–11	0–6	2	1–3	39,0; 0,001
ASS, score	42–112	68	60–77	31–44	33	32–34	4,5; 0,001

Note: HADS A – anxiety subscale; HADS D – depression subscale; Range – range from minimum to maximum value; Me – median; IQR – interquartile range (50% of the values in the sample are between these numbers); U – Mann-Whitney test; p – statistical significance.

Table 5. Results of regression analysis (*) of data of military personnel with mild traumatic brain injury as a result of mine-blast trauma in the presence of cognitive impairment

Indicator	Odds ratio	95% confidence interval		p
		LL	UL	
Age	1,01	0,98	1,05	0,490
Headache and fatigue (complaints inherent in psychoasthenic syndrome)	2,52	1,9	3.05	**0,020**
Dizziness	1,00	0,93	1,07	0,928
Hearing loss	1,55	0,65	3,72	0,324
Autonomic disfunction in the form of discoloration, moisture and temperature of the skin	0,55	0,14	2,16	0,389
Facial asymmetry, cranial nerve dysfunction	1,80	0,73	4,44	0,200
Pyramidal insufficiency, unilateral, with brisk tendon reflexes	1,68	1,29	1,63	0,392
Brisk tendon reflexes bilateral	2,6	1,24	2,82	**0,017**
Ataxia in the Romberg test	1,01	0,99	1,02	0,428
Coordination disorders	1,44	0,67	3,09	0,345
Limb tremor	1,02	0,87	1,19	0,856
Hyperhidrosis of the hands and feet	1,90	1,896	0,41	0,411
Anxiety level on the HADS scale >8–10 points	1,8	1,59	2,2	**0,040**
Depression level on the HADS scale >8–10 points	1,03	0,99	1,07	0,137

Note: * – binary logistic regression (univariate analysis); LL – lower limit; UL – upper limit; p – statistical estimated value.

Information disclosure

Conflict of interest

The authors declare no conflict of interest.

Ethical approval

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent

The written informed consent was obtained from each patient.

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References

1. Kobeissy F, Mondello S, Tümer N, Toklu HZ, Whidden MA, Kirichenko N, Zhang Z, Prima V, Yassin W, Anagli J, Chandra N, Svetlov S, Wang KK. Assessing neuro-systemic & behavioral components in the pathophysiology of blast-related brain injury. Front Neurol. 2013 Nov 21;4:186. doi: 10.3389/fneur.2013.00186
2. Owens BD, Kragh JF Jr, Wenke JC, Macaitis J, Wade CE, Holcomb JB. Combat wounds in operation Iraqi Freedom and operation Enduring Freedom. J Trauma. 2008 Feb;64(2):295-9. doi: 10.1097/TA.0b013e318163b875
3. Phipps H, Mondello S, Wilson A, Dittmer T, Rohde NN,

Schroeder PJ, Nichols J, McGirt C, Hoffman J, Tanksley K, Chohan M, Heiderman A, Abou Abbass H, Kobeissy F, Hinds S. Characteristics and Impact of U.S. Military Blast-Related Mild Traumatic Brain Injury: A Systematic Review. Front Neurol. 2020 Nov 2;11:559318. doi: 10.3389/fneur.2020.559318

4. Dwyer B, Katz DI. Postconcussion syndrome. Handb Clin Neurol. 2018;158:163-178. doi: 10.1016/B978-0-444-63954-7.00017-3
5. Cicerone K.D., Kalmar K. Persistent postconcussion syndrome: The structure of subjective complaints after mild traumatic brain injury // Journal of Head Trauma Rehabilitation 1995;10(3):1–17. doi:10.1097/00001199-199510030-00002
6. Thompson JM, Scott KC, Dubinsky L. Battlefield brain: unexplained symptoms and blast-related mild traumatic brain injury. Can Fam Physician. 2008 Nov;54(11):1549-51. PMID: 19005124; PMCID: PMC2592327.
7. Asadollahi R, Saghafinia M, Nafissi N, Montazeri A, Asadollahi M, Khatami M. Anxiety, depression and health-related quality of life in those injured by landmines, Ilam, Islamic Republic of Iran. East Mediterr Health J. 2010 Nov;16(11):1108-14. PMID: 21218732.
8. Zakharov VV. Nervno-psikhicheskiye narusheniya: diagnosticheskiye testy.[Neuropsychiatric disorders: diagnostic tests]. Moscow: Medpress Russia, 2018. Russian.
9. Solovyova AP, Goryachev DV, Arkhipov VV. [Criteria for assessment of cognitive impairment in clinical trials]. The Bulletin of the Scientific Centre for Expert Evaluation of Medicinal Products. 2018 Nov 22;8(4):218-30. Russian. doi: 10.30895/1991-2919-2018-8-4-218-230
10. Klymchuk VO. Klasternyy analiz: vykorystannya u psykholohichnykh doslidzhennyakh. Praktychna psykholohiya ta sotsialna robota. 2006;(4):30-6. Ukrainian.
11. Trinus KF, Claussen KF. [International clinical protocol for parietal disorders (dizziness)]. Eastern European Journal of Neurology. 2015;(4);4-47. Ukrainian.
12. Zavaliy YV, Solonovych OS, Biloshitsky VV, Tretiakova AI, Chebotariova LL, Suliy LM. Cognitive evoked potentials in the diagnosis of post-concussion syndrome due to blast mild traumatic brain injury. Ukrainian Neurosurgical Journal. 2021;27(4):3–9. doi: 10.25305/unj.236138
13. Chebotariova LL, Solonovych OS, Kadzhaya MV, Tretiakova AI, Solonovych AS, Pronoza-Stebliuk KV, Stebliuk VV. [Risk factors of cognitive impairment in patients with blast-related mild traumatic brain injury]. Ukrainian Neurosurgical Journal. 2019;25(4):16-24. Ukrainian. doi: 10.25305/unj.174610
14. Chebotariova LL, Tretiakova AI, Solonovych AS, Sulii LM, Zol'nikova AY. Post-concussion syndrome after a mine blast injury: neuropsychological consequences and changes of the cognitive evoked potentials (P 300). Neurophysiology. 2020 Jul;52(4):289-97. doi: 10.1007/s11062-021-09884-7