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ORIGINAL ARTICLE
ОРИГИНАЛЬНАЯ СТАТЬЯ

Trace elements content in the hair of patients at the maxillofacial surgery department

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Abstract. *Relevance.* The urgency of the problem of traumatism is constantly increasing, which is associated with an increase in road accidents, an increase in the number of interpersonal conflicts, the availability of firearms and cold steel weapon, etc. In addition, the proportion of victims with injuries of the maxillofacial region in a state of alcoholic intoxication is constantly growing. *The aim* of the study is to conduct a comparative analysis of trace elements in hospitalized patients with maxillofacial trauma, intoxicated, acute traumatic stress and the study of the effect of trauma on the balance of trace elements in patients of the Department of Maxillofacial Surgery with various alcohol history. *Materials and Methods.* The study involved 30 male patients of the department of maxillofacial surgery of the Moscow «city clinical F.I. Inozemtseva hospital located in the city of Moscow. All patients were joined to the department for trauma of the maxillofacial tract and were divided into two groups: 15 of them regularly took alcohol and were in a state of alcoholic intoxication at the time of injury (group 1), 15 — without alcohol history (comparison group 2). All patients carried a general clinical blood test, a biochemical blood test, and the content of essential and conditionally essential elements in the hair were also determined. *Results and Discussion.* As a result, significant differences were revealed in the content of micro elements between the groups of patients: the content of copper ($p = 0.013$) and zinc ($p = 0.000$) in the hair examined of the first group was 1.4 lower than in the comparison group 2. The manganese content ($p = 0.05$), on the contrary, was also increased by 1.4 times in the hair of group 1 patients. Besides, leukocytosis was detected in the blood in patients with a history of alcohol and an increase in AST levels. *Conclusion.* The study showed an increase in the content of manganese and a decrease in the content of selenium, zinc and copper in the hair of patients with an alcoholic history. Diselementosis was accompanied by a significant increase in aspartate aminotransferase activity, as well as leukocytosis and lymphocytosis. Such an imbalance of chemical elements, together with a changes of peripheral blood and an increase in the activity of ASaT, can be reflected on the period the timing and peculiarities of the course of the reparative process.

Key words: traumatic stress, alcohol, trace elements

Author contributions. The authors made an equal contribution to the preparation of the manuscript.

Conflict of interest statement. The authors declare no conflict of interest.

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Introduction

In the city of Moscow, thousands of people are daily victims of interpersonal violence and are involved in road traffic accidents, generating high emotional and social costs. Head, neck and face trauma is one of the most common etiological factors of facial trauma.

Acute traumatic stress (traumatic depression) is a type of anxiety disorder that usually develops as a result of life-threatening physical or mental events [1, 2]. ATS lasts two days after the onset of a critical event and smoothly turns into acute stress disorder, which can last up to one month [3].

The aim of the study was to conduct a comparative analysis of micronutrients (for levels of magnesium, calcium, sodium, potassium, phosphorus, selenium, zinc and chromium) of hospitalized patients with maxillofacial trauma in a state of alcohol intoxication, acute traumatic stress and to study the effect of trauma to the balance of microelements, mechanisms of changes in the concentration of microelements, influencing the occurrence of side effects [4, 5, 6].

Maxillofacial injuries constitute a significant part of the total number of patients in a surgical hospital. The urgency of the problem of injuries is constantly increasing, which is associated with an increase in the number of road accidents, an increase in the number of interpersonal conflicts against the background of socio-economic instability, the availability of firearms and cold steel weapons, etc [7, 8]. Besides, the proportion of victims with injuries of the maxillofacial tract in a state of alcoholic intoxication is constantly growing [9, 10]. Alcohol dependence is accompanied by disturbances in the normal functioning of various systems of the human body, which can lead to a greater number of complications, an increase in fatal nature, even with the optimal tactics of surgical help [11—13]. With the systematic abuse of alcoholic drinks, the reparative process in the break line is more often complicated by a prolonged course and a complicated inflammatory process with a manifestation of the failure of regenerative processes. The situation is further complicated by the fact that the overwhelming number of injured patients belong to the able-bodied part of the population (from 25 to 40 years old), which makes the problem not only medical, but also socio-economic [14].

Despite numerous studies of domestic and foreign scientists on the period of reparative processes and the factors influencing them, there is not enough data on the microelement status of patients with maxillofacial injuries [15, 16]. In this regard, the aim of our study was to study the content of essential and conditionally essential elements in patients' hair of the department of maxillofacial surgery with various alcohol histories.

Materials and methods

The study involved 30 patients of the department of maxillofacial surgery of the F.I. Inozemtseva hospital, located in the city of Moscow. All surveyed were males, the average age of the respondents was 30.7 years. All patients were joined to the department for trauma to the maxillofacial area and provided informed voluntary consent to participate in the study and personal data processing according to the Helsinki Declaration of the World Medical Association (WMA Declaration of Helsinki — Ethical Principles for Medical Research Involving Human Subjects, 2013). The examined patients were divided into two groups: 15 of them regularly took alcohol and were in a state of alcoholic intoxication at the time of injury (group 1), 15 had no alcohol history (comparison group 2).

All patients carried out a general clinical blood test, a biochemical blood test, and the content of essential and conditionally essential elements in the hair was also determined. Hematological and biochemical blood tests were carried out using standard methods in the laboratory of the hospital named F.I. Inozemtseva.

The analysis of the studied samples (hair) was carried out in the laboratory of ANO «Center for Biotic Medicine», Moscow (certificate of accreditation GSEN.RU.Ts.O.A.311, registration number in the state register ROSS R.U.001. 513118 from 29.05.2003). The determination of the content of chemical elements in the hair was carried out by atomic emission and mass spectrometry using an Elan 9000 mass spectrometer (PerkinElmer, USA) and an Optima 2000 V atomic emission spectrometer (PerkinElmer, USA).

The obtained material was processed using generally accepted statistical methods using an Excel spreadsheet editor from the Microsoft Office XP package. Descriptive statistics parameters for quantitative indicators are given as median (Me) and interquartile latitude (25th; 75th percentile — Q1; Q3). The statistical data were visualized using the Pylab procedural interface for the Matplotlib (Python) library.

Results and discussion

As a result of the study, we obtained the following data. So, in the general clinical analysis of blood, statistically significant differences between the two groups were found for leukocytes and lymphocytes (Table 1). Their number was 1.1 (p = 0.049) and 1.4 (p = 0.022) times higher, respectively, in the first group of patients. The number of leukocytes in the 1st group of the examined exceeded the reference values of this indicator (4.0–9.0 cells/l *109), while the number of lymphocytes was within the reference values (1.2–3.0 cells/l*109).

Table 1

Indicators of clinical blood analysis of patients, Me (Q1 — Q3)

Index	1 st group	comparison group 2	p
Hemoglobin g/l	150.000 (130.000–159.000)	148.000 (143.000–151.000)	0.602
Erythrocytes cells/l *10^{12}	5.000 (4.400–5.240)	4.890 (4.470–5.120)	0.928
Hematocrit, %	43.800 (42.300–45.800)	45.400 (43.300–47.300)	0.377
Platelets cells/l *10^{9}	229.000 (215.000–300.000)	224.000 (204.000–270.000)	0.717
Leukocytes cells/l *10^{9}	9.900 (6.600–13.800)	8.700 (7.800–12.800)	0.049
Monocytes cells/l *10^{9}	0.600 (0.400–0.800)	0.500 (0.400–0.700)	0.600
Lymphocytes cells/l *10^{9}	1.900 (1.800–1.930)	1.400 (1.100–1.760)	0.022
Neutrophils cells/ l *10^{9}	7.200 (4.000–10.400)	6.700 (5.600–9.500)	0.928
Basophils cells/l *10^{9}	0.000 (0.000–0.050)	0.090 (0.000–0.100)	0.196
Eosinophils cells/l *10^{9}	0.100(0.000–0.200)	0.100 (0.000–0.190)	0.888

When studying the parameters of the biochemical blood test of patients, statistically significant differences were received for aspartate aminotransferase (Table 2). Its number was 2.8 times higher (p = 0.001) in the group of patients veined to the hospital in a state of alcoholic intoxication.

Table 2

Indicators of biochemical analysis of patients' blood, Me (Q1 — Q3)

Index	1 st group	comparison group 2	p
Total protein g/l	70.900 (0.000–74.000)	69.400 (58.300–73.400)	0.909
AST unit/l	68.000 (60.000–84.000)	24.000 (19.000–36.000)	0.001
Total bilirubin μmol/l	10.800 (9.600–16.700)	15.300 (9.700–18.700)	0.526
Urea μmol/l	4.620 (2.300–5.260)	4.110 (2.760–5.300)	0.777
Creatinine μmol/L	80.000 (76.000–89.100)	86.000 (76.900–97.400)	0.511
Glucose mmol/l	5.130 (4.950–5.610)	5.490 (4.430–6.390)	0.667

The next stage of our study was to study the content of essential and conditionally essential elements in the of patients' hair (Table 3).

The number of the majority of essential and conditionally essential elements in the of patients' hair with an alcoholic history was within the average Russian values. However, significant differences in the number of elements between the patient groups were obtained for copper, manganese and zinc. Thus, the number of copper (p = 0.013) and zinc (p = 0.000) in the hair of the examined first group was 1.4 lower than in the comparison group 2. The manganese number (p = 0.05), on the contrary, was also increased by 1.4 times in patients' hair of group 1.

Table 3

The number of essential and conditionally essential elements in the hair of the examined patients, Me (Q1 — Q3)

	Central Russian meaning	1 st group	comparison group 2	p
As	0.00–0.56	0.088 (0.056–0.147)	0.065 (0.045–0.103)	0.204
B	0.00–5	1.150 (0.913–1.580)	1.160 (0.719–1.330)	0.892
Co	0.04–0.16	0.010 (0.010–0.016)	0.018 (0.015–0.027)	0.051
Cr	0.32–0.96	0.772 (0.675–1.520)	0.678 (0.506–0.847)	0.094
Cu	9,0–14,0	10.42 (9.81–12.10)	14.76 (12.47–16.21)	0.013
Fe	11,0–24,0	19.46 (14.53–23.18)	24.16 (19.40–35.17)	0.148
I	ref 0,27–4,2	0.653 (0.346–1.450)	0.774 (0.586–1.350)	0.634
Li	0,00–0,02	0.033 (0.025–0.052)	0.033 (0.025–0.045)	0.751
Mn	0,32–1,13	0.993 (0.438–1.670)	0.695 (0.481–0.930)	0.050
Ni	0,14–0,53	0.179 (0.156–0.277)	0.258 (0.190–0.339)	0.175
Se	0,69–2,20	0.372 (0.313–0.423)	0.314 (0.231–0.389)	0.189
Si	11,0–37,0	26.55 (25.10–31.15)	32.60 (25.90–36.96)	0.415
Sn	ref 0,05–1,5	0.180 (0.106–0.186)	0.151 (0.092–0.298)	0.982
V	ref 0,005–0,5	0.144 (0.137–0.292)	0.146 (0.097–0.184)	0.238
Zn	155,0–206,0	160.7 (119.3–171.5)	232.1 (201.9–290.2)	0.000

Note: 1 — reference values (Bertram P., 1992; Skalny A.V., 2000)

The number of the majority of essential and conditionally essential elements in the of patients' hair with an alcoholic history was within the average Russian values. However, significant differences in the number of elements between the patient groups were obtained for copper, manganese and zinc. Thus, the number of copper (p = 0.013) and zinc (p = 0.000) in the hair of the examined first group was 1.4 lower than in the comparison group 2. The manganese number (p = 0.05), on the contrary, was also increased by 1.4 times in patients' hair of group 1.

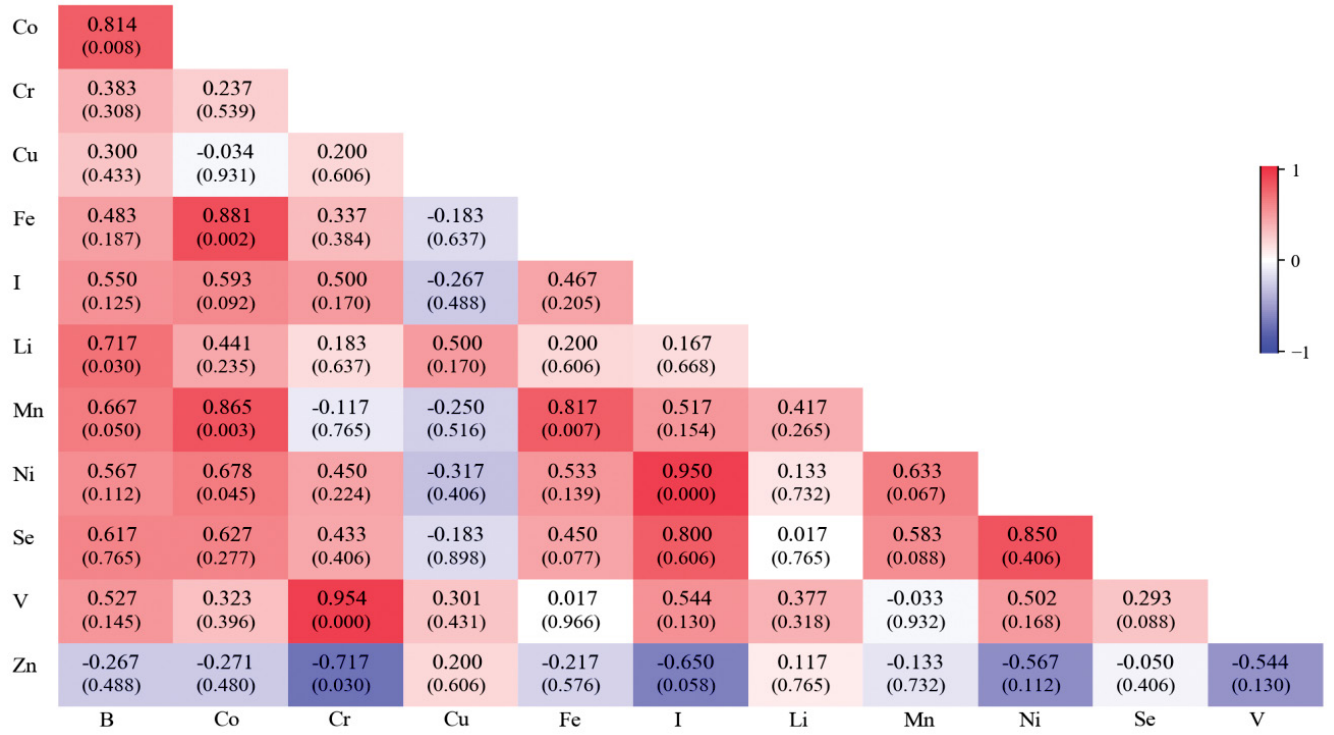

Fig. 1. Correlation matrix of mean values of the number of trace elements in the of patients' hair of group 1

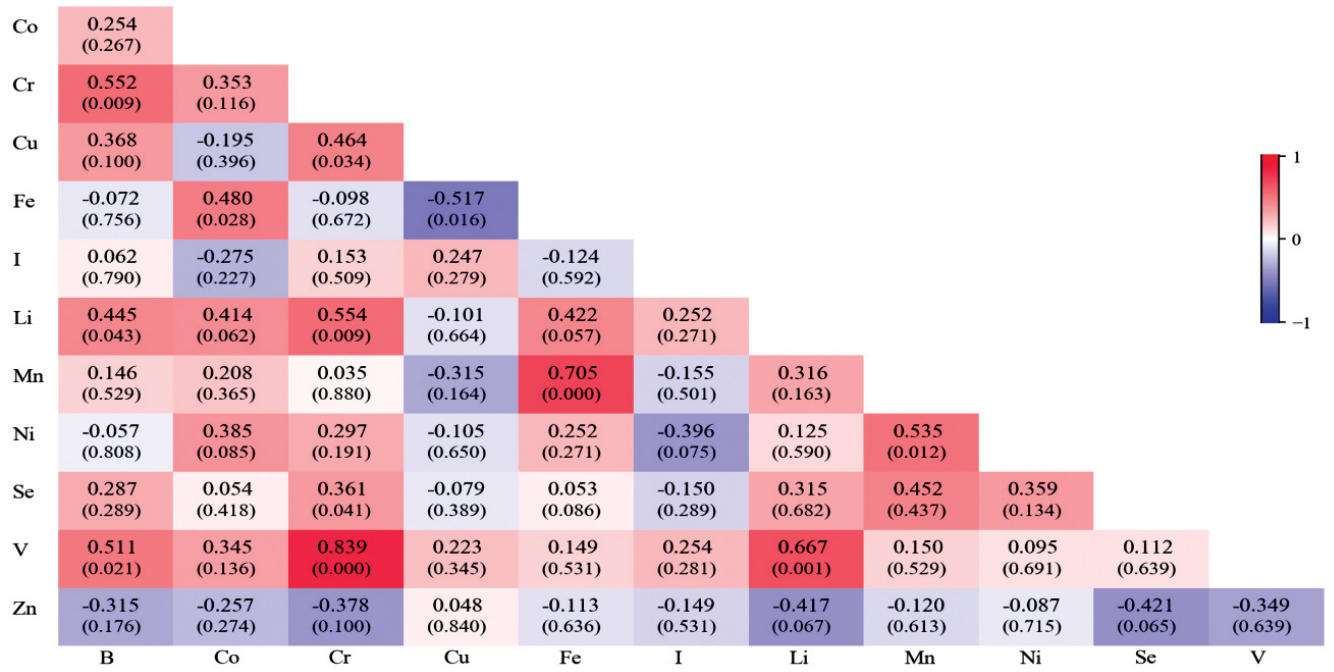

Fig. 2. Correlation matrix of middy values of the content of trace elements in the of patients' hair in the comparison group 2

It is known that chronic alcohol intoxication changes the levels of the main micro- and macroelements, which leads to a significant number of metabolic disorders [17]. Chronic alcohol use breaks zinc homeostasis, lowering its serum concentration by more than 25 % compared to healthy people [18, 19]. Alcohol-caused modulation of zinc transporters has been shown to reduce zinc levels in the lungs, liver, intestines and brain. Deficiency of zinc in the intestine leads to increased permeability of the intestinal wall, which ultimately leads to endotoxemia and systemic inflammation [20]. All this can affect the rate of reparative processes in various injuries. In addition, the data available in the literature indicate that the use of zinc preparations in the complex drug therapy of patients with break of the maxillofacial region who abuse alcohol is quite effective [21].

Attention is drawn to the decrease in the selenium number in the hair of the examined. It has been shown that selenium deficiency has a negative effect on physiological and reparative osteogenesis, manifested by impaired formation of bone regeneration, deterioration of the structural and functional state of bone tissue, the development of degenerative-necrotic changes in bone tissue and epiphyseal cartilage.

After conducting inter-element correlation analysis in each group of patients, we obtained the following data (Fig. 1, 2).

In the group of patients with an alcoholic history, 12 interelement relationships were identified: Co-B, Li-B, Mn-B, Fe-Co, Mn-Co, Ni-Co, V–Cr, Zn-Cr, Mn-Fe, Ni-I, Sn-I and Sn-Ni.

In the patients of the comparison group 2, 12 statistically significant relationships were also revealed: Cr-B, Li-B, V-B, Fe-Co, Cu-Cr, Li-Cr, V–Cr, Fe-Cu, V–Li, Ni- Mn, Sn-Mn. However, the correlations in this group were much weaker than in the group of patients with maxillofacial trauma who regularly took alcohol.

Our findings are consistent with previous studies. For example, Cezary Grochowski analyzed the interactions between seven trace elements (zinc, selenium, manganese, iron, copper, chromium, and cobalt) in the brain of alcohol abusers and people without an alcohol history. The number of correlations was greater, and their strength was stronger in the group of patients with alcohol history.

Conclusion

In the course of the study, an increase in the content of manganese and a decrease in the content of selenium, zinc and copper were found in the hair of patients who consume alcohol. These elements mediate vital biochemical reactions, acting as cofactors for many enzymes, and also act as stabilizing centers for enzyme and protein structures. Diselementosis was accompanied by a significant increase in aspartate aminotransferase activity, as well as leukocytosis and lymphocytosis. Such an imbalance of chemical elements, in conjunction with a changed picture of peripheral blood and an increase in the activity of ASaT, can affect the timing and characteristics of the course of the reparative process.

As strategic proposals for solving such problems, the following can be noted:

– creation (reconstruction and development) of a resource base for the food and pharmaceutical industries;

– creation and production of adapted preparations for nutraceuticals and pharmaceutical correction of deficiency / excess of trace elements (based on physiological, regional requirements);

– formation of a range of food products for the conducting of information policy on the problem of «functional foods and 220 essential trace elements for human health»;

– consideration of proposals for inclusion in the regional program for monitoring the elemental state of the population, forming a scientific and methodological base for monitoring the elemental status of the population and correcting deviations, forming a joint supply of fortification ingredients for regional producers of products for social and mass food in accordance with the monitoring results;

– carrying out the integration of scientific research, considering the study of an interdisciplinary approach and a bioelementological approach, providing people with «blocks of life», including basic micronutrients as simple primary bio elements that provide real personalized nutrition and therapy in the process of recovery from injuries.

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Содержание микроэлементов в волосах пациентов отделения челюстно-лицевой хирургии

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Аннотация. *Актуальность* проблемы травматизма постоянно возрастает, что связано с ростом дорожно-транспортных происшествий, увеличением числа межличностных конфликтов, доступностью огнестрельного и холодного оружия и т.д., Кроме того, удельный вес пострадавших с травмами челюстно-лицевой области в состоянии алкогольного опьянения постоянно растет. *Целью* исследования явился сравнительный анализ микроэлементов госпитализированных пациентов с челюстно-лицевой травмой, находящихся в состоянии алкогольного опьянения, острого травматического стресса, и изучение влияния травмы на баланс микроэлементов у пациентов отделения челюстно-лицевой хирургии с различным алкогольным анамнезом. *Материалы и методы.* В исследовании приняли участие 30 пациентов мужского пола отделения челюстно-лицевой хирургии ГБУ здравоохранения города Москвы «Городская клиническая больница им. Ф.И. Иноземцева», расположенной в городе Москве. Все пациенты поступили в отделение по поводу травмы челюстно-лицевой области и были разделены на две группы: 15 из них систематически употребляли алкоголь и находились в состоянии алкогольного опьянения в момент получения травмы (1 группа), 15 — без алкогольного анамнеза (группа сравнения 2). Всем пациентам был проведен общий клинический анализ крови, биохимический анализ крови, а также определялось содержание эссенциальных и условно эссенциальных элементов в волосах. *Результаты и обсуждение.* В результате были выявлены достоверные отличия в содержании микроэлементов между группами пациентов: содержание меди ($p=0.013$) и цинка ($p=0.000$) в волосах обследованных первой группы было ниже в 1,4 по сравнению с группой сравнения

2. Содержание марганца (p=0.05), наоборот, оказалось повышенным в волосах пациентов 1 группы также в 1,4 раза. Кроме того, у пациентов с алкогольным анамнезом в крови был выявлен лейкоцитоз и повышение уровня АСТ. *Выводы.* Проведенное исследование показало повышение содержания марганца и снижение содержания селена, цинка и меди в волосах пациентов с алкогольным анамнезом. Дисэлементоз сопровождался достоверным повышением активности аспартатаминотрансферазы, а также лейкоцитозом и лимфоцитозом. Подобный дисбаланс химических элементов, в совокупности с изменением состава периферической крови и увеличением активности АСаТ, может отразиться на сроках и особенностях протекания репаративного процесса.

Ключевые слова: травматический стресс, алкоголь, микроэлементы

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