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# RISK FACTORS FOR THE DEVELOPMENT OF AN UNFAVORABLE OUTCOME IN THE SURGICAL TREATMENT OF ACUTE TRAUMATIC BRAIN INJURY.

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***Abstract:*** *the results of surgical treatment of 1098 patients with acute traumatic brain injuries were analyzed. Among male patients – 926 (84.6%), women – 172 (15.4%) patients. The severity of the patients' condition was assessed on the ISS scale, SHKG. Excellent treatment outcomes (without neurological deficit) were obtained in 389 patients (35.4%) out of 1098, moderate disability — in 142 (12.9%), severe disability — in 77 (7.1%). Vegetative state developed in 20 (1.8%). Deaths were noted in 470 patients (42.8%).*

***Key words:*** *traumatic brain injury, ISS scale, SHG, coma, mydriasis, perifocal edema, hypertension, dislocation, hematoma.*

**Relevance**. Surgical treatment of traumatic brain injury (TBI) is currently an extremely urgent problem of modern medicine and has great socio-economic importance. Every year, the frequency of TBI increases by 2%, while there is an increase in the number of more severe types of brain damage. The main contingent of victims are persons of working age (from 20 to 50 years) [1-4]. TBI remains one of the leading causes of mortality and disability of the population. The proportion of people with permanent disability as a result of TBI reaches 25-30%. In the structure of mortality from all types of injuries, 30-50% are accounted for by TBI. The total mortality in TBI, including mild and moderate TBI, is 5-10%. In severe forms of TBI with the presence of intracranial hematomas, foci of brain injury, mortality increases to 41-85%.

**The aim of the study** was to determine the risk factors for the development of an unfavorable outcome in operated patients with acute TBI based on the study of clinical and instrumental data and outcomes of surgical treatment.

## MATERIAL AND METHODS.

From 2012 to 2019, the neurosurgical department of the Andijan branch of the RNCEMP performed surgical treatment of 1,098 victims with acute TBI (the time from the moment of injury to the operation did not exceed 72 hours). There were 926 men (84.3%), 172 women (15.7%). The average age of the victims was 42.3±12.5 years. 947 patients (86.2%) were delivered by ambulance crews and gravity from the scene, 151 (13.8%) were transferred from other hospitals. Isolated TBI was diagnosed in 794 victims (72.3%), combined TBI — in 304 (27.7%). The severity of the condition of patients with combined TBI (n=304) on the Injury Severity Score (ISS) scale ranged from 29 to 76 points (on average 37.3 ± 7.1 points). Upon admission, a clinical and neurological examination of all the victims was carried out. The level of wakefulness was assessed using the Glasgow Coma Scale (SHG) [14]. Of the 1098 patients, 169 (15.4%) had no impaired wakefulness (15 points on SHG), 280 (25.5%) had depression of the level of wakefulness to stun (13-14 points on SHG), 141 (12.8%) — to sopor (9-12 points on SHG) and 508 (46.3%) — before coma (4-8 points on the SHKG). The clinical stage of dislocation syndrome was established on the basis of a modified classification by F. Plum, J.B. Posner (1986) [15]. The following clinical stages of brain stem compression were distinguished: diencephalic (the clinical stage of compression of the structures of the intermediate brain), mesencephalic (the stage of compression at the level of the midbrain), pontine (the stage of compression of the brain stem at the level of the bridge) and medullary (the stage of compression at the level of the structures of the medulla oblongata). The clinical picture of acute dislocation syndrome was diagnosed in 677 patients (61.7%) out of 1098. The clinical stage of compression of the structures of the diencephalic region was noted in 252 patients (37.2%) out of 677, the midbrain — in 187 (27.6%), and the bridge — in 238 (35.2%). There were no victims with a clinical picture of dislocation syndrome at the level of the medulla oblongata in our study. The main method of neuroimaging was brain CT, which was performed on all patients within the first hour from the moment of hospitalization. According to CT data, the type, volume of the brain lesion, the amount of displacement of the median structures of the brain, the degree of axial dislocation were evaluated, ventriculocranial coefficients (VCC) were calculated. According to brain CT, 354 (32.2%) of 1098 victims had acute subdural hematomas, 257 (23.4%) had multiple brain injuries (combinations of shell, intracerebral hematomas and contusion foci), 182 (16.6%) had acute epidural hematomas, 181 (16.5%) — depressed fractures of the skull and 124 (11.3%) — intracerebral hematomas in combination with foci of brain contusion. All the victims underwent surgical intervention, which consisted in carrying out trepanation of the skull and removal of foci of brain damage. Bone-plastic trepanation of the skull was performed according to a generally accepted technique

— the dura mater was sewn tightly, the bone flap was put in place and fixed with bone sutures or craniofixes. Decompressive trepanation of the skull was performed only in the case of severe intraoperative edema and prolapse of the brain. ICP monitoring was performed in 75 patients during surgery and in the early postoperative period. The Glasgow Outcome Scale (SHIG) was used to assess the outcomes of surgical treatment [16]. Excellent treatment outcomes (without neurological deficit) were obtained in 389 patients (35.4%) out of 1098, moderate disability — in 142 (12.9%), severe disability — in 77 (7.1%). Vegetative state developed in 20 (1.8%). Deaths were noted in 470 patients (42.8%). The data obtained were processed on a personal computer in a Windows environment using the Statistica (version 7.0) application software package from StatSoft Inc., USA based on a formalized medical history. Spearman's rank correlation method for qualitative signs and Pearson's parametric correlation coefficient for quantitative signs were used to determine the strength and direction of the relationship between causal and resultant response signs. The value of the statistical coefficient $R \leq 0.25$ was taken as a weak correlation (association) between the signs, $0.25 < R < 0.75$ — as a moderate correlation (association) and $R \geq 0.75$ — as a strong correlation (association). To determine the differences in survival time between groups of patients, the Kaplan–Meyer analysis method was used. The effect on the outcome of the following signs was analyzed: the gender and age of the victims, the mechanism of injury, the nature of combined extracranial injuries, the presence of alcohol intoxication, aspiration at admission, data on the clinical picture and CT of the brain, the level of ICP and the state of the brain during the operation.

## RESULTS AND THEIR DISCUSSION.

As a result of the statistical analysis, factors influencing the outcome of surgical treatment of victims with acute TBI were identified. Depending on the value of the statistical correlation coefficient R, all factors were divided by significance and intensity of their action into factors of high risk of an unfavorable outcome, moderate degree and weak degree. During the statistical analysis, it was found that the factors of a high degree of risk of an unfavorable outcome in patients with acute TBI include clinical and CT signs of acute dislocation syndrome. It is known that in patients with TBI, acute dislocation syndrome, leading to rapidly increasing compression of the brain stem with subsequent disruption of vital respiratory and circulatory functions, becomes the main cause of the development of adverse treatment outcomes. Dislocation syndrome is formed in conditions of acute intracranial hypertension and is a displacement of the cerebral hemispheres or hemispheres of the cerebellum in horizontal and (or) axial directions, which is manifested by compression and deformation of the basal cisterns on computer and magnetic resonance imaging. With an

extreme degree of development of the dislocation process in the brain stem, secondary circulatory disorders and hemorrhages occur. The clinical picture of acute dislocation syndrome is characterized by the same type of symptoms and is manifested by depression of wakefulness and symptoms of brain stem damage at different levels. The more pronounced the dislocation syndrome, the worse the outcomes of treatment in patients with TBI [2, 8, 12]. So, in our study, with the spread of dislocation syndrome to the underlying structures of the brain stem, mortality increased. In the absence of symptoms of brain stem dislocation (n=421), deaths were reported in 84 patients (19.9%). Mortality in patients with dislocation syndrome clinic at the diencephalic (n=252), mesencephalic (n=187) stages and at the bridge stage (n=238) was 30.9% (78 patients), 60.9% (114 patients) and 81.5% (194 patients), respectively. Many authors have noted the prognostic significance of the level of depression of wakefulness of victims with TBI before surgery. It has been proven that with deeper depression of wakefulness, the probability of unfavorable treatment outcomes increases [3, 5, 8]. The level of wakefulness at the diencephalic stage of development of dislocation syndrome corresponds to stun or sopor (from 9 to 14 points according to SHG), at the mesencephalic stage — moderate coma (7-8 points according to SHG), at the bridge stage — deep coma (4-6 points according to SHG) [12]. In our study, with a deeper depression of the level of wakefulness of patients with acute TBI, the frequency of adverse treatment outcomes increased. The highest frequency of adverse outcomes was observed in patients with depression of wakefulness to moderate and deep coma. Many studies have found a deterioration in treatment outcomes in patients with TBI in the presence of oculomotor disorders and inhibition of photoreactions in the neurological status, which indicates the progression of dislocation syndrome and an increase in brain stem compression. Particularly unfavorable factors include the bilateral absence of photoreactions, reflecting damage to the midbrain and bridge [3, 5, 7, 8]. In our study, in patients with preserved photoreactions and the absence of oculomotor disorders, the incidence of adverse outcomes was 12.4%, and in the presence of anisocoria — 56.3%. In the case of bilateral mydriasis, mortality increased to 96.5%.

A group of high-risk factors for the development of an unfavorable outcome is clinical and CT manifestations of acute dislocation syndrome — a formidable complication in patients with TBI, leading to compression of the brain stem, circulatory disorders in it and the development of life-incompatible lesions of the respiratory and vasomotor centers. It follows that for victims with acute TBI accompanied by dislocation syndrome, surgical intervention should be carried out urgently, since a delay in performing the operation can lead to the development of irreversible changes in the brain stem. Treatment of victims with acute TBI must necessarily be carried out under the supervision of modern methods of

neuromonitoring in order to timely detect and correct factors of secondary brain damage. Special attention should be paid to elderly and senile victims (60 years and older) who are at risk of developing an unfavorable outcome, as well as patients with severe combined TBI, a significant part of whom are taken to the hospital in a state of traumatic shock, with hypovolemia and respiratory failure due to aspiration or complicated chest injury.

## Conclusions

1. Clinical and CT manifestations of acute dislocation syndrome should be considered as high-risk factors for an unfavorable outcome.

2. Clinical signs of a high risk of an unfavorable outcome are: depression of the level of wakefulness less than 7 points on the SHG, the presence in the clinical picture of anisocoria or bilateral mydriasis, pathological tonic reactions or diffuse muscular hypotension, the development of acute edema and swelling of the brain during surgery.

3. CT-signs of a high risk of an unfavorable outcome are considered to be a pronounced or gross degree of compression of the basal cisterns, hemorrhage into the brain stem.

4. Factors of moderate risk of an unfavorable outcome are: the presence of acute subdural hematoma or multiple brain injuries, according to CT, the volume of the lesion of brain damage is more than 100 cm3, the magnitude of lateral dislocation is more than 10 mm, the presence of subarachnoid or intraventricular hemorrhage.

5. Factors of a low risk of an unfavorable outcome are: the age of the victims 60 years and older, the development of "malignant" intracranial hypertension that cannot be corrected during surgery or in the early postoperative period.

6. The results obtained during the study can also be used in predicting outcomes at the early stages of providing medical care to victims with acute TBI.

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