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OPTIMIZATION OF POSTOPERATIVE MANAGEMENT IN TRAUMATIC BRAIN COMPRESSION BASED ON THE PHASIC CLINICAL COURSE

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Abstract.
Background. Traumatic brain compression represents one of the most severe forms of traumatic brain injury and remains associated with high mortality despite advances in neuroimaging and intensive care.
Objective. To improve intensive care outcomes in patients with traumatic brain compression by optimizing postoperative management based on the concept of a phasic clinical course.
Materials and Methods. A retrospective analysis of 104 patients with traumatic brain compression treated surgically between 2021 and 2024 was performed. Clinical, neurological, CT/MRI data, phases of clinical decompensation, and outcomes according to the Glasgow Outcome Scale were evaluated.
Results. Three clinical variants of brain compression and three postoperative phases were identified. Overall mortality was 11.5% and showed a significant correlation with preoperative Glasgow Coma Scale scores, midline shift, and timing of surgery. The most favorable outcomes were observed in patients operated during the subcompensation phase.
Conclusion. A phasic approach to the postoperative management of traumatic brain compression enables more accurate therapeutic decision-making and improves clinical outcomes.
Keywords: traumatic brain injury; brain compression; intracranial hematoma; postoperative management; Glasgow Outcome Scale.

ОПТИМИЗАЦИЯ ВЕДЕНИЯ ПОСЛЕОПЕРАЦИОННОГО ПЕРИОДА ПРИ ТРАВМАТИЧЕСКОЙ КОМПРЕССИИ ГОЛОВНОГО МОЗГА НА ОСНОВЕ ФАЗОВОГО КЛИНИЧЕСКОГО ТЕЧЕНИЯ

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Аннотация.
Актуальность. Травматическая компрессия головного мозга является одной из наиболее тяжёлых форм черепно-мозговой травмы и сопровождается высокой летальностью, несмотря на развитие современных методов нейровизуализации и интенсивной терапии.
Цель исследования. Улучшить результаты интенсивной терапии у пациентов с травматической компрессией головного мозга путём оптимизации ведения послеоперационного периода на основе концепции фазности клинического течения.
Материалы и методы. Проанализированы результаты лечения 104 пациентов с травматической компрессией головного мозга, оперированных в 2021–2024 гг. Выполнялась клинико-неврологическая оценка, КТ/МРТ-диагностика, анализ фаз клинической декомпенсации, а также оценка исходов по шкале Glasgow Outcome Scale.
Результаты. Выявлены три варианта клинического течения компрессии мозга и три фазы послеоперационного периода. Летальность составила 11,5% и достоверно коррелировала с уровнем сознания по шкале Глазго, степенью смещения срединных структур и сроками хирургического вмешательства. Наиболее благоприятные исходы отмечены при

выполнении операции в фазе субкомпенсации.
Заключение. Фазный подход к оценке клинического течения травматической компрессии головного мозга позволяет оптимизировать послеоперационное ведение пациентов и повысить эффективность нейрохирургического лечения.
Ключевые слова: черепно-мозговая травма; компрессия головного мозга; внутричерепные гематомы; послеоперационный период; шкала Глазго.

BOSH MIYA TRAVMATIK SIQILISHIDA OPERATSIYADAN KEYINGI DAVRNI FAZALI KLINIK KECHISHGA ASOSLANGAN HOLDA OPTIMALLASHTIRISH

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Annotatsiya.
Dolzarbligi. Bosh miya travmatik siqilishi og‘ir bosh miya shikastlanishining eng murakkab shakllaridan biri bo‘lib, yuqori o‘lim ko‘rsatkichlari bilan tavsiflanadi.
Tadqiqot maqsadi. Klinik kechishning fazali konsepsiyasiga asoslanib, operatsiyadan keyingi davrni optimallashtirish orqali davolash natijalarini yaxshilash.
Material va usullar. 2021–2024-yillarda jarrohlik yo‘li bilan davolangan 104 nafar bemorning klinik, nevrologik va KT/MRT ma’lumotlari tahlil qilindi. Davolash natijalari Glasgow Outcome Scale bo‘yicha baholandi.
Natijalar. Bosh miya siqilishining uchta klinik varianti va operatsiyadan keyingi davrning uchta fazasi aniqlandi. O‘lim ko‘rsatkichlari bemorlarning dastlabki holati, ong darajasi va jarrohlikning o‘z vaqtida bajarilishi bilan bog‘liq ekanligi isbotlandi.
Xulosa. Fazali yondashuv travmatik bosh miya siqilishida operatsiyadan keyingi davrni samarali boshqarishga va klinik natijalarni yaxshilashga imkon beradi.
Kalit so‘zlar: bosh miya jarohati; travmatik siqilish; intrakranial gematoma; operatsiyadan keyingi davr; Glasgow shkalasi.

Introduction. Traumatic brain injury (TBI), along with cardiovascular diseases and malignant neoplasms, is one of the main causes of death. The percentage of patients with head and brain injury reaches 80% of the total number of all neurosurgical patients. Despite the recent comprehensive study of various aspects of severe TBI, the use of modern visualization methods, multimodal neuromonitoring, and assessment of the functional state of the brain, mortality in severe TBI remains extremely high [1-7]. Currently, there is no consensus on the procedure, indications, and evaluation of the effectiveness of the main methods for correcting the leading pathological syndromes in severe TBI. The characteristics of the body's reactions in the early postoperative period after removal of traumatic intracranial hematomas in relation to the course of endogenous intoxication syndrome remain undisclosed. Studies devoted to the study of the characteristics of the course and management of the postoperative period after removal of intracranial hematomas are few in number [8-10]. This also confirms the relevance of developing algorithms for the timely and differentiated use of various intensive care methods to prevent the unfavorable course of traumatic disease in severe TBI [10-15].

Purpose of the work. To improve the results of intensive care in patients with traumatic brain compression by optimizing the management of the postoperative period based on the concept of the phasing of its clinical course and the development of a pathogenetic therapy system. Material and methods. This study is based on the analysis of data obtained in 104 patients with brain compression for the period from 2021 to 2024 and operated on at the Multidisciplinary Clinic of Samara State Medical University, Department of Neurosurgery. Among the treated patients, there were 88 men (84.6%), 16 women (15.4%). The age of the patients ranged from 12 to 79 years. The average age of the patients was 45.7 ± 7.4 years. Most often, traumatic brain compression was observed in people aged 20-39 (49 (47.1%) and more often in men. Traumatic brain compression

was significantly less common in patients under 19 years of age and over 60 years of age, accounting for 14 (13.5%) and 13 (12.5%) cases, respectively. Sixty-eight patients (65.4%) were delivered to the hospital by ambulance, while the remainder were transported by public transport. Of the 104 patients admitted, 21 (20.2%) sustained their injury while intoxicated. All patients underwent a clinical and neurological examination upon admission, CT or MRI of the brain, and, after diagnosis, underwent emergency surgery. Neuroradiological data obtained from CT/MRI of the brain included hematoma location, midline brain structure displacement, and the maximum width, height, and length of the blood clot. The patients examined in the hospital were diagnosed with severe traumatic brain injury with brain compression, which included epidural hematomas in 37 patients (35.6%), subdural hematomas in 62 patients (59.6%), intracerebral hematomas in 9 patients (8.7%), multiple intracranial hematomas in 5 patients (4.8%) and impression skull fractures in 18 patients (17.3%). Preoperative preparation of patients with traumatic brain compression was usually carried out urgently, since treatment in the early period should be comprehensive and pathogenetically justified. All of the 104 observed patients underwent surgery. The indication for surgical treatment is the presence of traumatic compression of the brain, causing increasing compression of the brain. The only contraindication to surgical intervention should be considered only the presence of an agonal state of patients. Results of the study Analysis of general cerebral, focal and brainstem symptoms characterizing the severity of brain damage revealed three main variants of the clinical course of traumatic brain compression: 1) variant without a "lucid interval" - 61 patients (58.7%); 2) variant with an erased "lucid interval" - 24 patients (23.1%); 3) variant with a "lucid interval" - 19 patients (18.3%). When considering the clinical semiotics, attention was drawn to the fact thatMost often, patients were admitted without SP (58.7%), in a comatose state (11.5%), with the presence of meningeal symptoms (72.1%). Of the disorders of the oculomotor nerves in patients with traumatic brain compression, the most common symptom was pupillary inconsistency - anisocoria (37 patients - 35.6%). It was usually combined with a decrease in photoreaction. Clinical data are considered pathognomonic for intracranial hematomas, but the triad of symptoms: "lucid interval", anisocoria and bradycardia were observed in only 36 (34.6%) of 104 of our patients. The transition from one clinical phase to another, as well as changes within each phase, can develop according to 4 parameters: 1 - general cerebral, 2 - stem, 3 - local, 4 - according to instrumental research methods. The dynamics after the elimination of brain compression according to the four above-mentioned parameters may go either towards the reverse development of decompensation or its deepening. The study of secondary brainstem symptoms in traumatic brain compression revealed four main forms of secondary brainstem syndromes: mesencephalic form – 26 (25.0%); extrapyramidal form – 12 (11.5%); diencephalic form – 21 (20.2%); mesencephalobulbar form – 5 (4.8%). Epidural hematomas were detected in 37 patients (35.6%), subdural hematomas in 62 (59.6%), intracerebral hematomas in 9 patients (8.7%), multiple intracranial hematomas in 5 (4.8%). And impression skull fractures were diagnosed in 18 (17.3%) patients. An assessment of the condition of victims with traumatic brain compression according to the Glasgow Compression Scale showed ($p<0.05$) that 51 (49.0%) of the victims were in serious condition, and their condition was assessed at 11 points or lower. At the same time, 53 (51.0%) patients were admitted to the hospital in a stunned state of consciousness, 39 (37.5%) in a soporous state of consciousness, and 12 (11.5%) in a comatose state of consciousness (Table 1).0%); extrapyramidal form – 12 (11.5%); diencephalic form – 21 (20.2%); mesencephalobulbar form – 5 (4.8%). 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Table 1. The degree of impairment of consciousness in patients with traumatic brain compression according to the Glasgow Coma Scale ($p<0.05$).

Age of patients (years)	12–15 points	9–11 points	< 8 points	Total
Up to 19	8	5	1	14
20–39	27	17	5	49
40–59	10	14	4	28
60 and older	8	3	2	13
Total, abs. (%)	**53 (51.0%)**	**39 (37.5%)**	**12 (11.5%)**	**104 (100%)**

The phase of severe clinical decompensation was characterized by severe or extremely severe conditions in patients. Fifty-three (51.0%) patients were in this phase before surgery. Consciousness was severely impaired, ranging from profound obtundation (23 cases), stupor (18 cases), and coma (12 cases). Focal symptoms were overlaid by general cerebral and secondary brainstem symptoms. Thirty-four (32.7%) patients were in the phase of moderate clinical decompensation before surgery. Their general condition was moderate to severe. Symptoms of brain compression or intracranial hypertension were clearly evident. Among the victims (primarily with subdural hematomas), obtundation was observed in 13 and stupor in 21. In the moderate clinical decompensation phase, signs of brainstem syndrome were detected in most cases, caused by both the primary contusion, especially in acute subdural hematomas, and dislocation phenomena due to brain compression. Immediately before surgery, the clinical subcompensation phase was observed in 17 (16.3%) patients. This phase was characterized by the overall relatively satisfactory condition of the victims. Fourteen patients were conscious, and three were obtunded. There were no brainstem neurological symptoms.

Table 2. Assessment of treatment results of patients according to the outcome scale

Glasgow Outcome Scale (score)	Abs.	%
1	10	9.6
2	4	3.8
3	8	7.7
4	16	15.4
5	66	63.5
Total	**104**	**100.0**

As can be seen from Table 2, when assessing the quality of life of the patients we treated using the Glasgow Outcome Scale, good recovery – return to normal life with minimal impairment (5 points) – was observed in 66 (63.5%) patients; moderate disability (4 points) – in 16 (15.4%); severe disability (3 points) – in 8 (7.7%) and persistent vegetative state (2 points) – in 4 (3.8%) patients ($p<0.05$).

The results of treatment for traumatic brain compression were largely determined by the timeliness and adequacy of neurosurgical intervention and drug therapy. However, according to our data, in 11 (10.6%) of 104 cases, repeat surgeries were required due to the formation of postoperative epidural hematomas, recurrent intracranial hematomas, and cerebral edema. In the postoperative period, as our observations showed, three main groups of complications occurred. The first is ongoing or new compression of the brain caused by postoperative epidural hematomas during the initial surgery and other compressing factors; the second is inflammatory complications involving wounds, the substance and membranes of the brain, and the lungs; the third is trophic disorders of the body's integuments and internal organs. The most common complications observed in 11 repeat-operated patients were postoperative epidural hematomas (4 cases, 4 deaths), and hematoma recurrences (2 cases, 2 deaths). The highest mortality rate was observed among patients diagnosed

with multiple brain compression factors (7 cases) and among those with acute subdural hematomas (4 cases) that developed against the background of severe brain contusion. The overwhelming majority of patients (8 cases) died within the first 9 days after surgery. Of the 104 patients operated on, 12 (11.5%) died. Analysis of our material showed that all of them were operated on in the phase of severe clinical decompensation. In isolated cases, death occurred on the 11-12th day, and in rare cases more than 1 month after the injury.

Preoperative GCS scores significantly correlated with in-hospital mortality. Of 12 patients (11.5%) with a preoperative GCS score of 8 or <8, 8 (7.7%) died. Meanwhile, 2 (1.9%) deaths occurred among 39 (37.5%) patients with a preoperative GCS score of 9 to 11 ($p<0.05$).

The degree of midline structure displacement according to brain CT/MRI data was also significant and correlated strongly with mortality. Compared with 27 (26.0%) patients with midline structure displacement of less than 5 mm (<=5), 44 (42.3%) patients with displacement of more than 15 mm had a comparatively high mortality rate ($p<0.05$).

The time between injury and surgery significantly influenced the final outcome. Patients who underwent surgery less than six hours after injury had a relatively lower mortality rate than other patients ($p<0.01$).

The percentage of fatal outcomes increased as the degree of impaired consciousness increased (stupor-stupor), and conversely, the percentage of favorable outcomes (improvement) decreased as the degree of impaired consciousness increased ($p<0.05$).

The following prognostic factors influenced the outcome of severe traumatic brain compression: the severity of the injury, the combination of intracranial hematomas and contusion foci, the severity of the patient's condition before surgery, the timing of the surgery, the method and technique of the surgery, and the course of the postoperative period ($p<0.05$). Moreover, an important component determining certain features of neurosurgical treatment of intracranial hematomas and the outcome of brain injury was not only the age factor but also the phases of the traumatic brain compression. A comprehensive and dynamic study of the postoperative period from the perspective of the concept of the phasic clinical course of traumatic brain compression, based on the state of compensatory mechanisms of the brain and the body as a whole, can contribute to more appropriate patient management after surgery and improved treatment outcomes.

Conclusion. The clinical phase in which victims undergo surgery largely determines their progression. The postoperative period for traumatic brain compression is characterized by a phased course. The clinical subcompensation phase is the smoothest postoperative period after surgery. The deepening or reversal of decompensation is determined by four parameters: general cerebral, vital signs, local, and instrumental data. To achieve more rapid restoration of compensatory mechanisms in the postoperative period, surgery should be performed at a pace that anticipates the worsening of clinical decompensation, removing all compressing factors and providing sufficient decompression.

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