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RESEARCH OF ESSENTIAL ELEMENTS COMPOSITION IN THE CEREBROSPINAL FLUID IN PATIENTS WITH OUTCOMES OF TRAUMATIC BRAIN INJURY

Summary: *The aim of this research is to investigate the essential elements composition in the cerebrospinal fluid of patients with different outcomes of traumatic brain injury before and after complex treatment with the use of endolumbal and intracystal introduction of ozone and pyracetam in dynamics.*

Essential elements composition was investigated in the cerebrospinal fluid of 83 patients. Thus, it may be noted positive changes in the metabolism of essential elements in the cerebrospinal fluid of patients who were treated according to our suggested methods – endolumbal introductions of nootropic ozone mixture and endocystal introductions of ozone.

Keywords: *essential elements, outcomes, TBI, cerebrospinal*

Introduction: Traumatic brain injury (TBI) for a long time is one of the most actual and complex problem of modern neurosurgery, that many domestic and foreign authors noted in their publications [2, 12, 13, 16, 18]. This is stipulated not only by a high frequency of occurrence, the complexity of the pathogenesis, clinical manifestations and high mortality, but also by an enormous economic damage. One of the most important circumstances stipulating the actuality of the problem is the frequent victims' disability, which arises due to the development of various pathological conditions, persistent symptom complex, united under the name of the consequences of TBI. Just their formation, in the most cases stipulated economic damage caused by cranial injuries [12, 13, 18].

Ozonated saline solution has been successfully used by intravenous introduction in patients with severe TBI in the acute period [1, 4, 5, 11, 17, 19]. One of the first endolumbal introductions of ozone-oxygen mixture has been carried out in 1967, by A. B. Bolgaev in patients with post-traumatic epilepsy. S. D. Madiyarov (1990) [6] has been used once endolumbal introduction of ozone-oxygen mixture as the prevention of cerebral arachnoiditis in patients with severe TBI in the volume of 15 cm³. In 1994, M. K. Agzamov has been carried out scientific researchers on the application of nootropic-ozone mixture in the complex treatment of severe TBI [1, 19]. In 2007, 25 patients

with meningitis of different etiologies have been successfully treated by V. M. Belopukhov and his colleagues with the use of endolumbal introduction of ozone-oxygen mixture in the complex treatment [11].

The beginning of the XXI century was marked not only the accumulation of fundamental knowledge in the field of neuroimmunology and neuroelementology, but also the beginning of the application of this knowledge in practice, according to the concept of metabolic protection of the brain [7, 10, 15].

Elaborated in the recent years problem of determining the role and significance of separate chemical elements presenting in tissues and biological fluids of human organism is important both in normal condition and in a variety of diseases, in particular of the nervous system. Variations in the content of macro- and microelements, imbalance of metalloligands' homeostasis caused by both food and ecological factors, as well as somatic diseases which change the status of the nervous system and form an unfavorable background not only for the beginning and development of injures and diseases of the nervous system, but also for the restoration process. The above changes have significantly influence on the understanding of neurorehabilitation measures [3, 7, 8, 9, 10, 20, 21, 23].

The study of domestic and foreign literatures have been showed the absence of researchers devoted to the

content of macro- and microelements in the cerebrospinal fluid in the consequences of TBI.

The aim of the study: The aim of this research is to investigate the composition of essential elements in the cerebrospinal fluid of patients with different outcomes of TBI before and after complex treatment with the use of endolumbal and intracystal introduction of ozone and pyracetam in dynamics.

Materials and methods: The data of 83 patients with various consequences of TBI in age from 1 year to 60 years old (63 men and 20 women) have been included in the investigation who were hospitalized in neurosurgical clinic of Samarkand Medical Institute from 2009 to 2013. All patients equally with clinical and neurological X-ray investigations (MRI, CT) were carried out laboratory investigations to determine the essential elements (K, Na, Cl, P, Mg, Fe) in the cerebrospinal fluid with the use of "Roche-Hitachi" analyzer before and after 4–6 months treatment. Among the examined patients in 31 patients (37,3%) it has been diagnosed with post-traumatic cerebral arachnoiditis (PTCA), in 21 patients (25,3%) it has been diagnosed post-traumatic chronic subdural hematoma (PCSH), in 15 patients (18,1%) it has been diagnosed post-traumatic epilepsy (PE), in 13 patients (15,7%) it has been diagnosed post-traumatic arachnoid cyst (PTAC) and in 3 patients (3,6%) it has been diagnosed chronic vegetative status (CVS) (Figures 1, 2).

For the treatment of patients with consequences of TBI we offered the new methods endocystal introduction of ozone and endolumbal introduction ozone with nootropics (certificates of priority № IAP 2011 0419 and 2011 0148 № IAP).

The method of treatment of arachnoid liquor cysts is that after the imposition of milling holes it has been made dissection and excision of the cyst walls and connection it with subarachnoid and subdural spaces and then vinyl chloride or silicone catheter has been introduced into the cystic cavity and through this catheter with the use of medical syringe it has been injected ozone in the amount of 10–30 cm³ depending on the cyst size, the catheter is left for 3–5 days for the re-introduction of ozone.

The next method is the way endolumbal insufflation of ozone and pyracetam in patients with different consequences of TBI, as mentioned above. These patients under sterile conditions after premedication and local anesthesia by the use of novocain solution 0,5% – 10,0 ml, a lumbar puncture was performed between the 3rd and 4th lumbar vertebrae, and then it has been evacuated liquor (20–40 ml depending on the liquor pressure) and endolumbal injected first ozone (10–30 cm³), and then pyracetam 2,5% – 3% from 200 mg to 1000 mg depending on the age of the patient.

Patients were carried out the following methods of treatment: in patients with PCSH it has been carried out mini-invasive removal of hematomas and endolumbal insufflation of ozone and pyracetam on 7–8 days after surgery; in patients with PTAC it has been carried out mini-invasive cysts emptying and endocystal introduction of ozone in the day of surgery and for 3–4 days after surgery. In PCA, PTE and in patients with CVS after severe TBI it has been conducted endolumbal insufflation ozone and 2–3% solution of pyracetam (doubly per treatment course).

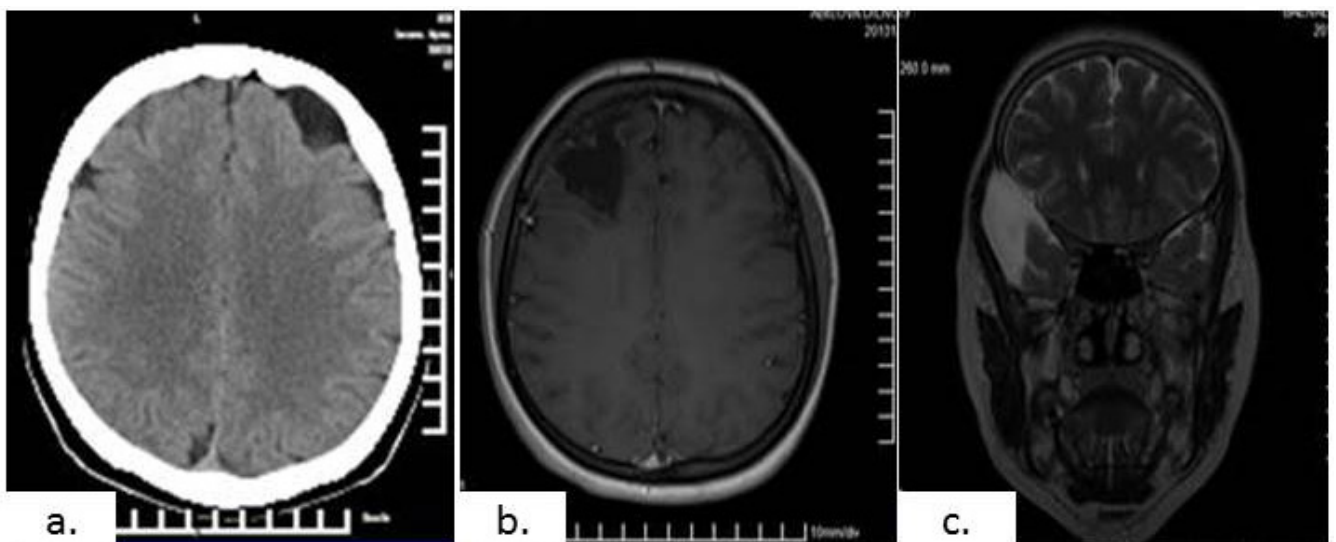


Figure 1. Forms of outcomes of TBI (MRI and CT examples). a) Posttraumatic cystic cerebral arachnoiditis. CT of patient K. Is determined by a small arachnoid cysts in the left frontal region and cystic-adhesive changes of convexital areas of the brain. b) Posttraumatic epilepsy. MRI of patient R. Determined by the seat of epilepsy – posttraumatic cystic-gliar degeneration in the right frontal region of the brain. c) Posttraumatic arachnoidal cyst. MRI of patient B. Is determined by a arachnoid cysts in the right temporal-basal region of the brain

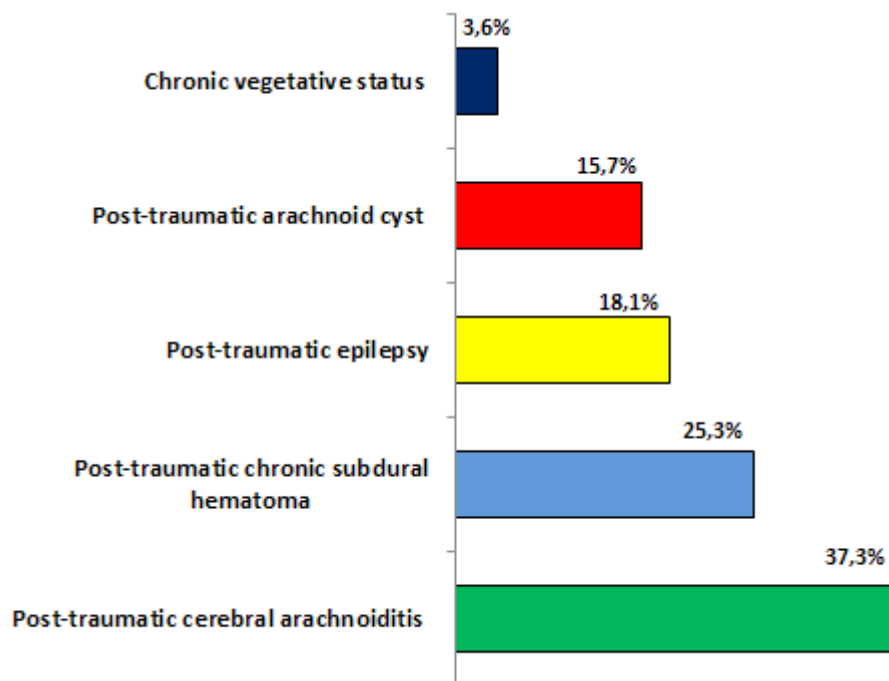


Figure 2. Distribution of patients according to the forms of outcomes of TBI

In order to assess the general condition and neurological changes in patients it has been used Glasgow Outcome Scale Extended – GOSE [14, 22, 24, 25]. (Table 1).

Results and discussion: In order to determine the value of pathogenetic changes of essential elements in the brain tissues during the outcomes of TBI after using endocystal and endolumbal introduction of ozone and pyracetam, laboratory tests including determination of chemical elements phosphorus (P), calcium (Ca), iron (Fe), magnesium (Mg), sodium (Na), potassium (K) and

chlorine (Cl) in the liquor, which play an important role in the activities central nervous system were performed.

As shown in Table 2. in the liquor tests of these patients it has been observed some distinctive changes compared with those in the blood serum, i.e. amounts Ca has been decreased in 89,2% of patients and amounts of elements such as K and Cl were low in all (100%) patients. Minimal and maximal amounts of P, Fe and Na in the liquor were normal, but the average amounts of P and Na were high (41% and 86,7% accordingly). An increased amount

Table 1

Glasgow Outcome Scale extended

1 point Death (D)	Death (D) in the first 24 hours
2 point Death (D)	The death (D) of more than 24 hours
3 point Vegetative State (VS)	Condition of unawareness with only reflex responses but with periods of spontaneous eye opening.
4 point Low Severe Disability (LSD)	Patient who is dependent for daily support for mental or physical disability, usually a combination of both.
5 point Upper Severe Disability (USD)	If the patient can be left alone for more than 8h at home it is upper level of SD, if not then it is low level of SD.
6 point Low Moderate Disability (LMD)	Patients have some disability such as aphasia, hemiparesis or epilepsy and/or deficits of memory or personality but are able to look after themselves. They are independent at home but dependent outside. If they are able to return to work even with special arrangement it is upper level of MD, if not then it is low level of MD.
7 point Upper Moderate Disability (UMD)	
8 point Low Good Recovery (LGR)	Resumption of normal life with the capacity to work even if pre-injury status has not been achieved. Some patients have minor neurological or psychological deficits. If these deficits are not disabling then it is upper level of GR, if disabling then it is lower level of GR.
9 point Upper Good Recovery (UGR)	

Table 2

Quantitative indexes of essential elements in the liquor in patients with outcomes of TBI (before treatment)

Elements	Average indexes (mmol/l)		Minimal indexes (mmol/l)		Maximal indexes (mmol/l)	
	In normal condition	Result	In normal condition		In normal condition	Result
P	0,5	0,83	0,39	0,24	0,68	1,43
Ca	1,4	0,99	1,12	0,69	1,75	1,18
Fe	17	14	5,4	2,1	28,6	25,9
Mg	1,3	1,51	1,23	1,22	1,4	2,06
Na	132,5	140,2	120	121,1	145	151,9
K	3,7	2,3	3,07	2,01	4,35	2,68
Cl	204,5	149,3	197	119,5	212	192

of Mg in the liquor has been noted in 38,6% (32) of patients in comparison with maximal indexes (Table 2.).

Thus, the quantitative changes of all macro- and microelements in the cerebro-spinal fluid in a range of research were noted and once again it has been proved the occurrence of this condition as a result of deep metabolic-biochemical deficiency in the human organism during different consequences of TBI, it gives us the basis to introduce new pathogenetically proved and effective treatment methods in the intermediate and distant periods of traumatic brain disease.

Study and evaluation of the general condition and neurological status of patients with the use of the extended Glasgow Outcome Scale at admission to the clinic showed that in a vegetative state (VS) were 4,8% of patients, rough disability (LSD) was detected in 2,4% of patients, relatively severe disability (USD) was detected in 12,1% of patients, moderate disability (LMD) was detected in 15,7% of patients, relatively average disability (UMD) was detected in 35% of patients and relatively

satisfactory restoration (LGR) was detected in 30,1% of patients (Table 3.).

Taking into consideration the above conditions, it has been used the new method of treatment – endolumbal and endocystal insufflation of ozone and pyracetam in the intermediate and distant periods of traumatic disease of the brain and the following results were obtained. On the expiry of 3–6 months after treatment the amount of macro- and microelements in the blood serum and cerebrospinal fluid were tested and the overall condition and neurological status of patients according to GOSE in dynamics were assessed.

Dynamic changes of the structure of essential elements in cerebrospinal fluid after treatment were in the following way: it has been noted the elevated amount of Ca from 0,99 mmol/l before treatment to 1,34 (in 1,4 times) mmol/l; the average index of K has been elevated from 2,3 mmol/l to 3,5 mmol/l (in 1,5 time) and the average index of Cl has been elevated from 149,3 mmol/l to 165,3 mmol/l (in 1,1 time) (Fig. 3 a, b, c).

Table 3

Distribution of the investigated patients according to the GOSE criterion

Points	Contingent	Number of observations					In total
		PVS	PCSH	PTAC	PE	PTCA	
1 point	Death (D) in the first 24 hours	-	-	-	-	-	-
2 point	The death (D) of more than 24 hours	-	-	-	-	-	-
3 point	Vegetative State (VS)	3 (3,6%)	1 (1,2%)	-	-	-	4 (4,8%)
4 point	Low Severe Disability (LSD)	-	2 (2,4%)	-	-	-	2 (2,4%)
5 point	Upper Severe Disability (USD)	-	10 (12,1%)	-	-	-	10 (12,1%)
6 point	Low Moderate Disability (LMD)	-	8 (9,6%)	3 (3,6%)	2 (2,4%)	-	13 (15,7%)
7 point	Upper Moderate Disability (UMD)	-	-	8 (9,6%)	12 (14,5%)	9 (10,9%)	29 (35%)
8 point	Low Good Recovery (LGR)	-	-	2 (2,4%)	1 (1,2%)	22 (26,5%)	25 (30,1%)
9 point	Upper Good Recovery (UGR)	-	-	-	-	-	-
	In total	3	21	13	15	31	83

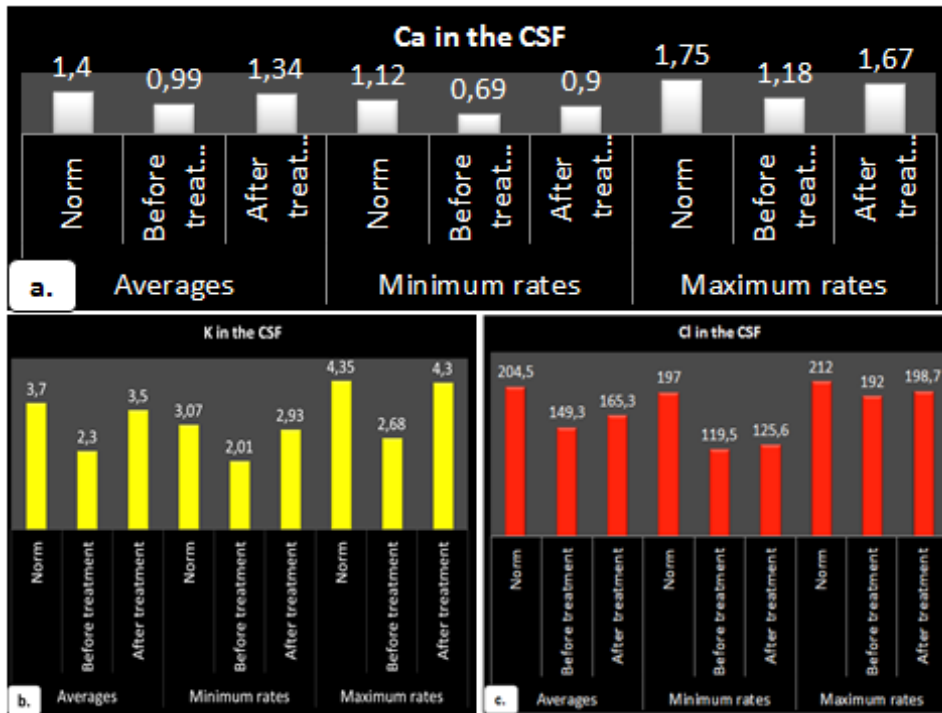


Figure 3. Changes in the structure of essential elements in the cerebrospinal fluid in patients with the outcomes of the TBI

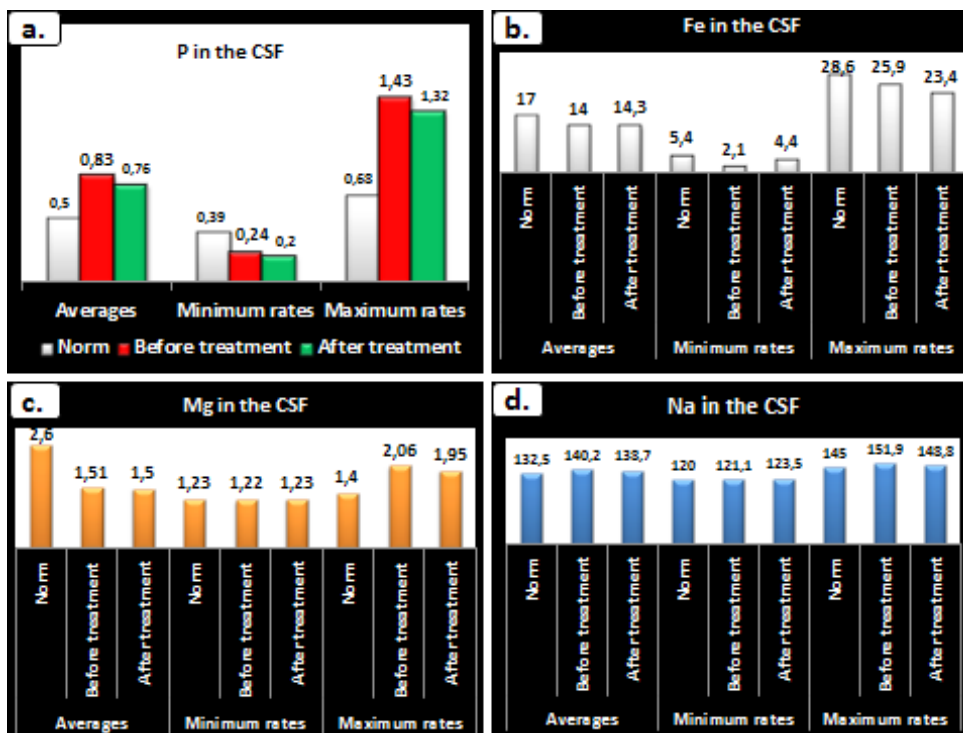


Figure 4. Changes in the structure of macro- and microelements in the cerebrospinal fluid in patients with the outcomes of the TBI

It has been noted reduction of the average indexes of essential elements which according to the quantitative indexes were up to the normal values: the amount of P was reduced from 0,56 mmol/l to 0,53 mmol/l, the amount of Na was reduced from 140,2 mmol/l to 138,7 mmol/l and

the amount of Mg was reduced from 1,51 mmol/l to 1,5 mmol/l (Fig. 4 a, b, c, d).

The study of the general condition and neurological status of patients according to the GOSE showed that in all 4 patients who were in “vegetative status” (VS)

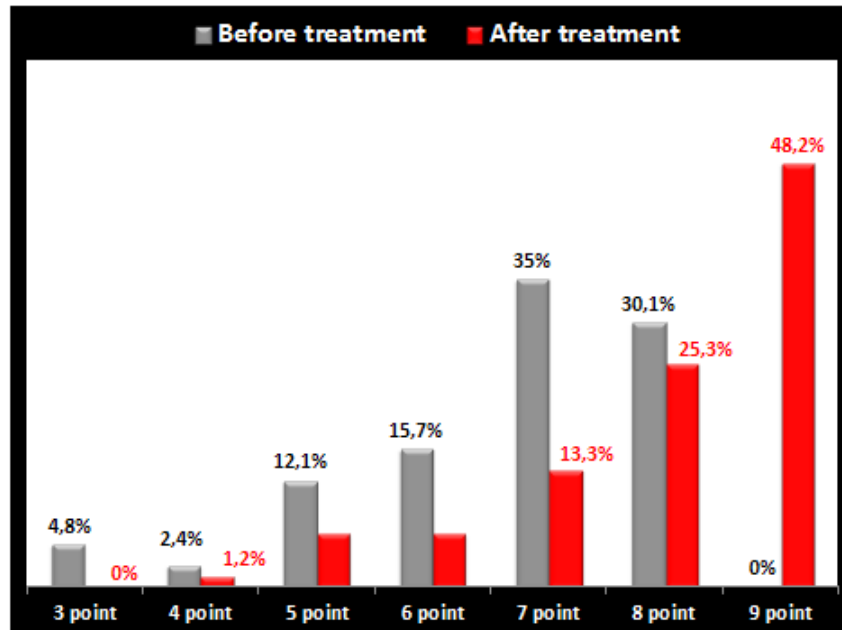


Figure 5. Dynamic changes of the neurological deficits determined according to GOSE in patients with outcomes of the TBI before and after treatment

(3 points) before treatment it has been noted positive dynamic after treatment. In 1 patient from this group of patients neurological status has been restored until “rough disabilities” (4 points) i.e. this patient had the ability to answer questions; in 1 patient with VS neurological status has been improved until the condition of “relatively severe disability” (5 points); in 2 patients this condition has been improved until “relatively moderate disability” (7 points).

During the evaluation of the patients' condition due to GOSE after endolumbal introduction of ozone and pyracetam and endocystal introduction of ozone in all left patients have been reached positive results. It should be noted that it was observed improvement in number of patients with “rough disabilities” (4 points) in 2 times after treatment, in contingent of patients with “relatively severe disability” (5 points) in 2 times, in patients with “moderate disability” (6 points) in 2,6 times, in patients with “relatively moderate disability” (7 points) in 2,6 times and in patients with “relatively satisfactory restoration” (8 points) in 1,2 times, i.e. by improving of metabolic processes and neurological status it has been noted “full restoration” of patients' condition (9 points), whose specific gravity has been reached to 48,2% (Figure 5).

Conclusions:

- Quantitative changes of essential elements in the cerebrospinal fluid in patients with the outcomes of the traumatic brain injury could cause criterion of the metabolic disorders in the patients' organism and could be the index of the clinical-neurological pathological changes.
- The investigation of the indexes of essential elements in dynamics in patients with the outcomes of the traumatic brain injury could give us the possibility to determine the effectiveness of the pathogenetical treatment of patients.
- Endocystal introduction of ozone and endolumbal insufflation of ozone and introduction of nootropics led to the normalization of essential elements in the cerebrospinal fluid because of the metabolic improvement in the organism and it could allow us to reach the early restoration of clinical-neurological disorders in patients with the outcomes of the traumatic brain injury.
- Thus, it may be noted positive changes in the metabolism of essential elements in the cerebrospinal fluid of patients who were treated according to our suggested methods – endolumbal introductions and nootropic ozone and endocystal introductions of ozone.

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