IRREVERSIBILITY OF ANTIANDROGENIC EFFECT OF LAMBDA-CYHALOTHRIN AFTER THE RECOVERY PERIOD IN THE STUDY ON MALE WISTAR HAN RATS

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Abstract. Previously conducted studies showed endocrine-disruptor properties of pyrethroids when exposed to mammals, causing disturbances in the reproductive system.

The purpose of these studies was to identify the hazard of lambda cyhalothrin (LCT) reproductive toxicity, as well as to study the reversibility and/or irreversibility of the resulting damage during the recovery period.

Research methods. Lambda-cyhalothrin 98.06% of purity was administered *ex tempore* daily, except Saturday and Sunday, by oral gavage to three groups of animals in doses 0,3; 3,0 and 10 mg/kg of body weight for 11 weeks. After the expiry of the exposure period, part of the males was selected to study the parameters of sperm and blood serum testosterone levels, while the remaining males were used for a recovery period without exposure for one full cycle of spermatogenesis (70 days). Morpho-functional indicators of the gonad state and the level of total testosterone in the blood serum were studied in all males after exposure and recovery period. The total amount and the absolute and relative number of motile sperm were determined, the percent of sperm abnormal forms was calculated. Morphometric parameters of testes and epididymis were recorded.

Results. Investigated LCT causes antiandrogenic effect which characterized by impaired of spermatogenesis and oligospermia, as well as a change in the testosterone content in the blood serum of experimental animals compared to the control. Dose dependence of the severity of oligospermia and spermatozoa adynamia is linear in nature both before and after the recovery period, increasing markedly at the end of the recovery period. While the response level of testosterone to increase of the dose is non-monotonic.The most pronounced statistically significant ($P < 0.01$) decrease in the level of testosterone relative to the control is noted at the end of exposure at the dose of 3.0 mg/kg of body weight. When exposed to the minimum and maximum doses, there is a tendency for this parameter to decrease as compared with the control. After the recovery period, the minimum and maximum doses cause the tendency to increase in testosterone compared with the control, while the middle dose of LCT, significantly ($P < 0.05$) induces a decrease in the content of this hormone relative to the control. The analysis of the qualitative and quantitative characteristics of the observed effects at the end of the exposure and recovery periods allows to presume that the tested LCT is irreversible xeno-agonists of estrogenic receptors with an intermediate degree of activity, causing damage to Sertoli cells and the spermogonial population of the germinative cells, depending on the dose level of exposure. The parameters characterizing the processes of spermatogenesis, and the testosterone content did not reach the control level during the recovery period, this indicates the irreversibility of the anti-androgenic effect for 10 weeks, and possibly the complete irreversibility of the observed effects. The systemic toxic effect, induced by the maximum dose tested and characterized by a decrease in the animals body weight, is reversible.

Within the studied range of doses in the experiment on the males of Wistar Han rats, no-observed effect level (NOEL) of LCT is the dose of 0,3 mg/kg of body weight, the low-observed effect level (LOEL) is 3 mg/kg of body weight. Maximum tolerated dose is 10 mg/kg of body weight.

Conclusions. The test system for the gonadotoxic activity identification is an adequate, highly sensitive methodological approach for testing the toxic effects of endocrine-disruptors.

Key words: lambda-cygalothrin, Wistar rats, anti-androgenic effect, recovery period, irreversibility.

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SURGICAL TREATMENT OF COMBAT CRANIOCEREBRAL GUNSHOT WOUNDS COMBINED WITH PARANASAL SINUSES INJURY

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Introduction. Skull base injuries caused by high-speed destruction objects during military operations are fundamentally different from the most injuries of civilian population. Two important aspects regarding combat-related injuries include weapons kinetics and characteristics of the most common wounds [1]. During Operation Iraqi Freedom and Operation Enduring Freedom, 25% to 40% of American patients had head, face, or neck wounds [2,3]. Skull and brain gunshot wounds were observed in 33.5% of all gunshot wounds of different head parts in local armed conflict in the Eastern Ukraine in 2014 [4,5]. High percentage of head and neck injuries is due to the fact that head and neck are not protected by body armors which are used nowadays by the military in the field [6].

Combat-related gunshot traumatic brain injuries combined with paranasal sinus damages are an important subgroup of fragment (bullet) traumatic brain injuries. Before penetrating into the skull through the anterior part of its base, a fragment crosses facial and orbital sections of the skull. Fragment passing through the face, eye sockets, structures of paranasal sinuses, and skull base creates an open, stable connection between subarachnoid cavity and cavities filled with air and lined with mucous membrane [7]. The most threatening are bacteria that live in oral cavity, in particular on larynx (staphylococci), or gram-positive or gram-negative cocci that contaminate the wound upon fragment penetration [8,9].

Much less common are cases when a fragment crosses skull roof and base and goes outside through maxillofacial area [10]. Fractures of skull base, including frontal sinuses and ethmoid sinuses, can be present without brain injury due to explosive wave. High speed bullets are able to split the skull base without crossing it [11]. In fact, it appeared that size and location of the fracture of anterior section of the skull base are factors contributing to infection and meningitis, regardless of rhinorrhea [12].

In any of these situations, connection of cerebrospinal fluid location with potentially infected sinuses filled with air and lined with mucous membranes is established, and such patients are prone infectious complications. The risk of purulent complications is the highest if fragment (bullet) trajectory goes through the skull base, especially when air sinuses and eye socket are perforated [9,13,14]. Such patients may suffer from recurrent meningitis, brain abscess, and hydrocephalus.

Anterior section of skull base is more likely to be wounded by fragments than other areas of skull base. A pathoanatomical study showed that this area suffered in 82% of cases [11]. According to the survey of patients in the Eastern Ukraine in 2014, it was found that 28% of patients had skull base injuries [4]. Anterior cranial fossa damage was diagnosed in 21% of patients; middle cranial fossa (petrous pyramid), in 6% of patients; of both anterior and middle cranial fossa, in 0.8% of patients.

Although TBI cases are well documented, especially in military medical literature, fragment (bullet) injuries of anterior part of skull base are rarely described as a separate subgroup of injuries [15].

At any time, treatment of combat-related gunshot traumatic brain injuries involving paranasal sinuses requires solution of the two issues: treatment of the brain injury itself and sealing of intracranial contents in order to prevent the infection [6]. Note that there is no consistent approach to management of such patients (surgical treatment or conservative therapy); there is uncertainty in surgical intervention timing (urgent, delayed) and its extent and high percentage of complications upon treatment of such category of patients people (nasal liquorrhea, meningitis, encephalitis, brain abscess, post-traumatic hydrocephalus) [14,16,17]. Thus, the problem of treatment of combat-related gunshot traumatic brain injuries with involvement of paranasal sinuses is poorly solved yet and requires further clinical research to select the optimal treatment approach and improve the outcomes.

The purpose of this paper is a prospective analysis of outcomes of surgical treatment of combat-related gunshot traumatic brain injuries (GTBI) involving paranasal sinuses (PNS).

Object and methods. The research was based on analysis of results of comprehensive prospective examination and treatment of 30 patients with combat-related gunshot traumatic brain injuries (GTBI) involving the paranasal sinuses (PNS). The injuries resulted from local armed conflict in the Eastern Ukraine. The patients were admitted to the Municipal Institution, Mechnikov Dnipropetrovsk Regional Clinical Hospital from May 25, 2014 to December 31, 2017 inclusive. During this period, a total of 184 patients with combat-related gunshot traumatic brain injuries underwent treatment in the Hospital. Thus, combination of traumatic brain injuries with paranasal sinus injury occurred in 16.3% of all patients.

Consciousness was assessed according to Glasgow Coma Score (GCS). Patients status on admission to the in-patient department was assessed according to the Injury Severity Score (ISS). In combined wounds, patients were also examined by ENT specialists and maxillofacial surgeons.

All patients with open head wounds underwent standard set of examinations which included craniography, lumbar puncture, and high-resolution brain spiral computed tomography (SCT). Brain SCT was performed on Hi Speed CT/e Dual (General Electric). Scanning was performed with a standard slice thickness of 10 mm or, for more detailed examination, of 5 mm or less. The field of view in all cases included all sections of patient's head and upper cervical vertebrae (C1-C3).

During brain CT, the brain matter, ventricular system, subarachnoidal, subdural and epidural spaces, skull bones, and soft head tissues were sequentially studied. Skull bones condition was studied by specially adjusting contrast and brightness (so-called bone window mode). Depending on dura mater integrity, penetrating and non-penetrating GTBIs were distinguished. Depending on wound tract characteristics, gutter, glancing, blunt, and perforating wounds were distinguished. Bound shot injuries were characterized by one entrance skull wound, which was both inlet and outlet. Blunt injuries were only characterized by inlet on skull surface, which lead to a blunt wound tract with a fragment at the tract end. Penetrating wounds were characterized by wound tract closed on all sides in skull cavity with separate inlet and outlet and absence of fragment in the wound tract.

There were two main types of military equipment: explosive devices and portable small arms. Explosive devices included: artillery shells, grenades, mortar bombs, bombs, missiles, mines, and makeshift explosive devices. Portable small arms included: pistols, rifles, assault rifles.

In case of penetrating craniocerebral injuries, an urgent surgical intervention was performed. The purpose of surgical treatment of such patients was, on the one hand, the removal of intracranial hematoma, wound debridement, and hemostasis, and, on the other hand, dura mater defects sealing without tension and skull base restoration while simultaneously sealing ethmoid and frontal sinuses. Surgical intervention was performed using microsurgical technique and OPMI VARIO 700 microscope (Carl Zeiss, Oberkochen, Germany). The microscope made it possible to minimize the retraction of already damaged and swollen frontal lobes while allowing effective skull base examination and restoration. We did not use external lumbar drainage before surgery. Nor did we use synthetic or biological glue compositions for autotransplants fixation. Patients with non-penetrating injuries underwent conservative treatment which included antibacterial and anti-edema therapy.

After the treatment, incidence of nasal liquorrhea and purulent and septic complications was assessed. Patients state assessment according to Glasgow Outcome Scale was performed 6 months after the injury.

Results and discussion. 30 male patients with GTBI and PNS injuries aged 21 to 49 (avg. (31.7±6.4)) were examined. 26 (87%) patients had penetrating wounds, 4 (13%) patients had non-penetrating brain wounds. In 26 (87%) cases, injuries were caused by fragments of mine and explosive devices and only 4 (13.3%) injuries were caused by small-arm bullets. Blunt wounds were diagnosed in 17 (57%) patients; bound shot wounds, in 7 (23%) patients; penetrating wounds, in 6 (20%) patients.

GCS score after initial resuscitation ranged from 5 to 15 (average 10.6±3.5). ISS score ranged from 16 to 50, avg. 26.4±7.3.

Patients breakdown by paranasal sinus injury location is shown in **table 1.** Thus, frontal sinus, in various combinations, was damaged in 25 (83%) cases; ethmoid bone, in 13 (43%) cases; sphenoidal sinus, in 1 (3%) case.

In 12 patients, along with paranasal sinus injury, there were numerous orbit roof fractures. Orbit roof fractures were observed in 4 patients with unilateral frontal sinus injury, 4 patients with ethmoid bone injury, 3 patients with bilateral frontal sinus and ethmoid bone injury and one patient with combined frontal sinus, ethmoid bone, and sphenoidal sinus injury.

Craniocerebral injuries involving paranasal sinuses were combined with intracranial hematomas and presence of bone fragments and metal fragments located intracranially. Breakdown of clinical findings by intracranial injuries incidence and structure based on brain SCT data is shown in **table 2.** Lateral dislocation signs were detected in 5 patients. Midline shift ranged from 2 mm to 9 mm. Axial dislocation signs were detected in 2 patients.

Four non-penetrating brain wound patients were treated conservatively. Initially, 26 (87%) patients underwent surgery. Breakdown of patients by extent of paranasal sinuses or brain surgery is shown in **table 3.**

High-resolution head and neck spiral computed tomography with the review of axial images in cerebral and bone mode and frontal view reconstruction allowed to clearly determine wound tract and nature of the extra- and intracranial injuries in all cases. Accurate information on the nature of the injury before the sur-

Table 1.

Patients breakdown by paranasal sinus injury location

Damaged anatomical area	Number of wounded persons vs. the total number of examined persons (%)
Frontal sinus, unilateral	13 (43%)
Frontal sinus, bilateral	4 (13%)
Frontal sinus, unilateral + ethmoid bone	3 (10%)
Frontal sinus, bilateral + ethmoid bone	4 (13%)
Ethmoid bone	5 (17%)
Frontal sinus + ethmoid bone + sphenoidal sinus	1 (3%)

Table 2.

Breakdown of clinical findings of intracranial changes on brain SCT

Intracranial changes on SCT	Number of wounded persons vs. the total number of examined persons (%)
Focal brain contusion	24 (80%)
Intracerebral traumatic hematoma	16 (53%)
Subarachnoid hemorrhage	11 (37%)
Subdural hematoma	6 (20%)
Intraventricular hemorrhage	3 (10%)
Epidural hematoma	1 (3%)
Brain matter bone fragments	21 (70%)
Brain matter metal debris	10 (33%)
Midline shift	5 (17%)

Table 3.

Breakdown of patients by extent of surgical intervention

Extent of surgical intervention on paranasal sinuses	Extent of surgical intervention on brain			
	Revision of basal dura mater	OPC + ICH and/or brain contusion foci removal	DC + ICH and/or brain contusion foci removal	Total (%)
Unilateral frontal sinus obliteration	1	7	—	8 (31%)
Bilateral frontal sinus obliteration	2	—	—	2 (8%)
Unilateral frontal sinus obliteration and ACF base reconstruction	—	3	—	3 (12%)
Bilateral frontal sinus obliteration and ACF base reconstruction	2	4	3	9 (35)
Frontal sinus cranialization and ACF plasty	1	—	—	1 (4%)
ACF plasty without frontal sinus obliteration	1	2	—	3 (12%)
Total (%)	7 (27%)	16 (62%)	3 (12%)	26 (100%)

Note. ACF = anterior cranial fossa, OPT = osteoplastic craniotomy, DC = decompressive craniectomy, ICH = intracerebral hematoma.

gery allowed planning all surgery stages and performing them in full during one surgical intervention.

Twenty-six patients were provided with urgent neurosurgical care which was required due to fragment (bullet) wounds. In order to open anterior cranial fossa, a scalp dissection was performed with formation of bicoronal flap. Pericranium was preserved so that it could be used as a separate flap. The following two variants of anterior pericranium flap were most commonly used: with anterior (with supratrochlear and supraorbital arteries) or lateral (with superficial and deep temporal arteries) pedicle. An additional variant of lateral flap was a temporomandibular flap comprised of temporal muscle (with or without fascia). The flap was separated along with the pericranium so that a longer and stronger flap could be formed. In isolated frontal sinus injuries, sinus mucosa removal, frontal and nasal junction tamponade, and frontal sinus obliteration by pericranial periosteal flap with anterior base was performed. In ethmoid bone damages, reconstruction of anterior cranial fossa was performed with a temporomandibular fascia flap with a lateral pedicle. If simultaneous sealing of defects of frontal sinus and ethmoid bone was required, both anterior and intracranial flaps were simultaneously used. In orbit roof defects, 5 of 12 patients underwent reconstruction with a dynamic titanium plate.

In order to remove intracerebral hematomas and focal cerebral contusions, in 16 (62%) patients osteoplastic craniotomy with bone flap insertion at the end of the surgery was performed. In 3 (12%) patients with severe traumatic intracranial injuries with concomitant cerebral edema, decompressive craniectomy was performed prior to skull base reconstruction to reduce increased intracranial pressure. Only after the decompressive craniectomy was performed and liquor was removed from basal cisterns, it was possible to obtain minimally traumatic access to anterior cranial fossa base. Inlet bone fragments were removed in all the patients. Metal fragments were only removed when they were in sight and their removal would not cause additional brain trauma. In all cases, antibacterial therapy was prescribed for 2 to 3 weeks. Antibacterial therapy was adjusted based on bacteriological CSF examination over time.

Nasal liquorrhea at admission was observed in 12 (40%) patients. After the treatment, nasal liquorrhea was observed in 2 (7%) patients. Liquorrhea was detected in one (4%) patient in a series of surgical treatment of 26 patients and in one of 4 patients (25%), they were treated conservatively. In both cases, nasal liquorrhea was eliminated by prolonged use of external lumbar drainage.

Purulent and septic complications in the form of meningoencephalitis, ventriculitis, and subdural empyema were found in one patient. Thus, the incidence of purulent-septic complications was 3% (1 out of 30) and 4% (1 out of 26) in the general group of GTBI patients with PNS injuries (operated and non-operated) and in surgical treatment group, respectively. Purulent and septic complications were much less severe than those presented in the literature. For instance, Bhatoe H. S. (13) claims that meningitis incidence in his study group was 13%. Other authors claim meningitis incidence of 18.8% to 25% [9,18].

Unfavourable prognostic factors of purulent and septic complications in patients from our series included: severe brain contusion, initial postresuscitation GCS score 9, multilobar trauma and transventricular wound, delayed patient delivery for specialized treatment, wound-related liquorrhea, and tamponade of lateral brain ventricle with blood. The patient underwent frontal bone craniotomy, removal of brain detritus, intraventricular hematoma, and metal fragments, obliteration of frontal sinus, and reconstruction of anterior cranial fossa with pericranial flap on pedicle. After the surgery, nasal liquorrhea was absent. However, the patient suffered from purulent meningocephalitis and subsequently, he underwent surgery for subdural empyema. In order to eliminate post-traumatic hydrocephaly, a four-month-old patient underwent CSF shunting surgery. The patient survived, a treatment outcome in 6 months was a severe disability.

In the study group, a treatment outcome in 6 months was good recovery in 13 (43%) patients; moderate disability, in 11 (37%) patients; severe disability, in 4 (13) patients. 2 (7%) patients died. No cases of vegetative state were diagnosed.

In one case, the cause of death was a multiple organ failure in a patient with a moderate brain contusion and severe internal organ injuries (abdominal cavity and lungs). In the second case, severe primary brain injury with cerebral edema, intracranial hypertension, and secondary cerebral ischemia occurred. In both of these lethal cases, we did not detect episodes of liquorrhea or purulent and septic complications after the surgery. Thus, the lethal cases were not directly related to paranasal sinus injury and concurrent pathological conditions.

Conclusions. Head and neck spiral computed tomography with the review of axial images in cerebral and bone mode and frontal view reconstruction allows to clearly determine wound tract and nature of the extra- and intracranial injuries in all cases. Aggressive surgical approach which includes urgent intervention with removal of intracranial hematomas and sealing of cranial cavity in the area of damaged paranasal sinuses can ensure satisfactory immediate and distant outcomes The use of anterior and lateral pericranial flaps on pedicle has proved its effectiveness in reconstructive skull base surgery.

Further study prospects. Although received from a small group of patients, our data give reason to believe that performing a surgery to the full extent, both on brain and paranasal sinuses during initial intervention, reduces incidence of purulent and septic complications if compared with historical data. Combination of anterior pericranial flap with additional lateral flap helps preventing spinal fluid leakage and reduces the risk of liquorrhea from 40% to 7%. The question of whether really urgent surgical interventions performed in full with the use of vascularized pericranial flaps are better than conservative treatment or phased surgical interventions shall be addressed in further major studies.

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ХІРУРГІЧНЕ ЛІКУВАННЯ БОЙОВИХ ВОГНЕПАЛЬНИХ ЧЕРЕПНО-МОЗКОВИХ ПОРАНЕНЬ, ПОЄДНАНИХ З УШКОДЖЕННЯМ ПАРАНАЗАЛЬНИХ СИНУСІВ

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Резюме. Проведено аналіз результатів хірургічного лікування 30 потерпілих з бойовими вогнепальними черепно-мозковими пораненнями (ВЧМП), поєднаними з ушкодженнями параназальних синусів (ПНС). Поранення були отримані в результаті локального збройного конфлікту на сході України.

Об'єкт і методи. Постраждалі були послідовно включені до проспективного дослідження в період з 25 травня 2014 року по 31 грудня 2017 року. Дана група потерпілих склала 16,3% від всіх постраждалих з ВЧМП, які були проліковані за цей період. При госпіталізації всім пацієнтам робили КТ дослідження головного мозку з високою роздільною здатністю. Ушкодження лобного синусу відзначені у 25 (83%) спостереженнях, решітчастої кістки у 13 (43), клиновидного синусу – в 1 (3%) спостереженні. 26 (87%) постраждалих мали проникаючі поранення, 4 (13%) – непроникаючі поранення головного мозку. У 26 (87%) випадках відзначені уламкові мінно-вибухові поранення, у 4 (13,3%) поранення були спричинені кулями. Сліпі поранення діагностовано у 17 (57%) постраждалих, рикошитуючі – у 7 (23%), наскрізні – у 6 (20%) постраждалих. Оцінка за ШКГ після первинної ресусцитації коливалась від 5 до 15 балів, у середньому 10,6±3,5 бали. Чотирьох потерпілих з непроникаючими пораненнями головного мозку лікували консервативно. Первинно оперовані 26 (87%) поранених. Проводили невідкладне втручання з метою видалення внутрішньочерепної гематоми, герметичного закриття дефектів твердої мозкової оболонки та відновлення основи черепа при одночасній герметизації решітчастих і лобних повітряних синусів. Для закриття лобного синусу та дефектів передньої черепної ямки використовували добре васкуляризований передній та латеральні перикраніальні клапті на живлячій ніжці у різних модифікаціях.

Результати. Назальна лікворея при госпіталізації зустрічалася у 12 (40%) потерпілих, після лікування – у 2 (7%) потерпілих. Гнійно-септичні ускладнення були виявлені лише у 1 (3%) пораненого. Вони були представлені у вигляді менінгоенцефаліту, вентрикуліту та субдуральної емпієми одночасно. Сприятливі результати лікування (добре відновлення та помірна інвалідизація) через 6 місяців відзначені у 24 (80%), несприятливі (глибока інвалідизація та летальність) – у 6 (20%). Вегетативних станів серед пролікованих хворих не відзначали. Два летальні випадки не були пов'язані з ушкодженнями параназальних синусів. В одному випадку мало місце тяжке первинне ушкодження головного мозку, в іншому – тяжкі поєднані ушкодження внутрішніх органів з поліорганною недостатністю.

Ключові слова: бойові вогнепальні поранення, черепно-мозкові поранення, параназальні синуси, назальна ліккворея, хірургічне лікування, пластика основи черепа, перикраніальний клапоть, результати лікування, гнійно-септичні ускладнення.

ХИРУРГИЧЕСКОЕ ЛЕЧЕНИЕ БОЕВЫХ ОГНЕСТРЕЛЬНЫХ ЧЕРЕПНО-МОЗГОВЫХ РАНЕНИЙ, СОЧЕТАННЫХ С ПОВРЕЖДЕНИЯМИ ПАРАНАЗАЛЬНЫХ СИНУСОВ

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Резюме. Проведен анализ результатов хирургического лечения 30 пострадавших с боевыми огнестрельными черепно-мозговыми ранениями (ОЧМР), сочетанными с повреждениями параназальных синусов (ПНС). Ранения получены в результате локального вооруженного конфликта на востоке Украины.

Объект и методы. Пострадавшие были последовательно включены в проспективное исследование в период с 25 мая 2014 года по 31 декабря 2017 года. Данная группа пострадавших составила 16,3% от всех пострадавших с ОЧМР, которые были пролечены за этот период. При госпитализации всем пациентам выполняли КТ головного мозга с высокой разрешающей способностью. Повреждение лобного синуса отмечено в 25 (83%) наблюдениях, решетчатой кости – в 13 (43%), клиновидного синуса – в 1 (3%) наблюдении. 26 (87%) пострадавших имели проникающие ранения, 4 (13%) – непроникающие ранения головного мозга. В 26 (87%) случаях отмечены осколочные минно-взрывные ранения, в 4 (13,3%) случаях – пулевые ранения. Слепые ранения диагностированы у 17 (57%) пострадавших, рикошитирующие – у 7 (23%), сквозные – у 6 (20%) пострадавших. Оценка по ШКГ после первичной ресусцитации колебалась от 5 до 15 баллов, в среднем 10,6±3,5 балла. Четыре пострадавших с непроникающими ранениями мозга лечили консервативно. Первично оперированы 26 (87%) раненных. Выполняли неотложное хирургическое вмешательство с целью удаления внутричерепной гематомы, герметического закрытия дефектов твердой мозговой оболочки и восстановления основания черепа при одновременной герметизации решетчатых и лобных воздушных синусов. Для закрытия лобного синуса и дефектов передней черепной ямки использовали хорошо васкуляризированный передний и латеральные перикраниальные лоскуты на питающей ножке в различных модификациях.

Результаты. Назальная ликворея при госпитализации отмечена у 12 (40%) пострадавших, после лечения – у 2 (7%) пострадавших. Гнойно-септические осложнения выявлены только у 1 (3%) раненного. Они были представлены в виде менингоэнцефалита, вентрикулита и субдуральной эмпиемы одновременно. Благоприятные результаты лечения (хорошее восстановление и умеренная инвалидизация) через 6 месяцев с момента ранения отмечены у 24 (80%), неблагоприятные (глубокая инвалидизация и смертельный исход) – у 6 (20%). Вегетативных состояний у пролеченных больных не отмечали. Два летальных случая не были связаны с повреждениями параназальных синусов. В одном случае имело место тяжелое первичное повреждение головного мозга, в другом – тяжелые сочетанные ранения внутренних органов с полиорганной недостаточностью.

Ключевые слова: боевые огнестрельные ранения, черепно-мозговые ранения, параназальные синусы, назальная ликворея, хирургическое лечение, пластика основания черепа, перикраниальный лоскут, результаты лечения, гнойно-септические осложнения.

SURGICAL TREATMENT OF COMBAT CRANIOCEREBRAL GUNSHOT WOUNDS COMBINED WITH PARANASAL SINUSES INJURY

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Abstract. Results of surgical treatment of 30 patients with combat-related gunshot traumatic brain injuries (GTBI) combined with paranasal sinuses injury (PNS) were analyzed. The injuries resulted from local armed conflict in the Eastern Ukraine.

Object and methods. The patients were consistently enrolled in the prospective study in the period from May 25, 2014 to December 31, 2017. This group of patients made up 16.3% of all GTBI patients treated during that period. All patients underwent high-resolution cranial CT at admission. Frontal sinus injuries were observed in 25 (83%) cases; ethmoid bone injuries, in 13 (43) cases; sphenoidal sinus injuries, in 1 (3%) case. 26 (87%) patients had penetrating wounds; 4 (13%) patients, non-penetrating cerebral wounds. Fragment mine blast wounds were observed in 26 (87%) cases; 4 (13.3%) wounds were caused by bullets. Blunt wounds were diagnosed in 17 (57%) patients; bound shot wounds, in 7 (23%) patients; penetrating wounds, in 6 (20%) patients. GCS score after initial resuscitation ranged from 5 to 15 (average 10.6±3.5). Four non-penetrating brain wound patients were treated conservatively. Initially, 26 (87%) patients underwent surgery. Emergency intervention was performed to remove intracranial hematoma, close dura mater defects and restore skull base while simultaneously sealing ethmoid and frontal air sinuses. Well-vascularized frontal and lateral pericranial flaps on pedicle in various modifications were used to close frontal sinus and anterior cranial fossa defects.

Outcomes. Nasal liquorrhea was observed in 12 (40%) patients at admission and in 2 (7%) patients after treatment. Purulent and septic complications were only detected in 1 (3%) patient. The complications had the form of combined meningoencephalitis, ventriculitis, and subdural empyema. Favourable treatment outcomes (good recovery or moderate disability) in 6 months after treatment were detected in 24 (80%) patients; unfavourable outcomes (severe disability or death), in 6 (20%) patients. Vegetative state was not observed in treated patients. Two lethal cases were not associated with paranasal sinus injury. In one case, there was a severe primary brain injury; in the other case, severe combined internal organ injuries with multiple organ failure.

Key words: combat-related gunshot wounds, traumatic brain injuries, paranasal sinuses, nasal liquorrhea, surgical treatment, skull base reconstruction, pericranial flap, treatment outcomes, purulent and septic complications.

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