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BLOOD SYSTEM IN PATIENTS WITH COMBINED INJURY OF THE MAXILLOFACIAL REGION AT DIFFERENT TERMS OF SURGICAL TREATMENT

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ABOUT ARTICLE

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Abstract: One of the urgent problems of modern medicine is the trauma of the maxillofacial region, which in the list of causes of death in men of working age (18-40 years) ranks third after oncological and cardiovascular diseases (WHO data). The lethal outcome in the early period after an injury is usually caused by shock and massive blood loss, and in the late period - by concomitant complications (thromboembolism, pneumonia, and infectious processes). Complications arising from trauma to the maxillofacial area are due to dynamic changes in coagulation hemostasis, and a decrease in immunity. This, in turn, can be caused by a violation of the function of blood cells.

INTRODUCTION

In the last two decades, there has been a rapid increase in injuries, a change in its structure towards an increase in the proportion of severe, mainly multiple and associated injuries (polytrauma) [2]. Improvement of the system of providing medical care and treatment of victims, the introduction of new methods of treatment, the participation of specialists of various profiles in the treatment of victims and wounded with concomitant injuries require a unified comprehensive approach to identifying combined craniofacial injuries of different nature and severity and building on this basis a rational surgical tactics [2, 5, 7, 9, 10].

THE MAIN RESULTS AND FINDINGS

Over the years, AIS, CRIS, ISS, PTS, TRISS, TRISSCAN, CRAMS, etc. scales were created abroad. [12, 13]. Another approach to determining treatment tactics in the late 90s was developed at the Department of

Military Field Surgery of the Military Medical Academy. S. M. Kirov, which was based on the study of the possibilities of optimizing the tactics of surgical treatment through the use of methods for objectively assessing the severity of injuries (HIH-SP, SG, SS) [1, 3, 4].

To determine the severity of the condition of the victim, the reasons for it, a diagnostic algorithm has been developed, an integral part of which is the scale for objective assessment of the severity of the condition of the victims upon admission to medical institutions - VPKh-SP [1, 5, 6].

In the resuscitation and intensive care unit, the IPH-SH scale is used to monitor the severity of the condition of the victims in the second period of traumatic disease - the period of relative stabilization of vital functions to determine indications for delayed operations. It allows you to monitor the condition of the victims in points at any time and distinguish three levels of condition: compensated, subcompensated and decompensated, outlined by quantitative boundaries [11].

In the second and third periods (the maximum likelihood of complications) during the periods of traumatic disease, multiple organ dysfunction develops, and then multiple organ failure of organs and systems of the body, which is a morphological substrate and functional basis for the development of severe infectious complications, up to sepsis [12].

Material and methods. In clinical conditions, 60 victims with trauma to the maxillofacial area as a result of a traffic accident were examined, including 43 men and 17 women aged 25 to 55 years (mean age 39.5 ± 3.6 years), who were admitted in critical condition to resuscitation and intensive care unit of the TMA multidisciplinary clinic. The victims were delivered within 2 hours from the moment of injury with traumatic shock of II-III degree (severity according to the APACHE-III scale ≈ 76 points), with an estimated blood loss of 1200-1500 ml (> 20% circulating blood volume (CBV)). An individual assessment of the amount of blood loss was carried out according to the sum of external and abdominal blood loss, taking into account the approximate blood loss in fractures. Criteria for inclusion of victims in the study program: age from 16 to 65 years, the presence of severe multiple (n = 21) or combined (n = 39) injuries of the maxillofacial area. Criteria for exclusion from the study: severe traumatic brain and/or abdominal trauma. Retrospectively, the patients were divided into 2 groups depending on the timing of surgical treatment of injuries to the chlo . Patients of the main (1st) group (23 men and 8 women) underwent early surgical treatment - within 1 day from the moment of injury. The comparison group (2nd) included the victims (20 men and 9 women), who underwent delayed surgical treatment - later than 3 days after the injury. The control group consisted of 20 practically healthy people aged 20-50 years. The characteristics of the examined patients are presented in Table 1.

Table 1.

Characteristics of the examined patients with a trauma to the penis at admission

Indicators	Main group (n = 31)	Comparison group (n = 29)	p-value
Age, years	38.8 ± 3.09	40.1 ± 4.18	0.216
Gender, m/f	23(8)	20 (9)	
The nature of the injury (n =, (%)): - combined, - multiple	20 (64.5%)11 (35.5%)	19 (65.5%)10 (34.5%)	
APACHE-III severity (points)	75.9 ± 12.1	77.1 ± 12.9	0.68
Volume of blood loss (l)	1.29 ± 0.200	1.15 ± 0.160	0.55
Heart rate, / min.	115.0 ± 6.20	110.0±5.80	0.59
BP cf.	65.0 ± 2.40	64.0 ± 2.56	0.28

Note: HR - heart rate; BP cf. - mean arterial pressure. APACHE III - (Acute physiology and Chronic Health Evaluation - assessment of acute physiological and chronic health, Knaus W., 1985).

The study was carried out in accordance with the ethical principles of the Declaration of Helsinki (World Medical Association Declaration of Helsinki – Ethical Principles for Medical Research Involving human Subjects , 2013) with the written consent of the patients to participate in the study (or their close relatives, in case of limited ability of the patient to communicate) and approved by the local ethical committee of the center. Venous blood parameters were examined at admission and on the 1st, 2nd, 3rd, 5th, 7th, 10th, 15th, and 21st days after injury. Hematological parameters were determined (the number of erythrocytes, platelets, hemoglobin concentration) on the analyzer " Sismex XT 4000i" (Japan). The ability of erythrocytes to aggregate was determined on a piezodynamic erythroaggregometer "Test-2"; the deformation ability of erythrocytes - viscometrically on a rotational viscometer at shear rates in the range from 10 to 200 s -1 . The ability of platelets to aggregate was determined on an aggregometer from BIO/DATA Corporation (USA). Fibrinogen concentration and prothrombin index (PTI) were determined in blood plasma using a STA COMPACT coagulometer (Stago , France). Determination of the spontaneous NBT-test (NBT- sp .) was carried out according to BN Park (1971) modified by A.N. Mayansky (1983), stimulated NST-test (NST-st.) according to RS Baechner (1968). Determination of bactericidal activity was carried out with the microbial culture of Staphylococcus aureus . Statistical processing of the obtained data was carried out using the IBM SPSS Statistics 20 software. The arithmetic mean value (M), the error of the arithmetic mean value (m) were calculated. The results were checked for normal distribution using the Kolmogorov-Smirnov test. In the

case when the law of distribution of the measured values could be considered normal, the differences between the groups were revealed using one-way analysis of variance followed by Tukey's multiple pairwise comparisons at an overall significance level of 0.05.

Results and discussion.

At the time of admission to the hospital of patients with trauma, there were no statistically significant differences in the severity of the condition, determined by the APACHE-III scale, between the groups (Table 1). The severity of the condition of patients with trauma to the forehead was clinically expressed by violations of systemic hemodynamics: their heart rate at the time of admission to the hospital was higher than the control data by 43% ($p < 0.05$), and the mean blood pressure was lower by 28% ($p < 0.05$). 05). These changes in the systemic circulation were due to blood loss (Table 1). As a result of blood loss , acute posthemorrhagic anemia developed in patients with chlo trauma : the number of erythrocytes (by 27%, $p < 0.05$) and hemoglobin (by 30%, $p < 0.05$) decreased, which is typical for victims with multiple and combined injuries of the penis . Despite compensation for blood loss, anemia increased, reaching a maximum on days 3-5 after injury, which, apparently, was due to hemodilution [5]. It has been established that in case of injuries with acute blood loss, the hemodilution phase develops later - by 5-8 days , instead of 1-2 days . after "clean" bleeding. Anemia persisted until the end of the observation period (day 21), probably as a result of a decrease in the plastic functions of the red bone marrow and an increase in erythrocyte hemolysis. By the 7th day of observation, the condition of patients in the main group improved significantly, which was confirmed by a decrease in the number of points on the APACHE-III scale to 44 ± 8.5. While in patients with delayed surgery for the musculoskeletal system during the same period of observation, the condition was more severe - the number of points on the APACHE-III scale was 60 ± 8.5 points.

Table 2.

Dynamics of changes in the index (J) and coefficient (K) of aggregation, and the deformability index (Id) of erythrocytes in patients with a trauma to the penis during early (I group, n = 31) and delayed (II group, n = 29) surgical treatment (M±m)

Observation period	Group	Aggregation index ($J \cdot 10^2$)	Aggregation coefficient ($K \cdot 10^2$)	Deformability index (Id)
Admission	Control	3.61 ± 0.190	1.44 ± 0.220	1.12 ± 0.003
	I	4.71 ± 0.170*	3.73 ± 0.220*	1.09 ± 0.008*
	II	4.72 ± 0.180*	3.7 ± 0.21*	1.09 ± 0.008*

1st day	I	4.34 ± 0.150*	2.21 ± 0.190*	1.11 ± 0.003*,**
	II	5.98 ± 0.150*,**	3.97 ± 0.210*,**	1.08 ± 0.004*
5th day	I	6.09 ± 0.220*	6.15 ± 0.200*	1.10 ± 0.007*
	II	6.97 ± 0.170*,**	6.64 ± 0.190*	1.06 ± 0.005*,**
7th day	I	6.86 ± 0.230*	5.02 ± 0.180*	1.11 ± 0.005
	II	7.3 ± 0.20*	7.18 ± 0.220*,**	1.08 ± 0.006*,**
10th day	I	5.04 ± 0.130*	3.45 ± 0.160*	1.11 ± 0.004*
	II	7.06 ± 0.180*,**	7.9 ± 0.23*,**	1.09 ± 0.006*,**
15th day	I	4.7 ± 0.13*	3.02 ± 0.160*	1.11 ± 0.006
	II	6.02 ± 0.170*,**	4.88 ± 0.170*,**	1.10 ± 0.007*
21st day	I	4.6 ± 0.15*	2.72 ± 0.150*	1.12 ± 0.008
	II	5.78 ± 0.200*,**	4.39 ± 0.200*,**	1.11 ± 0.005

Note: (*) - statistically significant differences according to Student's t-test in comparison with control values; (**) - between groups, at $p < 0.05$

The described violations of the aggregation and deformability of erythrocytes in patients of the comparison group could lead to impaired blood flow in the vessels of the microvasculature, aggravating hypoxia in certain organs and tissues and contributing to the development of local complications in these patients in the form of endobronchitis (19.6% of cases), osteomyelitis (7 .8% of cases), necrosis and bedsores (4.2% of cases), acute urethritis (3.9% of cases). In addition to local complications, in patients with trauma often developed pneumonia (23.5% of cases) and ARDS (23.5% of cases). The occurrence of such life-threatening complications in patients could be due to dysfunction of the immune system observed during trauma. member [9, 10]. At the same time, the total number of complications in the patients of the compared group was almost 3 times higher (50.1% versus 17.2% ($p < 0.05$)) than in patients of the main group. This, apparently, was due to a more pronounced dysfunction of the nonspecific link of immunity. This assumption was confirmed by a decrease in the functional activity of neutrophils in patients with delayed surgery. Thus, a study of the bactericidal activity of neutrophils (with a live culture of microorganisms) showed that if in victims with early surgical treatment, the bactericidal activity of neutrophils increased already upon their admission to the hospital (by 30%, $p < 0.05$) and continued to increase, with a maximum increase of 2 -th and 3rd day, then in patients with delayed surgery, this indicator increased for a short time, with a peak on the 1st day of observation. In addition, in patients of the 2nd group, the stimulated NBT-test (nitro blue recovery test) remained unchanged. tetrazolium) along with the positive dynamics of the spontaneous NBT test (Table 3).

Table 3.

Dynamics of bactericidal activity of neutrophilic granulocytes, NBT-spontaneous (NBT- sp .) and NBT-stimulated (NBT-st.) in patients with a trauma of the penis at early (I group, n = 28) and delayed (II group, n = 27) surgical treatment (M ± m)

Observation period	Group	Bactericidal activity, % killing of microbes	NST- sp . • 10^9	NST-st. • 10^9
Admission	Control	39.2 ± 0.89	0.14 ± 0.020	0.4 ± 0.03
	I	51.1 ± 0.90*	0.19 ± 0.030	0.42 ± 0.090
	II	51.9 ± 0.80*	0.189 ± 0.0200	0.41 ± 0.080
1st day	I	57.3 ± 1.10*	0.27 ± 0.050*	0.56 ± 0.050*
	II	56.4 ± 1.20*	0.26 ± 0.030*	0.4 ± 0.03**
2nd day	I	64.3 ± 1.30*	0.34 ± 0.040*	0.58 ± 0.060*
	II	46.3 ± 1.30*,**	0.24 ± 0.020*,**	0.42 ± 0.040**
3rd day	I	66.1 ± 1.50*	0.29 ± 0.020*	0.57 ± 0.050*
	II	40.4 ± 1.70*,**	0.22 ± 0.020*,**	0.44 ± 0.030**
5th day	I	55.2 ± 1.04*	0.26 ± 0.020*	0.49 ± 0.030*
	II	42.1 ± 1.30*,**	0.20 ± 0.020*,**	0.48 ± 0.020*
7th day	I	53.3 ± 1.10*	0.17 ± 0.010	0.49 ± 0.020*
	II	31.3 ± 0.92*,**	0.19 ± 0.020	0.44 ± 0.030
10th day	I	45.3 ± 0.99*	0.16 ± 0.010	0.48 ± 0.010*
	II	30.4 ± 0.99*,**	0.16 ± 0.040	0.36 ± 0.040**
15th day	I	42.5 ± 0.97*	0.15 ± 0.030	0.42 ± 0.030
	II	34.2 ± 1.20*,**	0.15 ± 0.020	0.42 ± 0.040
21st day	I	40.1 ± 0.98	0.14 ± 0.030	0.40 ± 0.050
	II	36.1 ± 0.99*,**	0.15 ± 0.020	0.40 ± 0.030

Note: (*) - statistically significant differences according to Student's t-test in comparison with control values; (**) - between groups, at p < 0.05

The decrease in neutrophil activity in patients with delayed surgery seems to be associated with the likelihood of progression of their systemic inflammatory response. Key cells in the development of the process of systemic inflammatory response are macrophages, which secrete cytokines, mainly tumor necrosis factor (TNF-α), IL-1 and IL-6. In the dynamics of traumatic disease, a strong correlation is revealed between the indices of cytokines and hemocoagulation . In this regard, we studied the dynamics of the hemostasis system in patients with polytrauma .

Patients with polytrauma developed hypercoagulability . It is known that with an injury in the hemostasis system, 2 consecutive phases are noted: short-term - immediately after the injury - hypocoagulation and longer subsequent hypercoagulation . An increase in the prothrombin index (PTI), observed up to the 10th day of observation, indicated an increase in blood coagulation, namely, activation of the external pathway of the hemostasis system. At the same time, in patients of the comparison group, blood hypercoagulation was more pronounced than in patients of the main group, which characterized higher numbers of PTI during this observation period (Table 4).

Table 4.

Dynamics of PTI, the amount of fibrinogen and platelets, platelet aggregation ability (when using inducers: ADP, adrenaline, ristomycin) in the blood of patients with pelvic trauma in early (group I, n = 31) and delayed (group II, n = 29)) surgical treatment (M ± m)

Observation period	Group	Indicator / Value					
		PTI (%)	Fibrinogen (g/l)	Platelet count (• 10^{11} /l)	Platelet aggregation		
					ADP	Adrenalin	Ristomycin
Admission	Control	90.5 ± 1.66	2.89 ± 0.230	232.7 ± 5.57	60.7 ± 2.31	56.99 ± 2.980	65.7 ± 2.30
	I	95.5 ± 1.29*	2.41 ± 0.400	206.6 ± 7.22*	66.5 ± 3.69	60.8 ± 2.98	69.4 ± 2.34
	II	96.2 ± 1.89*	2.28 ± 0.310	202.9 ± 6.07*	67.1 ± 3.12	61.99 ± 2.130	69.9 ± 2.04*
1st day	I	96.7 ± 1.39*	3.81 ± 0.230*	162.3 ± 5.25*	64.1 ± 3.31	64.8 ± 3.18	65.1 ± 3.70
	II	112.4 ± 2.55*,**	4.27 ± 0.350*	199.6 ± 13.71*,**	67.5 ± 3.50	65.9 ± 3.12*	66.5 ± 2.13

2nd day	I	99.2 ± 1.87*	7.05 ± 0.420*	140.1 ± 3.24*	70.9 ± 3.21*	67.4 ± 3.05*	66.5 ± 3.17
	II	111.7 ± 2.83*,**	6.84 ± 0.650*	188.7 ± 16.05*,**	70.99 ± 2.320*	65.4 ± 2.50*	67.8 ± 2.59
3rd day	I	105.4 ± 1.60*	7.87 ± 0.530*	161.9 ± 3.84*	69.1 ± 2.18*	65.4 ± 2.71*	78.9 ± 2.11*
	II	106.5 ± 2.85*	7.74 ± 0.660*	164.8 ± 12.10*	70.8 ± 2.34*	66.3 ± 2.51*	72.8 ± 2.12*,**
5th day	I	102.8 ± 1.79*	9.21 ± 0.650*	203.1 ± 9.94*	62.5 ± 2.56	71.2 ± 2.73*	72.1 ± 2.16*
	II	107.4 ± 2.29*	9.07 ± 0.600*	186.2 ± 12.09*	75.2 ± 2.16*,**	79.9 ± 3.14*,**	77.8 ± 2.21*
7th day	I	101.3 ± 1.72*	8.37 ± 0.650*	244.9 ± 9.04	62.0 ± 3.15	69.1 ± 2.40*	66.9 ± 2.64
	II	102.4 ± 2.09*	8.77 ± 0.320*	245.6 ± 8.86	74.7 ± 2.61*,**	78.4 ± 2.01*,**	78.6 ± 2.23*,**
10th day	I	95.8 ± 1.91*	7.61 ± 0.52*	364.2 ± 14.96*	61.5 ± 2.64	69.3 ± 2.16*	66.2 ± 2.64
	II	102.5 ± 1.42*,**	7.93 ± 0.69*	329.1 ± 12.11*	72.7 ± 2.19*,**	74.8 ± 2.86*,**	78.4 ± 2.88*,**
15th day	I	94.6 ± 2.21	6.99 ± 0.600*	380.5 ± 13.29*	61.7 ± 2.82	64.5 ± 2.18*	66.4 ± 2.09
	II	100.1 ± 2.20*	6.99 ± 0.550*	380.3 ± 14.49*	69.8 ± 2.22*,**	71.6 ± 2.17*,**	78.1 ± 3.09*,**
21st day	I	91.3 ± 1.89	6.77 ± 0.40*	328.0 ± 6.59*	60.4 ± 1.64	57.7 ± 2.07	65.5 ± 1.96
	II	95.5 ± 1.44*	7.09 ± 1.23*	368.0 ± 9.14*,**	61.9 ± 1.55	64.3 ± 1.71*,**	72.0 ± 2.99

Note : (*) - statistically significant differences according to Student's t-test in comparison with control values; (**) - between groups, at $p < 0.05$

An important factor in hypercoagulability is an increase in the amount of fibrinogen in the blood. In patients with a trauma, the level of fibrinogen increased from the first day of observation and reached its maximum values on days 5-7 (by 3.7 times, $p < 0.001$), without significant differences between groups throughout the entire observation period (Table 1). 4). Thrombocytopenia (platelet count decreased by 11%, $p < 0.05$), which was observed in patients with trauma chlo within 5 days was

probably due to hemodilution. Along with this, there was an increase in the aggregation ability of platelets when using various inducers (ADP, adrenaline, ristomycin), more pronounced in patients with delayed surgical treatment. Thus, when ADP was used as an inducer in patients of the 2nd group, platelet aggregation was higher from days 5 to 15, adrenaline - from days 5 to 21, ristomycin - from days 7 to 15 . day of the study (Table 4). More significant disorders in the hemostasis system in patients with delayed surgical treatment of musculoskeletal injuries could be the cause of microcirculation disorders. In turn, microcirculatory disorders exacerbate tissue hypoxia, that is, a “vicious circle” is turned on, which ultimately can affect the repair processes and the occurrence of various complications.

CONCLUSION

In case of injury However, acute posthemorrhagic anemia develops, which, in the case of delayed surgical treatment of facial skeleton injuries, is accompanied by a more pronounced, compared with early surgical treatment, violation of the deformability of erythrocytes with an increase in their ability to aggregate, which indicates a change in membrane stability and a deterioration in the gas transport function of these cells. Early operation of injuries in chlo injury improves the functional state of erythrocytes and platelets, hemodynamic parameters and the general condition of patients. The functional activity of neutrophilic granulocytes during early surgical treatment is characterized by an increase in their bactericidal activity, which probably causes an increase in the body's antimicrobial resistance and is reflected in fewer complications.

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