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თანამშრომლობითა და მისი პატრონაჟით

ЕЖЕМЕСЯЧНЫЙ НАУЧНЫЙ ЖУРНАЛ

ТБИЛИСИ - НЬЮ-ЙОРК

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Содержание:

Kuzmenko V., Usenko A., Skums A., Gulko O., Tedoradze V.
PERIOPERATIVE MULTIMODAL PROGRAM OF ENHANCED RECOVERY
FOLLOWING PANCREATICODUODENECTOMY 7

Grigorova A., Grigorov S.
METABOLIC, ENZYMATIC AND MINERAL MAINTENANCE OFREPARATIVE OSTEOGENESIS 12
OF FACIAL CRANIUM INJURIES

Oniani B., Beselia K., Shaburishvili T., Shaburishvili N., Megreladze I.
COMPARISON OF EARLY POST-OPERATIVE PERIOD OF ENDO-ACAB WITH OFF-PUMP CABG:
RETROSPECTIVE STUDY CONDUCTED AT TBILISI HEART AND VASCULAR CLINIC 17

Munjishvili V., Barabadze E., Musashvili T., Gachechiladze M., Burkadze G.
MORPHOPHENOTYPIC CHARACTERISTICS OF OVARIAN SEROUS BORDERLINE TUMORS 20

Asanidze E., Kristesashvili J., Andguladze S.
CORRELATION BETWEEN LEVELS OF HOMOCYSTEINE, ANTI-MULLERIAN HORMONE
AND INSULIN RESISTANCE IN PCOS PATIENTS WITH RECURRENT PREGNANCY LOSS 25

Khetsuriani-Millischer T., Nabi A.
SOME PATHOLOGIES OF THE UMBILICAL CORD AND THEIR ROLE
IN PERINATAL COMPLICATIONS (CASE REPORT) 30

Abdullaiev R., Pavlov S., Kulikova F., Sibihankulov A., Medvediev M., Larionova I., Aleksenko O.
ULTRASOUND DIAGNOSTICS OF CERVICAL CHANGES WITH DIFFERENT LOCALIZATION
OF THE CERVICITIS IN WOMEN WITH THE ECTOPY OF THE VAGINAL PORTION OF THE CERVIX 32

Shchehlov D., Bortnik I., Svyrydiuk O., Vyval M., Gunia D.
CEREBRAL ARTERIOVENOUS MALFORMATION WITH PARANIDAL ANEURYSMS. CLINICAL COURSE
AND OUTCOME AFTER ENDOVASCULAR EMBOLIZATION 38

Квезерели-Копадзе М.А., Мтварелидзе З.Г.
СИНДРОМ ИМЕРСЛУНД-ГРЕСБЕКА - НАСЛЕДСТВЕННАЯ ФОРМА
ВИТАМИН B_{12} –ДЕФИЦИТНОЙ АНЕМИИ 45

Слуцкая Т.В., Овчаренко Л.С., Вертегел А.А., Кряжев А.В., Самохин И.В.
СОДЕРЖАНИЕ СУБСТАНЦИИ Р, ЭНДОТЕЛИНА-1 И ВАЗОАКТИВНОГО ИНТЕСТИНАЛЬНОГО ПЕПТИДА
В СЫВОРОТКЕ КРОВИ ДЕТЕЙ С РЕКУРРЕНТНЫМИ БРОНХИТАМИ
И ВЕРТЕБРОБАЗИЛЯРНОЙ НЕДОСТАТОЧНОСТЬЮ 48

Koval S., Snihurska I., Yushko K., Lytvynova O., Berezin A.
PLASMA microRNA-133a LEVEL IN PATIENTS WITH ESSENTIAL ARTERIAL HYPERTENSION 52

Gotsadze M., Narsia N., Momtselidze N., Mantskava M.
MONITORING OF HEMORHEOLOGICAL PARAMETERS IN PATIENTS
WITH ATRIAL FIBRILLATION (INITIAL DATA) 59

Ivanov V., Iuzvyshyna O., Baranova O., Shchepina N., Savitska Y.
GENDER DIFFERENCES OF STRUCTURAL AND FUNCTIONAL CHANGES, AND LEFT VENTRICULAR
MYOCARDIAL REMODELING IN PATIENTS WITH AORTIC VALVE CALCIFICATION 63

Zubchenko S., Maruniak S., Yuriev S., Sharikadze O.
PECULIARITIES OF MIR-146A AND MIR-155 EXPRESSION IN PATIENTS
WITH ALLERGOPATHY IN COMBINATION WITH CHRONIC EPSTEIN-BARR VIRUS INFECTION
IN LATENT AND ACTIVE PHASES 69

Moroz L., Soni S., Dudnyk V., Zaichko N.
PREDICTIVE VALUE OF SERUM IL-17A AND IP-10 FOR EVALUATION
OF LIVER FIBROSIS PROGRESSION IN PATIENTS WITH HBV/HIV CO-INFECTION 73

Kozishkurt O., Babienko V., Golubyatnikov M., Amvrosieva T., Maksymenko Yu., Savchuk A.
MODERN ETIOLOGICAL STRUCTURE OF ACUTE GASTROENTEROCOLITIS
IN THE SOUTHERN UKRAINE 77

ჯირკვლის თავის და პრეამპულური ზონის დაავადებით 2003 წლიდან 2017 წ. პერიოდში. შედარებითი ანალიზის მიზნით პაციენტები გაყოფილი იყო 2 ჯგუფად: I ჯგუფი - 39 პაციენტი -2015-2017 წწ., რომელთა პერიოპერაციული მკურნალობა ჩატარდა დაჩქარებული აღდგენითი პროგრამის შესაბამისად; II ჯგუფი – 29 პაციენტი, 2003-1014 წწ., რომელთა მკურნალობა ტარდებოდა ტრადიციული მეთოდით. ჩესწავლილი იყო პერორალური კვების აღდგენის ვადები, ოპერაციისშემდგომი გართულებების სიხშირე და ხასიათი და სტაციონარული მკურნალობის ვადები.

გამოვლინდა, რომ გართულებათა საერთო სიხშირე Clavien-Dindo კლასიფიკაციის მიხედვით პაციენტების I ჯგუფში უფრო ნაკლებია შედარებით II ჯგუფთან - 10 (26.5%) და 18 (46,1%), p=0,029. პაციენტების I ჯგუფში აღინიშნა გასტროსტაზის უფრო დაბალი სიხშირე ვიდრე II ჯგუფში - 6 (15,4%) და 14 (35,9%), შესაბამისად, p=0,009. პანკრეატული ფისტულის (პფ) ფორმირების სიხშირე ორივე ჯგუფში მნიშვნელოვნად არ განსხვავდებიდა - 4 (10,2%) პაციენტი და 5 (12,8%), შესაბამისად (p=0,036). I ჯგუფში დარეგისტრირდა ინფექციური გართულებების განვითარების სიხშირის შემცირება შედარებით II ჯგუფთან - 2 (5,1%) პაციენტი 7 (17,9%), შესაბამისად, p=0,031. I ჯგუფის პაციენტების სტაციონარში ყოფნის ხანგრძლივობა ბევრად უფრო მცირე იყო შედარებით II ჯგუფთან - 14 დღე 95% CI: [13, 17] და 18 დღე, 95% CI: [16, 18], p=0,012. ლეტალური შემთხვევები არ აღინიშნა.

დაჩქარებული აღდგენის პროგრამის გამოყენება პრდ-ის დროს საშუალებას იძლევა შემცირდეს ოპერაციისშემდგომი გართულებების რაოდენობა და პაციენტების სტაციონარში ყოფნის ხანგრძლივობა.

METABOLIC, ENZYMATIC AND MINERAL MAINTENANCE OFREPARATIVE OSTEOGENESIS OF FACIAL CRANIUM INJURIES

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The features of reparative osteogenesis in patients with injuries of facial cranium (IFC), in particular in the case of complicated course, are insufficiently studied, and the main areas of research are focused on the improvement of therapeutic tactics by immunotropic therapy and surgical method [1,2]. At the same time, the study of the structural and functional mechanisms of formation of bone tissue (BT) may be the basis for the improvement of treatment and clinical monitoring with the computation of other risk factors [3]. The rate of formation or destruction of the matrix of BT can be assessed either by changing the activity of specific enzymes of bone–forming or bone–destroying cells (alkaline and acid phosphatase), or by determining the metabolic components that enter to blood flow during bone formation. Despite the fact that these indicators are divided into markers of synthesis and resorption, it should be considered, that in conditions of the pathological process, when the processes of bone metabolism transformation are qualitatively and quantitatively changed, each of these markers may be informative to predict the complicated course of IFC and, respectively, for differentiated correction of disorders – prevention [4].

Aim - analysis of marker enzymes, hormonal and carbohydrate–protein indicators of the reparative osteogenesis in patients with complicated and uncomplicated course of IFC.

Material and methods. The study was conducted with the involvement of 81 patients, including $n_1 = 53$ with complicated course (CC) of IFC ($^1n_1 = 28$ – without traumatic brain injury (TBI) and $^2n_1 = 25$ – combined with TBI); control group was $n_o = 28$ patients with uncomplicated course (UC) of IFC. Patients in all groups have received complex treatment, according to clinical protocols. The research was performed at the moment of initial hospitalization of patients with IFC. The tasks of the research included the study of interconnections between CC IFC, the presence or absence of TBI and metabolic, enzymatic and hormonal changes of reparative osteogenesis.

To identify the features of metabolism in patients with CC and UC of IFC, we studied the level of excretion of oxyproline (collagen exchange indicator) in the daily urine by method of A. Krel′, L. Furtseva [5]. The activity of alkaline phosphatase (ALP), as a marker of function of osteoblasts, and the activity of acid phosphatase (ACP), as a marker of osteoblastic activity, we studied by method of Bodens′kyy. The percentage of bone isoenzymes of alkaline phosphatase (BI ALP) was determined by the method of B. Vlasova and T. Voinovich.

To evaluate the mineral metabolism indicators, the levels of total and ionized calcium and inorganic phosphorus in blood serum were determined, as well as their excretion with urine. Phosphorus in blood serum and daily urine was determined by the Fiske–Subarrow method [3], total and ionized calcium in blood serum by an electrolyte analyzer AEC–01, calcium excretion in urine – by the complexometric method [5].

In order to identify the features of carbohydrate–protein metabolism during the formation of CC IFC, we studied the concentration of glycosaminoglycans (GAG) and three of their fractions: GAG_I – the fraction contains mainly chondroitin–6–sulfate, GAG_{II} – chondroitin–4–sulfate and GAG_{III}, which contains highly sulfated GAG (mainly creatine sulfates), using the method of R. Shtern et al (1982) .

Studies of the structural and functional state of BT were performed using an ultrasonic densitometer “Sonost–2000” on the heel bone. To assess the results of densitometry according to the international standards of World Health Organization (bone density, which corresponds to 1,0 SD (standard deviation), and the I degree of osteopenia was diagnosed in the case of reduction of the indicator to (1,0 ÷ 1,5) SD; II degree – to (1,5 ÷ 2,0) SD; III degree – to (2,0 ÷ 2,5) SD [8,9]. In determining the structural and functional state of bone tissue (elasticity, density, quality, durability of the bone) the following parameters were determined: the ultrasound bone velocity (UBV, m/s), broad-

band ultrasound attenuation (BUA, dB/MHz), calculating the bone strength index (BSI,%) [2,8,9].

The calculation of the sample size of patients in comparable clinical groups (minimum required number of research objects) was performed according to a special sample size formula [7], which, in accordance with the basic theoretical principles of medical statistics [9] guarantees quantitative and qualitative representativeness of the conclusions. In carrying out the research, clinical, statistical and informational methods [11], probabilistic distribution of clinical signs with the estimation of reliability of the obtained results were applied. In analyzing the results of the study, licensed software products ("STATISTICA", "EXCEL" with an additional set of programs [12]) were used on the PC, which allowed to provide the necessary standardization of the process and procedure of clinical and statistical analysis.

Results and their discussion. The evaluation of bone remodeling processes at marker enzyme levels showed that in patients with CC IFC, the concentration of ALP was significantly (p<0,05) higher than in the control group and did not depend on the presence of TBI (Table 1).

The level of ACP was also significantly (p <0.05) higher in patients with CC IFC.

It was rather indicative that the percentage of BI ALP in patients with CC IFC was significantly lower (p <0.05). At the same time, in absolute indicators of BI ALP in CC IFC was significantly (p <0,05) and substantially (in three times!) higher. The above suggested in favor of metabolic changes, which characterized the higher intensity of BT resorption processes in patients with CC IFC.

The level of osteocalcin in blood serum in patients with CC IFC was significantly (p <0.05) lower than in the control group, which may indicate a low level of osteoporosis. It was found that the concentration of osteocalcin in patients with TBI and CC IFC was almost twice lower than in patients without TBI, which indicated a low level of bone formation with a high degree of reliability (p<0,001). Consequently, in cases of CC IFC without TBI there was a high level of bone resorption, while maintaining the activity of bone formation processes, whereas with the presence of TBI, a high level of bone resorption was combined with a low level of bone formation.

Table 1. Marker indicators of metabolic, enzymatic and mineral components of the reparative osteogenesis in patients with different clinical variants of the IFC

Indicators		Patients with UC of IFC n_0=28	Patients with CC IFC		
			total n_1=53	without TBI $^1n_1$=28	with TBI $^2n_1$=25
ALP, mmol/g·h		0.94±0.11	2.15±0.21*	2.11±0.28	2.23±0.22
ACP, mmol/g·h		0.48±0.11	1.31±0.09*	1.25±0.15	1.30±0.13
BI ALP	mmol/g·h	0.241±0.032	0.803±0.064*	0.811±0.029	0.761±0.018
	in % to ALP	68.2±2.2	49.1±3.2*	47.2±4.8	51.1±5.3
Osteocalcin, ng/l		55.6±2.3	42.4±4.7*†	55.8±6.1	29.4±6.3†
MIR BT (C_1/C_2)		2.04±0.11	1.66±0.13*	1.64±0.16	1.69±0.14
FIR BT (C_3 / C_2)		0.527±0.021	0.621±0.034*	0.633±0.042	0.583±0.035
Serum calcium, mmol/l		2.64±0.01	2.48±0.03*	2.52±0.04	2.46±0.02
Serum ionized calcium, mmol/l		1.13±0.02	1.03±0.01*	1.05±0.02	0.97±0.01
Serum phosphorus, mmol/l		1.73±0.04	1.55±0.05	1.69±0.03	1.41±0.06*†
Urinary phosphorus, g/day		0.88±0.10	1.23±0.16*	1.37±0.15*	0.94±0.10 †
Urinary calcium, mg/day		183.2±23.1	164.6±14.1	191.2±18.3	129.7±16.5*†
Urinary magnesium, mmol/l		0.97±0.03	0.76±0.03*	0.73±0.03*	0.91±0.01*†
Uronic acids, mg/day		4.39±0.16	5.64±0.52*	6.41±0.38*	4.67±0.47*†
Oxiprolin, ng/l		37.9±2.1	65.1±5.7*	69.3±5.2*	58.1±4.3*†
GAG (all fractions), IU		12.6±0.14	10.32±0.28*	10.64±0.41*	9.87±0.46*
I fraction (GAG_I)	abs., IU	5.69±0.10	6.53±0.28*	6.75±0.33*	6.32±0.34*
% total GAG	47.1±3.6	62.9±4.1*	63.0±3.7*	64.4±3.3*	
II fraction (GAG_{II})	abs., IU	3.74±0.08	2.33±0.16*	2.41±0.23*	2.21±0.18*
% total GAG	30.5±2.0	22.4±1.7*	22.8±1.5*	22.1±1.3*	
III fraction (GAG_{III})	abs., IU	2.60±0.03	1.56±0.17*	1.82±0.31*	1.33±0.10*†
% totalGAG	21.3±1.0	15.2±0.8*	17.1±1.2	13.4±0.7*†	
Chondroitin sulfate, g/l		0.978±0.002	0.144±0.010*	0.137±0.019*	0.152±0.016*†
Sialic acid (SK), mmol / l		1.740±0.140	3.130±0.140*	2.920±0.110*	3,390±0.121*†
Glycoproteins (GP; seroglycoids), g/l		0.319±0.038	0.518±0.029*	0.531±0.021*	0.517±0.016*

*note: *– the reliability of the differences between the UC and CC IFC at the level p<0,05 † – the reliability of the differences, depending on the presence of TBI at the level p<0,05; MIR BT – metabolic index of remodeling of bone tissue; EIR BT – enzymatic index of remodeling of bone tissue*

For a standardized reflection of the bone remodeling process in patients with CC IFC, we proposed and calculated two indices: metabolic index of remodeling of bone tissue (MIR BT) and enzymatic index of remodeling of bone tissue (EIR BT). MIR BT shows the level of metabolic support for the remodeling process and is the ratio between the levels of ALP and ACP in the blood serum of patients, whereas EIR BT is the ratio between BI ALP and ALP levels. Analysis of these indices showed that remodeling of BT in patients with CC IFC was characterized by a decrease in the level of metabolic support of bone formation while simultaneously increasing the activity of its enzymatic chain, due to an increase in the absolute production of ALP.

Indicative analysis of hormonal maintenance of bone remodeling in patients with CC IFC showed that without accompanying TBI the level of parathormonone (PTH) did not differ from the similar indicator of the control group, whereas in the presence of TBI – a decrease in the level of parathormone in blood serum was detected. It should be noted that this decline is significant both in relation to patients in the control group and in patients with CC IFC without TBI ($p < 0,05$). The opposite trend was observed when analyzing the blood serum calcitonin (CT) content: in the control group its level was 4,96±0,13 IU and in the CC IFC – 3,93±0,14 IU, which was significantly ($p<0,05$) lower. It should be noted that the presence of TBI significantly affected on the level of CT ($p<0,05$), which indicates the disorder of neuro–regulatory mechanisms of bone formation in TBI that leads to the disorder of hormonal maintenance of reparative osteogenesis.

To determine the state of mineral metabolism of reparational osteogenesis we studied the levels of calcium and phosphorus in the blood serum and urine. It was found that serum calcium in patients with CC IFC was significantly lower ($p<0,05$) than in control group and does not depend on existing concomitant TBI ($p>0,05$). Level of serum ionized calcium was also significantly lower in patients with CC IFC that can be considered as a decrease in the metabolic activity of bone formation.

Similarly, a decrease in serum phosphorus was found, however there was a significant ($p<0,05$) decrease of it in patients with TBI when comparing not only with the control group, but also with patients CC IFC without TBI.

Consequently, the decrease in the levels of calcium and ionized calcium and phosphorus in blood serum of patients with CC IFC are not diagnostically significant, while the level of serum phosphorus, which was significantly lower in patients with CC IFC associated with TBI, has the differential diagnostic value. Clinical laboratory analysis of the excretion levels of mineral and organic components of bone remodeling showed that in patients with CC IFC the levels of excretion ($p<0,05$) of phosphorus, uronic acids and oxyproline increased, however, the calcium excretion didn't decrease ($p>0,05$) and magnesium – decreased ($p<0,05$).

In patients with CC IFC associated with TBI, some other patterns of excretion were found: medium levels of excretion of phosphorus and uronic acids, a significant ($p<0,05$) decrease in excretion of calcium and magnesium with a relative (compared with patients without TBI) reduction of the level of oxyproline excretion (however, its level remained significantly higher than in the control group).

Excretion of organic components of bone metabolism was characterized by a significant increase in the CC IFC and their relative decrease in patients with CC IFC combined with TBI.

In the analysis of carbohydrate-protein metabolism, it was found that the level of total GAG in the blood serum of patients in the control group was significantly ($p<0,05$) higher than in the patients with CC IFC with or without TBI.

In the complicated course of the IFC, an absolute increase ($p<0,05$) of the concentration of chondroitin–6–sulfates was revealed. It should also be noted that among patients with CC IFC without TBI, GAG_I level was lower than in cases with the presence of TBI.

In analyzing the results, it was found that in the absolute values and in structural indices, in the presence of CC IFC, the percentage of GAG_I increased, which may indicate instability of mechanisms of reparative osteogenesis in this category of patients.

The opposite trend was observed in the chondroitin–4–sulfate concentration in patients with CC IFC: there was an absolute decrease ($p<0,05$) of chondroitin–4–sulfates concentration. It should be noted that among patients with CC IFC in combination with TBI, GAG_{II} level was characterized by a tendency to less expressive decrease than in the presence of TBI ($p>0,05$). In analyzing the results, it was found that in absolute terms values, and in the structural indicators, in the groups of patients with with CC IFC, the percentage of GAG_{II} significantly decreased and did not depend on the presence of TBI, which is explained by the redistribution of the GAG fractures in favor of increasing GAG_I and GAG_{III} and indicates the disorder of physiological mechanisms of reparative osteogenesis.

It was found an absolute increase ($p<0,05$) in the concentration of creatine–sulphates (GAG_{III}) in patients with CC IFC.

It should be noted separately that by CC IFC and TBI, the level of GAG_{III} had significantly ($p<0,05$) more expressive decrease than in the absence of TBI ($p<0,05$). In analyzing the results, it was found that both in the absolute values and in structural indicators, the specific weight of GAG_{III} decreased, which could indicate the tension of compensatory mechanisms, especially in the case of CC IFC and TBI, even when difficult–to–dissolve GAG ("metabolic response reserves") were decreasing.

Densitometric equivalents of reparative osteogenesis processes were an increase of the BUA and a decrease of the UBV while reducing the absolute or relative level of chondroitin–6–sulfates.

Conclusions. 1. Clinical and laboratory analysis of the levels of excretion of mineral and organic components of remodeling of BT showed that in case of the CC IFC there were an increase ($p<0,05$) of excretion of phosphorus, uronic acids and oxyproline, whereas calcium excretion was not affected ($p>0,05$), and magnesium was reduced ($p<0,05$). It was found that the level of serum calcium in patients with complicated course was significantly ($p<0,05$) lower than in the control group and did not depend on the presence of TBI ($p>0,05$).

2. The level of ionized calcium in serum was significantly lower among patients with CC IFC, which may indicate the less metabolic activity of reparative osteogenesis, primarily due to damage of central mechanisms as a consequence of cerebral concussion.

3. In the analysis of results, an absolute increase ($p<0,05$) of the concentration of chondroitin–6–sulfates in patients with CC IFC was indicated, and it was found that both in absolute values and in structural indicators, the percentage of different fractions of GAG varied, which may reflect the instability of the mechanisms of bone formation (due to the redistribution of the percentage of GAG_{II} in favor of increasing GAG_I and GAG_{III}) and the disorder of physiological mechanisms of reparative osteogenesis.

4. Densitometric equivalents of CC IFC formation were the increase of the UBV and the decrease of the BUA against the background of low levels of chondroitin–6–sulfates.

5. The prospects for further research are related to the analysis of the dynamics of enzyme, hormonal and carbohydrate–protein markers of the bone remodeling in the different courses of IFC, with the definition of informative indicators of clinical monitoring of the reparative osteogenesis.

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SUMMARY

METABOLIC, ENZYMATIC AND MINERAL MAINTENANCE OFREPARATIVE OSTEOGENESIS OF FACIAL CRANIUM INJURIES

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Aim - study of marker enzymes, hormonal and carbohydrate–protein indicators of the state of reparative osteogenesis in patients with complicated and uncomplicated course of injuries of facial cranium**.**

The study included 81 patients with injuries of facial cranium, which were divided into 2 groups, depending on the presence of complications. The following enzyme indicators were studied: the level of excretion of hydroxyproline in daily urine; alkaline and acid phosphatase activity; the percentage of bone isoenzymes of alkaline phosphatase. To assess the mineral metabolism, the level of total and ionized calcium and inorganic phosphorus in the blood serum, as well as their excretion in the urine, were determined. To assess the state of metabolism, the concentration of glycosaminoglycans and their fractions in the blood serum were studied. To study the structural and functional state of the bone tissue the densitometry was performed.

In patients with complicated course of injuries of facial cranium assosiated with traumatic brain injury there was revealed the increase ($p<0,05$) of: excretion of phosphorus, uronic acids and oxyproline, while the excretion of calcium was not disturbed ($p>0,05$), and excretion of magnesium was decreased ($p<0,05$). It was found out that the level of calcium of blood serum in patients with complicated course is significantly ($p<0,05$) lower than in the control group and does not depend on the presence of craniocerebral injury ($p>0,05$). The decrease of the level of ionized calcium content in blood serum can be the confirmation of lower metabolic activity of reparative osteogenesis processes, first of all at the expense of damage of central mechanisms. When studying the content of carbohydrate–protein metabolites by complicated course of injuries of facial cranium, the absolute increase ($p<0,05$) of concentration of chondroitin–6–sulfates was revealed, and during the analysis of results it was found out that in absolute values, as well as in structural indexes, the specific weight of various fractions changes, that can be the evidence of instability of mechanisms of osteogenesis and of damage of physiological mechanisms of reparative osteogenesis. Densitometric equivalents of forming of complicated course of injuries of facial cranium are the increase of broadband ultrasonic attenuation and the decrease of its spreading speed on the background of low levels of chondroitin–6–sulfates.

Keywords: injuries of facial cranium, complicated course, diagnostics, reparative osteogenesis.

РЕЗЮМЕ

МЕТАБОЛИЧЕСКОЕ, ФЕРМЕНТАТИВНОЕ И МИНЕРАЛЬНОЕ ОБЕСПЕЧЕНИЕ РЕПАРАТИВНОГО ОСТЕОГЕНЕЗА ПРИ ПОВРЕЖДЕНИЯХ ЛИЦЕВОЙ ЧАСТИ ЧЕРЕПА

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Цель исследования - изучение маркерных ферментов, гормональных и углеводно–белковых индикативных показателей состояния репаративного остеогенеза у пациентов с осложненным и неосложненным течением повреждений лицевой части черепа.

Исследован 81 пациент с повреждениями лицевой части черепа. Пациенты, в зависимости от наличия осложнений, разделены на 2 группы. Изучены ферментативные показатели: уровень экскреции гидроксипролина в суточной моче; активность щелочной и кислой фосфатазы; доля костного изофермента щелочной фосфатазы. Для оценки минерального обмена определены уровень общего и ионизированного кальция и неорганического фосфора в сыворотке крови и их экскреция с мочой. Состояние обмена веществ оценивали посредством определения концентрации гликозаминогликанов

и их фракций в сыворотке крови, структурное и функциональное состояние костной ткани - денситометрией.

У пациентов с осложненным течением повреждений лицевой части черепа при сопутствующей черепно–мозговой травме выявлено увеличение экскреции фосфора, уроновых кислот и оксипролина ($p<0,05$), при этом экскреция кальция не нарушалась ($p>0,05$), а экскреция магния - снижена ($p<0,05$). Выявлено, что уровень кальция в сыворотке крови у больных с осложненным течением значительно ниже ($p<0,05$), чем в контрольной группе и не зависит от наличия черепно-мозговой травмы ($p>0,05$). Снижение уровня содержания ионизированного кальция в сыворотке крови может свидетельствовать о снижении метаболической активности процессов репаративного остеогенеза, прежде всего, за счет повреждения центральных механизмов. При изучении содержания углеводно-белковых метаболитов при осложненном течении повреждений лицевой части черепа выявлено абсолютное увеличение ($p<0,05$) концентрации хондроитин-6-сульфатов. Анализ результатов выявил, что в абсолютных величинах, а также в структурных показателях изменяется удельный вес различных фракций, что, по всей вероятности, свидетельствует о нестабильности механизмов остеогенеза и повреждении физиологических механизмов репаративного остеогенеза. Денситометрическими эквивалентами формирования осложненного течения повреждений лицевой части черепа являются увеличение широкополосного ослабления ультразвука и снижение скорости его распространения на фоне низкого уровня хондроитин-6-сульфатов.

რეზიუმე

სახის ქალის დაზიანების დროს რეპარაციული ოსტეოგენეზის მეტაბოლური, ფერმენტული და მინერალური უზრუნველყოფა

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უკრაინის ჯანდაცვის სამინისტროს ხარკოვის ეროვნული სამედიცინო უნივერსიტეტი

კვლევის მიზანს წარმოადგენდა რეპარაციული ოსტეოგენეზის მდგომარეობის მარკერული ფერმენტების, ჰორმონული და ნახშირწყლოვან-ცილოვანი ინდიკატორული მაჩვენებლების შესწავლა პაციენტებში სახის ქალის დაზიანებებით გართულებული და გაურთულებელი მიმდიმარეობით.

კვლევაში ჩართული იყო 81 პაციენტი სახის ქალის დაზიანებით. გართულებების გათვალისწინებით პაციენტები გაყოფილი იყო 2 ჯგუფად. შესწავლილია შემდეგი ფერმენტული მაჩვენებლები: დღე-ღამის შარდში ჰიდროქსიპროლინის ექსკრეციის დონე; ტუტე და მჟავე ფოსფატაზას აქტივობა; ტუტე ფოსფატაზას ძვლოვანი იზოფერმენტის წილი. მინერალური ცვლის შეფასების მიზნით განისაზღვრა საერთო და იონიზირებული კალციუმის და არაორგანული ფოსფორის დონეები სისხლის შრატში, ასევე მათი ექსკრეცია შარდში. ნივთიერებათა ცვლის მდგომარეობის დადგენის მიზნით შესწავლილი იყო გლიკოზამინოგლიკანების და მათი ფრაქციების კონცენტრაცია სისხლის შრატში. ძვლოვანი ქსოვილის სტრუქტურული და ფუნქციურო მდგომარეობის შესწავლა განხორციელდა დენსინომეტრიის მეშვეობით.

პაციენტებში ქალა ტვინის და თანხვედრი სახე ქალის დაზიანებებით გამოპვლინდა ფოსფორის, ურონის მჟავას და ოქსიპროლინის ექსკრეციის მატება, კალციუმის ექსკრეცია არ დარღვეულა ($p>0,05$), მაგნიუმის ექსკრეცია კი იყო შემცირებული ($p<0,05$). აღმოჩნდა, რომ ავადმყოფებში გართულებული მიმდინარეობით კალციუმის დონე სისხლის შრატში მნიშვნელოვნად უფრო დაბალია, ვიდრე საკონტროლო ჯგუფში და სრულიადაც არ არის დამოკიდებული ქალატვინის ტრავმის არსებობაზე ($p>0,05$).

სისხლის შრატში იონიზირებული კალციუმის დონის დაქვეითება, სავარაუდოა, რომ მიუთითებს რეპარაციული ოსტეოსინთეზის პროცესების მეტაბოლური აქტივობის დაქვეითებაზე, პირველ რიგში ცენტრალური მექანიზმების დაზიანების ხარჯზე. სახის ქალის დაზიანების გართულებული მიმდინარეობის დროს ნახშირწყლების და ცილების მეტაბოლიზმის შემცველობის შესწავლამ აჩვენა ქონდროიტინ-6-ფოსფატის კონცენტრაციის აბსოლუტური მატება ($p<0,05$). შედეგების ანალიზმა კი გამოავლინა, რომ სხვადასხვა ფრაქციის ხვედრითი წილი აბსოლუტურ სიდიდეებში და სტრუქტურულ მონაცემებში განიცდის ცვლილებებს, რაც მოწმობს ოსტეოგენეზის მექანიზმების არასტაბილურობაზე და რეპარაციული ოსტეოგენეზის ფიზიოლოგიური მექანიზმების დაზიანებაზე. სახის ქალის დაზიანების გართულებული მიმდინარეობის ფორმირების დენსიტომეტრული ექვივალენტის გამოხატულებას წარმოადგენს ულტრაბგერის ფართო სიგრძივი შესუსტების მატება და მისი გავრცელების სიჩქარის შემცირება ქონდროიტინ-6-ფოსფატის დაბალი დონეების ფონზე.