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STUDY OF THE QUALITATIVE CHARACTERISTICS OF THE MAXILLA BONE TISSUE ACCORDING TO THE QUANTITATIVE CONTENT OF MACROELEMENTS (P, NA, CA, MG, S) IN THE DYNAMICSOF PRENATAL ONTOGENESIS

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The germs of the maxillas of 131 fetuses in the age of 11-40 weeks of fetal development have been investigated in order to determine the quantitative macroelements (P, Na, Ca, Mg, S) content in the dynamics of prenatal ontogenesis. The bone tissue sampling was carried out on the both sides of the upper jaw germ of human fetuses from different areas, that had macroscopically the most marked density. A complex of methods of morphological research was applied, which included macroscopy, morphometry, fine preparation of objects under the control of loupe were used during the investigation; methods of flame atomic emission and atomic absorption analysis; photometric and turbidimetric methods; the method of statistical groupings in the study of qualitatively homogeneous aggregates, the variational analysis of statistical data with the calculation of average values for each macroelement, the errors of the average values, the reliability of the average values and the probability of accurate prognosis. A significant difference was found in the dynamics of the fetal period of prenatal ontogenesis between the indices of macroelements content, which is a qualitative result of quantitative morphology in determining their content during the study of the upper jaw bone tissue in human fetuses. The regularity of the dynamics of the upper jaw bone density of human fetuses, depending on the mineral content and the presence of the revealed synchronism of these processes, suggests that the change in density is the evidence of a change in the content of individual mineral elements, but the macroelements (Ca, P, Na, Mg, S), as the main building material are the most important. The obtained results are well-grounded and can be the basis for developing new methods of early diagnosis of congenital anomalies of the maxillofacial area in the preclinical stages of its development and methods of their prevention, by correcting the mineral content.

Keywords: maxilla, prenatal ontogenesis, human, macroelements.

The research is a fragment of a research project "Regularities of the morphogenesis and structural and functional features of tissues and organs in human ontogenesis", state registration No. 0116U002938.

Quality of the jaw bone tissue is of particular importance, as it is characterized by the marked age dynamics [10] and depends both on the progress of skeleton mineralization process in general, and specifically the characteristics of jaw bone mineral content [6, 10, 12]. The scientific medical literature contains data about the regularities of age dynamics of individual mineral elements in the jaw bone tissue throughout different periods of ontogenesis [3, 10], but information regarding the study of qualitative characteristics of the maxilla bone tissue of human fetuses according to the quantitative content of macroelements (P, Na, Mg, Ca, S) in the dynamics of prenatal ontogenesis is missing.

The bone tissue formation of the maxilla germ in the prenatal human ontogenesis is the result of the histogenesis and, in fact, its mineralization [13]. Methods of flame atomic emission and atomic absorption analysis reveal the possibilities for modern researchers to investigate the peculiarities of structure and quality of the maxillofacial bones by studying the content of micro- and macroelements [5]. The study results are often crucial to select the prevention methods in the early stages of prenatal ontogenesis [6]. However, the determination of quantitative indices of macroelement content of the maxilla bone tissue of human fetuses is a significant contribution to the development of quantitative morphology [2, 8].

The purpose of the paper was to study the age dynamics of indices of bone density of the maxilla germ of human fetuses during prenatal ontogenesis on the content of macro-elements; to conduct the statistical analysis of the obtained data and to improve significantly the study of the quantitative morphology of the human maxilla.

Materials and methods. The maxilla germs of 131 human fetuses aged from 11 to 40 weeks of intrauterine growth (IUG) have been involved in the study. They were obtained during the pathoanatomical research of spontaneous miscarriages and stillbirth premature fetuses, that had died from the causes not related to the maxillofacial diseases. They were developing in the uterus in the absence of clearly expressed harmful for human factors of external and internal environment. The material was received in accordance with the Agreement on the scientific cooperation with the Chernivtsi Regional Municipal Medical Institution "Pathoanatomical Bureau", Chernivtsi (Ukraine). In addition, macropreparations of fetuses from the Morphological Museum of the University were used in the research. The bone tissue sampling for study the macroelements (P, Na, Ca, Mg, S) was carried out on the both sides of the maxilla germ of human fetuses from different areas, that had macroscopically the most marked density.

All the studies were conducted in compliance with the main principles of the GCP (1996), the Council of Europe Convention on Human Rights and Biomedicine (of 04.04.1997), the Helsinki Declaration of the World Medical Association on the Ethical Principles of Scientific Medical Research with Human Participation (1964-2013), orders of Ministry of Health of Ukraine No. 690 dated 23.09.2009, No. 616 dated 03.08.2012, and according to "Procedure for withdrawal of biological objects from the dead, whose bodies are the subject to forensic medical examination and pathoanatomical study, for scientific purposes" [4].

The methods of macroscopy, morphometry, fine preparation of objects under the control of loupe were used during the investigation. Sodium (Na) was investigated using the method of the flame atomic emission analysis, calcium (Ca) and magnesium (Mg) were studied using atomic absorption analysis on the atomic absorption spectrophotometer AAS-1N (Carl Zeiss Jena, Germany) using propane-butane-air flame. The content of phosphorus (P) was determined using the photometric method (range of obtained values was 4.97-23.99 mg/g, δ=10 %) with the help of calibration graph and addition procedure, the light absorption was measured on photocolorimeter KFK-2-UHL 4.2 (Ukraine). Determination of the sulfur content (S) in the form of sulfate ion was carried out by means of a turbidimetric method using the formed suspension (suspension) $BaSO_4$ when interaction of sulfate ion and barium chloride (the range of obtained values was 2.14-2.91 mg/g, δ = 10%). The drying cabinet 2B-151 (Ukraine) and analytical scales of the second class of accuracy XAS 100 / C (RADWAG, Poland) were used in the work.

Determination of macroelements was carried out directly from the initial solutions at the appropriate wavelengths given below:

- P (phosphorus) – λ = 690.0 nm, linearity of 0.05-1.0 mg/l, C_n = 0.01 mg/l;
- Na (sodium) – λ = 589.0 nm, linearity of 0.1 - 2.0 mg/l, C_n = 0.02 mg/l;
- Ca (calcium) – λ = 422.7 nm, linearity of 1.0 – 10.0 mg/l, C_n = 0.05 mg/l;
- Mg (magnesium) – λ = 285.2 nm, linearity of 0.05 – 5.0 mg/l, C_n = 0.02 mg/l;
- S (sulfur) – λ = 400.0 nm, linearity of 1.0-10.0 mg/l, C_n = 0.1 mg/l.

There have been selected 131 objects for grouping, using the method of statistical groupings in the study of qualitatively homogeneous aggregates, where there are no qualitative transformations yet, but there are quantitative differences. Their numerical data are given in the table 1.

Table 1

Grouping of research objects

Group number	Age (weeks)	The number of observations
1	11-16	35
2	17-24	33
3	25-29	32
4	30-40	31
The total number of observations		131

A variational analysis of statistical data with the calculation of average values for each macroelement and errors of the average values was used to study the quantitative macroelements content of the human maxilla bone tissue in the dynamics of the fetal period of prenatal development. An assessment was made to confirm the reliability of the averages and the probability of an accurate prediction. To determine the level of the phenomenon, we compared the index in dynamics and calculated the relative values, namely, the percentage correlation of the macroelements content in the investigated fragments (samples) of bone tissue.

All the indices (relative and averages) were evaluated to determine their reliability. The assessment of the relative values was carried out by calculating their error ($m_{\%}$) by the formula for a large number of observations:

$$m = \sqrt{\frac{P \cdot q}{n}}; \quad (1)$$

where P – the index; q =100-P; n - the number of observations.

The result was considered reliable if the quotient from the division of the index by its error ($\frac{P}{m}$) was equal to 2 or more. The criterion of reliability (t) = 2 showed that the result obtained in a sample, in 95.5% of cases, differed from the result of the general population by 2m.

That is, the probability of accurate prognosis (P) was 95.5%. This result is considered acceptable for statistical research in the field of medicine, as it is graphically depicted in fig. 1.

The assessment of the reliability of the average quantities of quantitative indices of mineral content, that is macroelements of human maxilla bone tissue was performed by calculating their error (m_M) using the formula:

$$m = \frac{\sigma}{\sqrt{n}}; \qquad (2)$$

Where σ is standard deviation; n - the number of observation units.

In order to determine the substantial difference between the indices in different groups of prenatal and fetal periods of IUG, the validity of the difference was evaluated. Student's t-test (t) was calculated for relative values by the formula:

$$t = \frac{P_1 - P_2}{\sqrt{m_1^2 + m_2^2}}; \qquad (3)$$

where: $P_1$and P_2 – the values of the indices in the two groups to be compared;
m_1 and m_2 – error of indices.
Student's t-test (t) was calculated for average values by the formula:

$$t = \frac{M_1 - M_2}{\sqrt{m_1^2 + m_2^2}}; \qquad (4)$$

where: $M_1$and M_2 – the values of the average values in the two groups to be compared; $m_1$and m_2 – errors of average values. The difference was considered substantial if $t \geq 2$.

In order to evaluate homogeneity of statistical data (average indices of macroelements of maxilla bone tissue), to determine the type and reliability of the mean, the coefficient of variation (CV) was determined in each study group and assessed according to the scale (low, medium and high a variety of features), the results of which indicate the quality of the obtained indices through the above-mentioned research methods. Therefore, numerical statistical indices are presented in this section (materials and methods), as the main focus of our study is the dynamic analysis, that is the rate of growth (%), which gives priority and efficiency to the results for their further implementation into practical activities.

The analysis of dynamics series was used to determine the trends of qualitative characteristics of human upper jaw bone tissue in the dynamics of prenatal ontogenesis. The regularities of increase or decrease in the content of individual macroelements in the human maxilla bone tissue, depending on the age of the ontogenesis of the fetus, are established.

Thus, the use of the mentioned above methods of photometric research and statistical analysis allowed us to obtain qualitatively new and reliable data which underlie the scientific substantiation of the peculiarities of the structure and mineral content of the human maxilla bone tissue in the early prenatal period of ontogenesis.

Results and their discussion. The results of the mean of the studied parameter (M), standard deviation (m), Student's paired two-tailed t-test or the reliability index (t) and the probability level have shown that the data in comparison with the first and second groups are: for phosphorus (P) 1.253 ± 0.051 in the first and 2.441 ± 0.140 in the second group (t = 7.97, p<0.001); for sodium (Na) – 0.301 ± 0.022 and 0.311 ± 0.013 (t = 0.40, p<0.05); for calcium (Ca) – 3.268 ± 0.195 and 7.446 ± 0.343 (t = 10.60, p<0.001); for magnesium (Mg) – 0.351 ± 0.022 and 0.220 ± 0.017 (t = 4.68, p<0.001); for sulfur (S) – 1.143 ± 0.138 and 1.835 ± 0.042 (t = 4,80, p<0,001).

A significant result of the difference of the indices was also obtained between the first and third groups: for phosphorus (P) 1.253±0,051 in the first and 3.047 ± 0.224 in the third group (t = 7.83, p<0.001); for sodium (Na) – 0.301 ± 0.022 and 0.456 ± 0.024 (t = 4.84, p<0.001); for calcium (Ca) – 3.268 ± 0.195 and 7.102 ± 0.222 (t = 12,99, p<0,001); for magnesium (Mg) – 0.351 ± 0.022 and 0.232 ± 0.011 (t = 4.96, p<0.001); for sulfur (S) – 1.143 ± 0.138 and 1.989 ± 0.051 (t = 5.75, p<0.001).

The reliability of the difference is confirmed to be significant ($t \geq 2$) between the first and fourth groups, except for the magnesium (Mg) – 0.351 ± 0.022 and 0.318 ± 0.035 (t = 0.80, p <0.05); for phosphorus (P) 1.253 ± 0.051 in the first and 4.512 ± 0.476 in the fourth group (t = 6.82, p<0.001); for sodium (Na) – 0.301 ± 0.022 and 0.557 ± 0.037 (t = 5.95, p<0.001); for calcium (Ca) – 3.268 ± 0.195 and 6.686 ± 0.289 (t = 9.53, p<0.001); for sulfur (S) – 1.143 ± 0.138 and 1.636 ± 0.047 (t = 3.40, p<0.001), that indicates a significant difference between the indices and obtaining qualitative results of quantitative morphology in determining the macroelements content during the study of the maxilla bone tissue fragments of human fetuses.

Therefore, a detailed dynamics analysis with the definition of the percentage (%) of the macroelements content was conducted for the efficiency of comprehensive consideration and further study and implementation in practical applications. It is presented in table 2 and graphically depicted in fig. 2, and the pace of its growth (table 3) in the investigated bone tissue fragment (mg/g) of specimens weighing 0.15-0.55 g, which both provide a complete basis for mineralization and qualitative characteristics of bone tissue development in prenatal ontogenesis.

Table 2

The structure of the upper jaw bone tissue of human fetuses according to the macroelements, %

Group	Age (weeks)	Number of observations	Macroelements, %				
			Phosphorus (P)	Sodium (Na)	Calcium (Ca)	Magnesium (Mg)	Sulfur (S)
1	11-16	35	19.84	4.77	51.75	5.55	18.09
2	17-24	33	19.92	2.54	60.76	1.80	14.98
3	25-29	32	23.76	3.55	55.37	1.81	15.51
4	30-40	31	33.16	4.09	48.40	2.33	12.02

In our opinion, such an approach in this study comprehensively shows the dynamics of each macroelement in prenatal ontogenesis and can be the basis for developing new methods of early diagnosis of congenital anomalies of the maxillofacial area in the preclinical stages of its development and methods of their prevention, by correcting the mineral content.

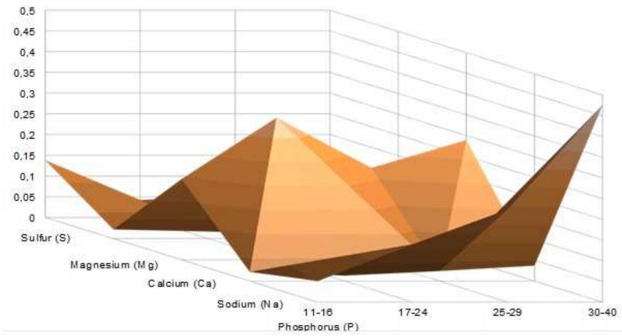

Fig. 1. Standard error (11-16, 17-24, 25-29, 30-40) in age groups, weeks.

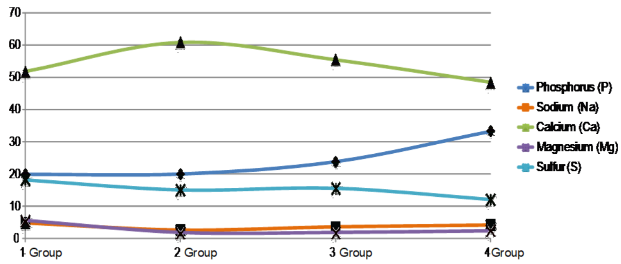

Fig. 2. The upper jaw bone tissue structure of human fetuses in prenatal ontogenesis according to the macroelements content, %

The content of macroelements Na, Mg, S decreases between the first and second groups of study, and the rate of their growth shows negative indices, as it is shown in the tables (tables 2, 3) and the graphic representation (fig. 2). Also, the generally accepted coefficient with the molar ratio Ca / P (1.67), which is responsible for the formation of the required hydroxyapatite compound ($Ca_{10}(PO_4)_6(OH)_2$) cannot be traced, with the subsequent aniage of hard tissue, in particular of the maxilla and its structures in the fetus – the growth rate of which is for Ca – 17.41% and P – 0.40 %.

Table 3

Age dynamics of the macroelements content in the maxilla bone tissue of human fetuses, %

Macro-elements	Groups		Growth rate, % (+) – increase (-) - decrease	Groups		Growth rate, % (+) – increase (-) - decrease	Groups		Growth rate, % (+) – increase (-) - decrease	Groups		Growth rate, % (+) – increase (-) - decrease
	1	2		2	3		3	4		1	4	
Phosphorus (P)	19.84	19.92	+0.40	19.92	23.76	+19.27	23.76	33.16	+39.56	19.84	33.16	+67.14
Sodium (Na)	4.77	2.54	-46.75	2.54	3.55	+39.76	3.55	4.09	+15.21	4.77	4.09	-14.25
Calcium (Ca)	51.75	60.76	+17.41	60.76	55.37	-8.87	55.37	48.40	-12.59	51.75	48.40	-6.47
Magnesiu m (Mg)	5.55	1.80	-67.57	1.80	1.81	+0.55	1.81	2.33	+28.73	5.55	2.33	-58.02
Sulfur (S)	18.09	14.98	-17.19	14.98	15.51	+3.54	15.51	12.02	-22.50	18.09	12.02	-33.55

During the fetal period of the prenatal human ontogenesis, apositive dynamics of the macroelements growth can be observed when comparing the second and third age groups with the exception of calcium (Ca), which growth is negative (-8.87%). The same dynamics of the calcium (Ca) content with a minus sign can be observed also when comparing the third and fourth age groups (-12.59 %) and even the first and fourth comparison groups (-6.47 %), which indicates the need for it to form the skeleton bones of both a fetus, and, in our opinion, the deficiency of its content, admission, fixation and redistribution in the mother's body.

The sulfur content (S) is noticed to have a positive growth rate in only one comparison group, comparing the second and third age groups (3.54 %), which is an integral part of the amino acids (methionine, cysteine, cystine, taurine), that, in our case, are involved in the synthesis of proteins for the formation of fibrous connective tissue. Sulfur (S) is a component of the hormones of insulin and calcitonin, which regulates the metabolism of calcium (Ca) in the body, as well as enzymes and cell membranes, coenzyme (coenzyme A), which are the major product of the intermediate metabolism of carbohydrates, lipids, proteins and starting substances for biosynthesis of many compounds [1, 7].

The phosphorus (P) content is the highest among all macroelements – 39.56 %, when analyzing the growth rate between the third and fourth age groups. The positive trend of its growth is observed in all periods of prenatal development (fig. 3). The maximum increase (28.73 %) among all age groups of comparison, is set for magnesium (Mg) (fig. 2), namely when comparing the growth rate between the third and fourth age groups, which in the given age comparison period ranks second in terms of growth.

The numerical and graphical analysis (fig. 2, table 2) confirms the interdependence of magnesium (Mg) and sodium (Na), which growth has a positive dynamics and is 15.21 %.

We have carried out a general analysis of the growth rate and its comparison between the first and fourth groups. A negative growth rate has been observed among all macroelements, except for phosphorus (P) – an increase of which is 67.14 % (tables 2, 3), which indicates the growing need for this macroelement and, with the help of these data, confirms its positive dynamics of distribution for the formation of the fetus. Nevertheless in our opinion, the negative dynamics of the calcium (Ca) growth rate (-6.47 %) can be regarded to have negative effect on the formation of tissues and organs of the fetus, in particular, the upper jaw bone tissue the fetal period of human prenatal ontogenesis. The numerical data of the dynamics are given in fig. 2, with a graphical generalization (fig. 3).

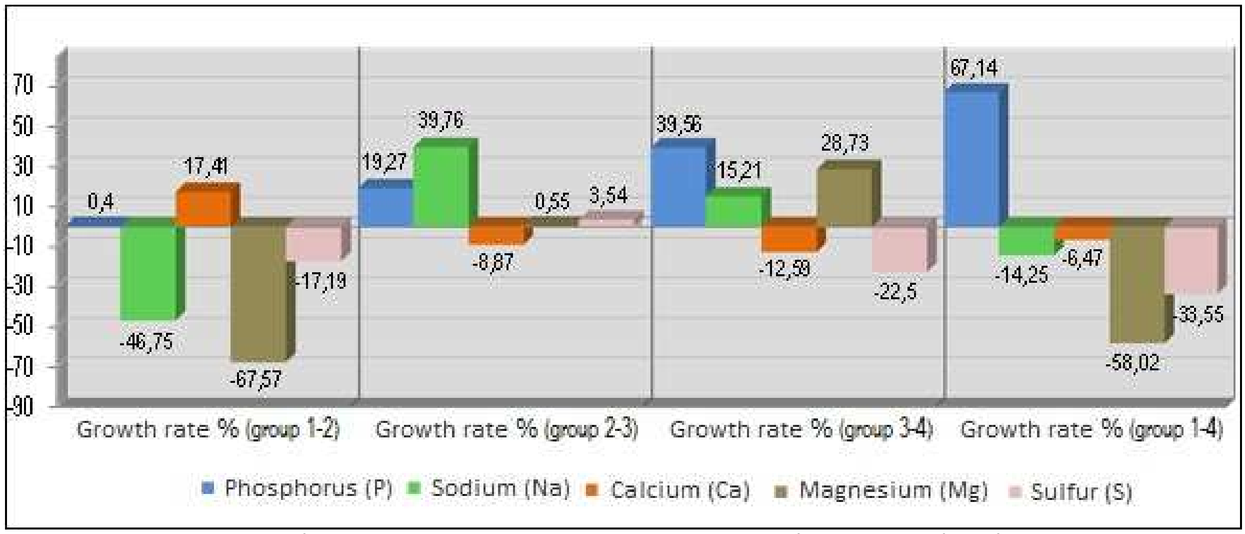

Fig. 3. The summarizing image of the macroelements (P, Na, Ca, Mg, S) growth rate in the prenatal ontogenesis of the upper jaw germs of human fetuses, %.

In our point of view, the negative growth rate of sodium (Na), magnesium (Mg), sulfur (S) is justified, as the construction of the organism systems is completed (30-40 weeks of prenatal ontogenesis) and the need for their content for the formation of organs directly proportional decreases.

Thus, the use of the mentioned above methods of photometric research and statistical analysis allowed us to obtain qualitatively new and reliable data which underlie the scientific substantiation in studying the quantitative morphology of the structural features, depending on the mineral (macroelement) content of the human maxilla bone tissue of human fetuses in the prenatal ontogenesis.

The maxilla is known to develop from the first pharyngeal arch and is ossified intramembranously from the sixth week of IUG, in utero. The maxilla is the third bone after ossification after the collarbone [14] and the mandible. The main centers of ossification are located bilaterally over the future deciduous canine teeth in the area of the output of the infraorbital nerve and horns of the upper jaw.

According to the nature of the development the maxilla belongs to the cover bones, because there are only two stages in the process of ontogenetic and phylogenetic development - membranous and bony, bypassing the cartilage.

Since the processes of organic matter formation can be assessed only on histological preparations, the bone tissue development is judged by the processes of mineralization, that is, the micro and macroelements content, which is the main building material. It is presented in detail (the dynamics of changes in the macroelements content) in scientific researches during the writing of this work, with the help of the above-mentioned research methods, which have also been successfully used in a number of studies [3, 10] on similar topics.

Any violations of bone tissue mineralization [11], but primarily the macroelements content, interact with the development and mineralization of solid dental tissues. The dentin formation, the histogenesis of which passes first, can occur both at the stage of formation of its organic matrix, and during mineralization. Histogenesis of dentin already begins on the 4th month of embryonic development. Calcium salts fixation and the formation of so-called specialized bone tissue, that is the residual dentin, begin at the end of the 5th month of embryonic development of the predentin of the tooth germ. In case of insufficient mineralization, the structure of the enamel has not changed, but its connection with the dentin is not stable, as a result of which the enamel is easily peeled off. In case of excessive mineralization, calcospherites are found which can merge and remain separate from each other, and form very large interglobular dentin zones. In turn, if the effect of the traumatic influence factor [15] happens during the period of bone tissue mineralization, precisely when the histogenesis of the enamel occurs, then it usually leads to malformations of the enamel, e.g. hypoplasia or hyperplasia.

We know that starting with 6-month-old fetuses, all structures of the maxilla are X-rays contrast [9], that is, they have a certain density, which affirms the interdependence of the mineralization degree.

The author [3] notes that one of the most important factors determining the quality of bone tissue is its mineral composition. The content of 8 macro and microelements (Ca, P, Na, Mg, K, Zn, Fe, Sr) in the bone tissue of the cellular part of the mandible in males and females postnatally in the age dynamics was investigated by means of atomic absorption spectral analysis. The author confirms that all investigated elements are available in bone tissue in quantities that are suitable for determination, and also absolute content indices and specific particles of each element and their age dynamics are determined.

Conclusion

The regularity of the dynamics of the maxilla bone density of human fetuses, depending on the mineral content and the presence of the revealed synchronism of these processes, suggests that the change in density is the evidence of a change in the content of individual mineral elements, but the macroelements (Ca, P, Na, Mg, S) are the most important, as the main building material.

Based on our previous studies and work of the above-mentioned authors, we believe that this principle is well-grounded and can be the basis for developing new methods of early diagnosis of congenital anomalies of the maxillofacial area in the preclinical stages of its development and methods of their prevention, by correcting the mineral content.

References

1. Boiechko FF, Boiechko LO. Osnovni biokhimichni poniattia, vyznachennia i terminy. Kyiv. 1993. 528 s. [in Ukrainian]

2. Dzerzhynskyi ME, Vareniuk IM. Navchalnyi posibnyk dlia laboratornykh zaniat z velykoho morfometrychnoho spetspraktykuma dlia studentiv kafedry tsytolohii, histolohii ta biolohii rozvytku. Kyiv: Fitosotsiotsentr. 2006; 83 s. [in Ukrainian]

3. Krynytskyi RP. Analiz mineralnoho skladu kistkovoi tkanyny komirkovoi chastyny nyzhnoi shchelepy ta yoho vikovoi dynamiky u osib cholovichoi ta zhinochoi stati. Klinichna anatomiia ta operatyvna khirurhiia. 2015; 14(3): 40–43. [in Ukrainian]

4. Mishalov VD, Voichenko VV, Malysheva TA, Dibrova VA, Kuzyk PV, Yurchenko VT. Poriadok vyluchennia biolohichnykh obiektiv vid pomerlykh, tila yakykh pidliahaiut sudovo-medychnii ekspertyzi i patolohoanatomichnomu doslidzhenniu, dlia naukovykh tsilei: metodychni rekomendatsii. Osvita Ukrainy: spetsvypusk hazety. Kyiv: Pedahohichna presa. 2018; 2(62): 3–13. [in Ukrainian]

5. Oshurko AP, Oliinyk IYu, Hryshchuk HV. Perspektyvy vyvchennia yakisnykh ta kilkisnykh kharakterystyk kistkovoi tkanyny plodiv liudyny kombinovanymy ta hibrydnymy metodamy doslidzhennia. Visnyk problem biolohii i medytsyny. 2018; 2(144): 43–49. Doi: 10.29254/2077-4214-2018-2-144-43-49 [in Ukrainian]

6. Ponomarenko SI. Zviazok mizh parametramy stomatolohichnoho statusu ta systemnymy pokaznykamy stanu kistkovoi systemy. Problemy osteolohii. 2015;18(2):40–50. [in Ukrainian]

7. Sytnyk KM, Topachevskyi VO, redaktory. Biolohichnyi slovnyk. Kyiv. 1986; 680 s. [in Ukrainian]

8. Slabyi BO. Kilkisna morfolohiia hipertrofovanoho sertsia. Visnyk naukovykh doslidzhen. 2017; 4: 6–9. [in Ukrainian]

9. Slobodian OM, Korchynska NS. Renthenanatomiia ta morfometriia verkhnoi shchelepy v druhomu trymestri vnutrishnoutrobnoho rozvytku. Ukrainskyi zhurnal klinichnoi ta laboratornoi medytsyny. 2013; 8(3): 98–101. [in Ukrainian]

10. Chaikovska SYu. Analiz vikovoi dynamiky mineralnoho skladu kistkovoi tkanyny komirkovoi chastyny nyzhnoi shchelepy u ditei doshkilnoho viku. Klinichna anatomiia ta operatyvna khirurhiia. 2016; 15(3): 53–57. [in Ukrainian]

11. Ferros IN, Mora MJ, Obeso IF, Jimenez P, Martinez-Insua A. The nasomaxillary complex and the cranial base in artificial cranial deformation: relationships from a geometric morphometric study. Eur. J. Orthod. 2015 Aug; 37(4): 403–411.

12. Govindraju P, Chandra P. Radiomorphometric indices of the mandible – an indicator of osteoporosis. J. Clin. Diagn. Res. 2014; 8(3): 195–198.

13. Oshurko AP, Oliinyk IYu. Features of morphogenesis of the maxillofacial area in the embryonic and pre-fetal periods of human prenatal ontogenesis. In: Development and modernization of medical science and practice: experience of Poland and prospects of Ukraine: Collective monograph. Vol. 1. Lublin: Izdevniecіba "Baltija Publishing". 2017; 203–236.

14. Szpinda M, Baumgart M, Szpinda A, Woz´niak A, Mila-Kierzenkowska C, Dombek M, et al. Morphometric study of the T6 vertebra and its three ossification centers in the human fetus. Surg. Radiol. Anat. 2013; 35: 901–916.

15. Xiaochen F, Loebel DAF, Bildsoe H, Wilkie EE, Qin J, Wang J, et al. Tissue interactions, cell signaling and transcriptional control in the cranial mesoderm during craniofacial development. AIMS Genetics. 2016; 3(1): 74–98.

Реферати

ДОСЛІДЖЕННЯ ЯКІСНИХ ХАРАКТЕРИСТИК КІСТКОВОЇ ТКАНИНИ ВЕРХНЬОЇ ЩЕЛЕПИ ЛЮДИНИ ЗА КІЛЬКІСНИМ ВМІСТОМ МАКРОЕЛЕМЕНТІВ (P, Na, Ca, Mg, S) У ДИНАМІЦІ ПРЕНАТАЛЬНОГО ОНТОГЕНЕЗУ

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Досліджено зачатки верхніх щелеп 131 плода людини віком 11-40 тижнів внутрішньоутробного розвитку з метою визначення кількісного вмісту макроелементів (P, Na, Ca, Mg, S) у динаміці пренатального онтогенезу. Забір кісткової тканини проводили на обох сторонах зачатка верхньої щелепи плодів людини із різних ділянок, що мали макроскопічно найбільш виражену щільність. Застосовано комплекс методів морфологічного дослідження, який включав макроскопію, морфометрію, тонке препарування об'єктів під контролем лупи; методи полуменевого атомно-емісійного та атомно-абсорбційного аналізу; фотометричний та турбідиметричний методи; метод статистичних згрупувань при вивченні якісно однорідних сукупностей, варіаційний аналіз статистичних даних з визначенням пересічних величин для кожного макроелемента, похибки пересічних величин, оцінки достовірності середніх величин та ймовірність безпомилкового прогнозу. Отримано значну відмінність у динаміці перебігу плодового періоду пренатального онтогенезу між показниками вмісту макроелементів, що є якісним результатом кількісної морфології у визначенні їх вмісту під час дослідження кісткової тканини верхньої щелепи у плодів людини.Закономірність динаміки щільності кісткової тканини верхньої щелепи плодів людини залежно від мінерального складу та наявності виявленої синхронності цих процесів дозволяє стверджувати, що зміна щільності є свідченням зміни вмісту окремих мінеральних елементів, проте головну роль, як основний будівельний матеріал, відіграють саме макроелементи (Ca, P, Na, Mg, S). Отримані результати обґрунтовані та можуть бути основою для розробки нових методик ранньої діагностики вроджених аномалій щелепно-лицевої ділянки ще на доклінічних етапах та способів їх профілактики, шляхом корекції мінерального складу.

Ключові слова: верхня щелепа, пренатальний онтогенез, людина, макроелементи.

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ИССЛЕДОВАНИЕ КАЧЕСТВЕННЫХ ХАРАКТЕРИСТИК КОСТНОЙ ТКАНИ ВЕРХНЕЙ ЧЕЛЮСТИ ЧЕЛОВЕКА ЗА КОЛИЧЕСТВЕННЫМ СОДЕРЖАНИЕМ МАКРОЭЛЕМЕНТОВ (P, Na, Ca, Mg, S) В ДИНАМИКЕ ПРЕНАТАЛЬНОГО ОНТОГЕНЕЗА

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Исследованы зачатки верхних челюстей 131 плода человека в возрасте 11-40 недель внутриутробного развития с целью определения количественного содержания макроэлементов (P, Na, Ca, Mg, S) в динамике пренатального онтогенеза. Забор костной ткани проводили на обеих сторонах зачатка верхней челюсти плодов человека из разных участков, макроскопически имеющих наиболее выраженную плотность. Применен комплекс методов морфологического исследования, который включал макроскопию, морфометрию, тонкое препарирования объектов под контролем лупы; методы пламенного атомно-эмиссионного и атомно-абсорбционного анализа; фотометрический и турбидиметрический методы; метод статистических группировок при изучении качественно однородных совокупностей, вариационный анализ статистических данных с определением рядовых величин для каждого макроэлемента, погрешности рядовых величин, оценки достоверности средних величин и вероятность безошибочного прогноза. В динамике течения плодного периода пренатального онтогенеза получено значительное различие между показателями содержания макроэлементов, что является качественным результатом количественной морфологии в определении их содержания во время исследования костной ткани верхней челюсти у плодов человека. Закономерность динамики плотности костной ткани верхней челюсти плодов человека в зависимости от минерального состава и наличия выявленной синхронности этих процессов позволяет утверждать, что изменение плотности является свидетельством изменения содержания отдельных минеральных элементов, однако главную роль, как основной строительный материал, играют именно макроэлементы (Ca, P, Na, Mg, S). Полученные результаты обоснованы и могут быть основой для разработки новых методик ранней диагностики врожденных аномалий челюстно-лицевой области еще на доклинических этапах и способов их профилактики, путем коррекции минерального состава.

Ключевые слова: верхняя челюсть, пренатальный онтогенез, человек, макроэлементы.

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