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Tel.: + 49 51519191533
Fax.:+ 49 5151 919 2560
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Marina Kisiliuk
Korrektur:
O. Champela
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N. Gavrilets

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Tovkach Yu.V.,
Bazik O.N.,
Andriets V.I.
Higher State Educational Establishment of Ukraine "Bukovinian State Medical University", Chernivtsi, Ukraine

FEATURES OF THE MUSTICATORY MUSCLE MICROCIRCULATORY BLOODSTREAM IN THE IN THE EARLY POST-TRAUMATIC PERIOD OF THE EXPERIMENTAL TRAUMA IN THE MAXILLOFACIAL AREA (literature review)

Abstract. *The paper presents the scientific substantiation, development and implementation into clinical practice of the results of experimental studies simulating disorders which tend to occur in the masticatory muscles in the injuries of the maxillofacial area and similar to those in polytrauma. We have studied the peculiarities of hematological changes with the presence of reactive shifts in the microcirculatory bloodstream in the muscles of the jaw apparatus of various functional types under the conditions of posttraumatic hypodynamia, attained through the biodeterioration effect of the experimental modeling. We have obtained new data on the adaptive capabilities of the chewing musculature microcirculatory bloodstream to normal muscular load after posttraumatic changes in the jaw apparatus in a model experiment on laboratory animals.*
Key words: *injuries to maxillofacial area, polytrauma, hematological changes, posttraumatic changes in masticatory muscles.*

Introduction. The problem of the traumatism in the population as a result of road traffic accidents and the presence of polytrauma in the victims are one of the topical areas in interdisciplinary research concerning both medical and social aspects and issues related to road safety [8].

Besides the overall increase in injuries, the frequency and severity of maxillofacial injuries and associated injuries are growing as well. This is evidenced by numerous data of domestic [4, 9] and foreign authors [13]. The proportion of maxillofacial injuries among the total number of bone injuries varies from 3.2 to 3.8% [7, 10]. The number of victims with facial traumas is from 21 to 40% in the structure of inpatients according to the materials of some authors [6]. Many authors note an increase in fractures of the facial bones with injuries to the muscular system by 10-15%, which should be taken into account when organizing specialized inpatient and outpatient care [1, 5, 11].

Methods. Modeling in clinical and experimental surgery has become one of the main methods of scientific research, allowing to accelerate the understanding of the key issues of the pathogenesis of extreme conditions, in particular, traumatogenesis and disorders, including those in the muscular apparatus of the facial skeleton in combined injury of the maxillofacial area, as well as to outline and substantiate the ways of their prevention and treatment.

To implement the method of experimental modeling, we tested and applied a device for reproducing combined injuries of the face in a series of experiments on laboratory animals.

The proposed experimental model with the reproduction of this trauma in laboratory animals made it possible to trace possible features of hematological changes with the presence of reactive shifts in the system of the microcirculatory bloodstream in the muscles of the maxillary apparatus of various functional types in conditions of posttraumatic hypodynamia during reparative myogenesis similar to those occurring in victims with an identical trauma.

Objective. This paper was aimed at studying the dynamics of the hemogram indices in laboratory animals during reparative myogenesis, which causes a series of hematological changes with the presence of reactive shifts in the blood system, which are an integral part of the body's response to destructive and recovery processes

that manifest themselves a great deal and are characterized by their size and duration.

Methods. The study of quantitative parameters of the peripheral blood was carried out on 20 clinically healthy rats-analogs. Before the experiment to study the quantitative changes in peripheral blood cells, 5 laboratory rats had been involved in the study to work out the bench mark (BM). The changes in the period of the reparative process were studied after causing a complete fracture of the facial skull bones damaging the masticatory muscles of 15 rats. The analysis of the data was carried out with respect to the bench mark characterizing the physiological indices that we obtained in the process of preparing the experiment.

Under experimental conditions, the animals were traumatized to different parts of the facial skull injuring the chewing musculature in a single stage by means of a device for traumatization of laboratory animals (Patent of Ukraine 6548 of May 16, 2005).

By studying the rates of injuries resulting from accidents with maxillofacial trauma in Ukraine and CEE countries, we used the methods of mathematical statistics, econometric ones and methods of time series analysis. For calculations, Statistica and Excel packages were used, as well as the R package, in which the possibilities of using the methods of spatial econometrics and statistics with visual display of calculation results were realized [2, 3, 12].

Results. Analysing the erythroid component of peripheral blood (Table 1) showed that in the injured group, hematological parameters were represented by pronounced dynamics throughout the entire experiment. One day after the beginning of the reparative process of the chewing musculature, the number of red blood cells decreased by 1.2 times (BM 7.8 ± 0.2 x 10 12/l); hemoglobin - by 1,1; hematocrit – by1.04 times. On the 2nd day of the experiment, we recorded an even greater loss of the red blood component. The quantitative indicator of erythrocytes decreased by 1.73 and amounted to 4.5 ± 0.16 x 1012 / l; hemoglobin – by 1,4; The hematocrit decreased by 1.18 times. The color index, which characterizes the ratio of hemoglobin to erythrocyte, increased by 1.12-1.24 times. This process, in our opinion, characterizes the response of the body to blood loss, pain irritation and death of erythrocytes as a result of powerful metabolic stress in the post-traumatic period. Low quantitative values of the erythroid component of the peripheral blood were also determined on the 7-14th day of the experiment.

Erythrocytopenia was associated with the influence of acute-phase proteins and a damage to the erythrocyte membrane. There is a possibility of depositing blood in the central parenchymatous organs and stagnation in the area of trauma. Later on, there was a gradual recovery of red blood values to the level of physiological ones. On the 28th day, the number of erythrocytes increased to 6.0 ± 0.13 x 1012 / l, although their level was 1.3 times lower in relation to the bench mark. During this period, the parameters of hemoglobin and hematocrit were restored, and the color index decreased insignificantly.

Table 1

Dynamics of the quantitative indicators of the erythrogram during the period of the rats' reparative myogenesis

Days	Erythrocytes, x1 x10^{12}/l		HB, r%		Ht, **%**		Colour index r%		ESR, mm/h	
	M	m	M	m	M	m	M	m	M	m
BM	7,8	0,20	12,9	0,20	36,9	0,11	0,50	0,05	3,3	0,01
1	6,3	0,13	11,7	0,29	35,2	0,27	0,56	0,06	3,9	0,03
2	4,5	0,16	9,2	0,42	31,4	1,29	0,62	0,07	5,6	0,07
7	4,9	0,18	8,7	0,20	35,4	0,22	0,46	0,07	7,3	1,02
14	5,2	0,11	10,8	0,20	34,3	0,73	0,62	0,12	8,6	1,03
28	6,0	0,13	11,2	0,24	37,7	0,82	0,56	0,09	6,1	1,02
42	7,2	0,33	10,8	0,42	35,8	0,60	0,45	0,06	4,9	0,03
56	7,8	0,18	12,2	0,40	35,6	0,51	0,47	0,08	3,7	0,02

BM — bench mark

The indicators of quantitative changes in the red blood which are presented in Table 1, we regard as a creation of an adaptive buffer in response to a trauma of the maxillofacial area with injuries to the masticatory muscles, as well as a compensation for the acidotic state that occurs after the damage to even a part of the muscle mass. During the final days of the experiment (on the 42-56th days), the index of the erythrocytic link of the peripheral blood reached the bench mark (7.8 ± 0.18 x 1012 / L). The color index of the peripheral blood on the 42nd and 56th days did not reliably differ from the initial data.

At the same time, the quantitative values characterizing the parameters of hematocrit and hemoglobin reached the physiological values as well. Post-traumatic period, accompanied by the development of the inflammatory reaction, was recorded by characteristic changes in the rate of erythrocyte sedimentation. On the 14th day after the injury, the erythrocyte sedimentation rate increased by 2.61 times in comparison with the bench mark. Later on, there was a gradual decrease in this index characterizing the weakening of the inflammatory reaction.

Thus, the erythrograms of experimental rats show a direct correlation between the changes caused by a trauma in the maxillofacial region with injuries to the masticatory muscles, which is manifested by loss of erythrocytic mass during 14 days and restoration of the functional activity of the red blood by the 28th day.

In the further stages of the experiment, the leukograms of the peripheral blood (Table 2) revealed a marked leukocyte reaction, which was manifested by an increase in the number of leukocytes on the first day after modeling a trauma in the maxillofacial region by 1.4 times compared to the initial index (7.2 ± 0, 24 x10^{9}/l).

By the second day the number of leukocytes in the blood of rats had decreased, but had significantly exceeded the initial values. A gradual decrease in leukocytes was noted until the 28th day, after which the period of an increase in the quantitative index of leukocytes in the peripheral blood of experimental animals occurred. The dynamics of stab neutrophils (SNP) in the injured group compared to the bench mark (6.8 ± 0.29 x 109 / l) is as follows: during the first days the increase in this indicator was observed by 2.1 times, and starting with the 7th day, there was a persistent tendency to its reduction. During the final days of the model experiment with the damage to the chewing muscular apparatus of the maxillofacial region, the number of stab neutrophils increased slightly. The content of segmented neutrophils in the injured group in relation to the bench mark (31.6 ± 1.6 %) was marked by a steady increase through the entire experiment. When studying the dynamics of lymphocytes, we established that on the first and second days their number decreased by 1.3-1.34 times, respectively, relative to the BM (58.0 ± 3.11 %). The lymphatic cells tended to accumulate starting with the 7th day of the post-traumatic period. A slight decrease on the 42nd day changed into an increase in the percentage of lymphocytes by the 56th day.

The number of eosinophilic granulocytes in the injured group, relative to the bench mark, only increased in the initial post-traumatic period, but later on their dynamics remained rather even. The

Table 2

Dynamics of the leucogram figures in the period of reparative osteogenesis in rats

Days	Leucocytes, x10$^{9/l}$		Lymphocytes, %		Neutrophils, %				Basophils		Eosinophils		Monocytes	
					Stab		Segmented							
	M	m	M	m	M	m	M	m	M	m	M	m	M	m
BM	7,2	0,24	58,0	z,i	6,8	0,29	31,6	1,60	0,6	0,06	2,0	0,06	1,5	0,0
1	10,	0,18	44,0	2,67	15,	0,89	36,0	0,89	-	-•	1,3	0,03	3,3	0,0
2	8,1	0,11	43,1	0,67	14,	0,44	38,3	1,11	0,3	0,03	2,3	0,07	2,0	0,0
7	7,6	0,16	46,3	1,11	12,	0,44	37,7	0,67	0,7	0,03	2,7	0,03	1,2	0,0
14	6,8	0,29	48,3	1,11	9,1	0,44	39,3	1,56	0,7	0,06	1,3	0,04	2,0	0,0
28	6,3	0,38	55,3	1,11	4,2	0,00	38,3	1,56	0,3	0,03	1,5	0,07	0,7	0,0
42	6,8	0,24	49,7	2,89	5,7	0,44	43,3	4,70	-	-	0,9	0,03	0,7	0,0
56	5,6	0,78	58,7	1,56	5,3	0,44	35,3	1,11	-	-	0,3	0,01	1,3	0,0

BM- bench mark

study of the percentage of basophils in the group revealed a decrease in their number on the 2nd day of the experiment, their number increased by the 7th day and the figure remained at this level until the 8th day. In later terms, they were not noticed in the leukogram. The number of monocytes in rats (Table 2) on the 1st day of trauma increased by 2.54 times in comparison with the bench mark (1.5 ± 0.04%). By the 7th day, the monocyte content decreased and reached the level of the initial data. By the 14th day they increased by 1.54 times in comparison with the bench mark. On the 28th and 42nd days, the level of monocytes started to decrease, and by the 56th day it reached the level of physiological values.

Discussion. The presence of the above changes in the hemogram is regarded as an indicator of an adaptive response of the body, suggesting the development of common processes characterizing the post-traumatic period, which makes it possible to predict and control the course of reparative transformations in the masticatory muscles of laboratory animals.

Conclusions. Thus, in laboratory animals, the effect of the experimental polytrauma with a damage to the chewing musculature in case of a trauma to the maxillofacial area on the reparative capabilities of muscle tissue in the early post-traumatic period has been studied in detail. When comparing the results obtained in the study, we established the nature of adaptive reaction of the body based on the hematological indices of red and white blood under the influence of the polytrauma.

At the same time, the erythrograms of the experimental rats showed a direct dependence of the changes caused by a trauma to the the maxillofacial area with a damage to the masticatory muscles, manifested by the loss of erythrocyte mass during 14 days and restoration of the functional activity of red blood by the 28th day. Also, a pronounced leukocyte reaction was revealed, which was manifested by an increase in the number of white blood cells on the first day after modeling the trauma of the maxillofacial region, reaching the level of physiological values at the end of the experiment. At the same time, the erythrograms of the experimental rats showed a direct correlation between the changes caused by the trauma of the maxillofacial region and the damage to the masticatory muscles, which is manifested by the loss of erythrocyte mass during 14 days and restoration of the functional activity of red blood by the 28th day. We have also found a pronounced leukocyte reaction, which was manifested by an increase in the number of white blood cells on the first day after modeling the trauma of the maxillofacial region, reaching the level of physiological values at the end of the experiment.

These experimental studies broadened the awareness and confirmed the priority of metabolic disorders in a polytrauma, allowed to provide a prognostic assessment of the further development of the pathological process and to substantiate the tactics of management of such patients in the early period of combined maxillofacial trauma.

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