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CLINICAL CHARACTERISTIC OF STRUCTURE AND PROPERTIES OF SOLID TISSUES OF INTACT TEETH AMONG CHILDREN OF SCHOOL AGE LIVING IN THE CONDITIONS OF THE NORTH

ABSTRACT

Complex laboratory research of solid tissues condition of the intact teeth extracted according to orthodontic indications among school age children living in conditions of the North-East of Russia has been carried out. Specific regional risk factors of the development of dental diseases are necessary to take into account for improvement of the treatment-and-prophylactic help to the population. So, researchers have established certain changes of structure and properties of solid tissues of teeth which are connected with disorders of structural uniformity and calcium - phosphorus coefficient. At the same time the received results of weight ratio of calcium and phosphorus characterized decrease of enamel resistance of intact teeth among children of school age. It is connected with the fact that there is a replacement of calcium and phosphorus with others macro - and microelements in the crystal lattice of hydroxyapatite which cause susceptibility of teeth enamel to the influence of the cariogenic factors of external and internal environment. At that time the indicator of tissues mass from oral surfaces of intact premolars and molars was on the sites with low level with the reliable importance that is connected with anatomy-topographical features of molars and premolars as vestibular hillocks were more expressed.

The revealed quantitative and qualitative changes of enamel and dentine of second teeth create prerequisites for development of pathological processes of solid tissues of demineralizing character that respectively can be considered as specific regional risk factor. In this regard it is necessary to consider the revealed and established risk factors organizing events, directed to the improvement of dental help to the population. These facts dictate need of the comprehensive program development of the teeth caries prevention among children of preschool and school age in the region directed to increase of resistance of teeth solid tissues with use of calcium, phosphorus and fluorine.

On the other hand, the obtained data define need of carrying out further complex researches directed to detection of regional risk factors of the development of pathological processes of organs and tissues of oral cavity.

Keywords. Caries of teeth, microhardness of teeth, structural uniformity, hydrostatic weight, resistance of solid tissues of teeth.

INTRODUCTION

Nowadays pathogenetic mechanisms of pathological processes of teeth solid tissues of demineralizing character are widely studied that it is connected with the high level of their prevalence among various age groups of the population [1, 6, 7, 8, 10, 11, 13, 14, 15, 16]. Despite it, problems of treatment and prevention of teeth caries are not solved yet [3, 4, 5, 12]. Caries of teeth and its complication in oral cavity often form the chronic odontogenic infection center which can lead to the development of focal caused diseases (diseases of kidneys, liver, joints, etc.) [2, 9]. In this regard the researches directed to the solution of treatment and prevention of teeth caries are actual.

Natural and climatic conditions of Yakutia are characterized as severe that leaves a negative print on a functional condition of organs and tissues of oral cavity including teeth solid tissues that demands carrying out the researches directed to studying of structural uniformity of solid tissues, and also their quantitative changes.

Research aim. To determine teeth functional state level on the basis of complex research of quantitative and qualitative changes of teeth solid tissues.

Materials and methods of research. Research of solid tissues of the intact teeth extracted according to orthodontic indications was conducted. In total 88 stones of incisors, canines, premolars and molars have been examined. Research of contact and lateral surfaces, vestibular and oral sides, apex of cheek, oral tubercles, fissures of chewing surfaces, contact front and back surfaces, cheek and oral sides of premolars and molars was done.

Studying of microhardness of teeth solid tissues was carried out by Vickers's method, regulated by GOST 2999-75. Hardness was measured at loadings from 9,8 N (1 kgf) to 980 N (100 kgf) in the device "DIGITAL MIKROINDENTATION TESTER LM-700" (Japan). The metod was based on diamond tip caving-in in the form of the regular tetrahedral pyramid in the sample under the influence of the loading P enclosed during certain time and measurement of a diagonal print of d1 and d2, which have remained on the sample surface after loading removal. Vickers's method is considered to be the most perfect, it allows to measure the hardness of both soft and solid materials. The measurement was carried out according to the scheme shown in Figure 1, at each point was carried out at least 3 measurements, then calculate the everage.

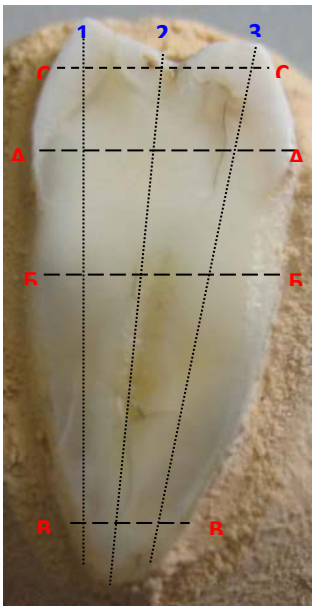

Figure 1. Microhardness measurement diagram of the section of the tooth on the Vickers hardness test.

Research was conducted at the department of solid state physics and technology institute "North-eastern federal university named after M. K.Ammosov".

Determination of density of solid tissues of intact teeth was carried out by measurement of the linear sizes of samples and method of hydrostatic weighing with measuring scales.

Studying of structural uniformity of inside layers of enamel and teeth dentine was carried out with application of method of x-ray power-dispersive microanalysis with standardless analysis detector by means of the combined device XL 20 (Philips), raster electronic microscope, radiological microanalyzer with dispersion on energy (Scott V.D., Love G., 1983). Microphotos were received in the mode of secondary electrons, quantitative analysis was carried out by standardless method promoting obtaining considerably bigger volume of reliable experimental data. Also the radiological power-dispersive spectral microanalysis of inorganic elements (sodium, magnesium, aluminum, silicon, inorganic phosphorus, sulfur, chlorine, potassium, calcium) of enamel and dentine was carried out.

Statistical processing of clinical material was carried out with application of standard methods of variation statistics. The received results have been grouped in a set of identical signs. A critical significance value when checking statistical hypotheses was $p \leq 0,05$.

RESULTS AND DISCUSSIONS

The analysis of the obtained data of the spectral microanalysis characterizing the saturation of teeth solid tissues of micro-microelements confirm some of their features of their weight ratio and ratio of atomic mass. In structure of weight ratio indicators, the important place is taken by calcium and phosphorus which indicators fluctuated within 40,42-41,42 and 18,22-18,64%. At the same time these concentration of fluorine and sodium were in limits of digital values 0,99-1,82 and 0,86-2,31%. Dta of such components as chlorine and magnesium were characterized as insignificant levels of concentration and they respectively made 0,48-1,02 and 0,32-0,42%. Meanwhile, the received results of weight ratio of calcium and phosphorus characterize disorders of enamel structural uniformity of intact teeth among children of school age that was confirmed by indicator of calcium - phosphorus molar coefficient made 1,93 (optimum value 1,67). It was connected with the fact that there is a replacement of calcium and phosphorus with others macro –microelements in a crystal lattice of hydroxyapatite which cause decrease in resistance of teeth enamel to influence of cariogenic factors of external and internal environment.

It is necessary to emphasize that ratios of atomic mass of fluorine and chlorine in enamel fluctuated within 2,93-3,25 and 0,57-1,96%. At the same time average indicators of a share of atomic mass of calcium and phosphorus made considerable part and was 95,48% where the specific weight of calcium was 54,61% and the second component was 40,87%. The atomic mass of sodium and magnesium are at the level of digital values 1,40 and 0,71 % in intact teeth enamel among children of school age living in sharply continental climate of the North.

The above analysis showed that disorders of structural ratio of calcium and phosphorus concentration in indicators of the radiological spectral microanalysis of intact enamel of second teeth among children and teenagers removed according to orthodontic indications which promoted decrease in resistance of teeth solid tissues to aggressive influence of factors of external and internal environment were revealed. These facts of cariogenic situation create prerequisites to formation and development of pathological processes of teeth solid tissues of demineralizing character in children of school age of the Republic of Sakha (Yakutia) and respectively they are one of specific regional biological risk factors of development of teeth caries among indigenous population.

Knowledge of features of structural uniformity and composition of solid tissues is an important point for dentists for the rational organization of the teeth caries treatment-and-prophylactic help. In this regard we have carried out an assessment of properties and some features of composition of solid tissues of intact teeth among children of school age living in the Central Yakutia.

The carried-out analysis of these measurements of teeth tissues hardness by Vickers's method characterized existence of variations of numerical values (tab. 1). In such sites as, enamel of chewing surfaces of molars and premolars, tooth hardness reached maximum level and respectively it ranged from 964,3 to 1952,7 N (kgf), at the same time indicators of enamel surface in neck area were 305,1 and 548,2 N (kgf). Data of dentine root hardness in the area ½ and near apex fluctuated ranged from 294,7 to 467,8 N (kgf) and from 217,1 to 404,9 N (kgf).

Table 1

Characteristic of microhardness of solid tissues of intact teeth among children of school age

Measurement point	Measurement of tooth hardness by Vickers's method (kgf)			Mean value by measurement points
	Vestibular surface	Central surface	Oral surface	
А	411,91±4,17	381,4± 5,14	422,01±4,84	405,10±0,88
Б	352,55±3,75	391,2±3,30	385,38±3,78	376,37±0,83
В	206,43±4,03	314,8±4,11	311,71±4,076	277,61±2,35
С	1359,5±16,61	1315,03±20,71	1129,8± 16,18	1268,11±4,97

Researches by method of hydrostatic weighing measurement of solid tissues of intact teeth have given data of their mass and density which had some features. So, the indicator of tissues mass from oral surfaces of intact premolars and molars was in sites below digital values from the vestibular side in 0,18 m/g, with the reliable importance ($P<0,05$).

It, most likely, is connected with anatomy-topographical features of molars and premolars as vestibular tubercles were more expressed. The assessment of these linear measurements hasn't revealed existence of features. So, indicators of density of the studied sites from oral and vestibular surfaces varied from 1,79 to 2,25 g/cm ³. At the same time average indicators had no special distinctions.

Conclusion. The conducted research characterized certain quantitative and qualitative changes of solid tissues of intact teeth among children of school age who were connected with disorders of their structural uniformity due to expense of calcium - phosphorus coefficient imbalance. These facts reduced resistance of teeth solid tissues to aggressive factors of external, internal environment and cariogenic situation promoted the development of pathological processes of demineralizing character. The revealed risk factors need to be considered when carrying out treatment-and-prophylactic actions in the conditions of the North.

REFERENCES

1. Alekseeva N.A. Kliniko-fiziologicheskie obosnovanie profilaktiki kariesa zubov u detey v Respublike Saha (Yakutiya) : dis. … kand. med. nauk [Clinical-physiological basis of prevention of teeth caries among children in the Republic of Sakha (Yakutia): thesis. … candidate of medical sciences]. Yakutsk, 2010,138 p.
2. Filippov S.V. Osnovnyie stomatologicheskie zabolevaniya u detey yakutskoy natsionalnosti Kobyayskogo rayona Respubliki Saha (Yakutiya) [The main dental diseases among children of the Yakut nationality of Kobyaysky district of the Republic of Sakha (Yakutia)]. Siberian medical journal, 2007, №2, V.22, P. 97-99.
3. Kuzmina E.M. Profilaktika stomatologicheskih zabolevaniy: Ucheb posobie [Prevention of dental diseases: Manual]. Moscow, 2001, 214 p.
4. Opravin A.S. Ovodova G.F. Kuzmina L.N. Sostoyanie stomatologicheskogo zdorovya vzroslogo naseleniya Arhangelskoy oblasti [Condition of dental health of adult population of the Arkhangelsk region]. Osnovnye stomatologicheskie zabolevanija, ih lechenie i profilaktika na Evropejskom Severe: sbor. nauch. trudov. Vyp.11 / pod red. A.S. Opravina [The main dental diseases, their treatment and prevention in the European North: collection of scientific works. Issue 11/ editor A.S. Opravin, Izd-vo Severnogo gosud. med. univer [Publishing house of Northern state medical university]. Arkhangelsk 2011, P. 150-152.
5. Pikhur O. L., Ryzhak G. A., Iordanishvili A.K. Mineralnyiy i himicheskiy sostav tverdyih tkaney zubov zhiteley Severo-Zapadnogo regiona Rossii [Mineral and chemical composition of solid tissues of teeth of inhabitants of the Northwest region of Russia]. Aktual'nye problemy stomatologii Arkticheskogo regiona, sovremennye tendencii i perspektivy diagnostiki, lechenija i profilaktiki stomatologicheskih zabolevanij: materialy I Arkticheskogo stom. foruma / pod red. A.S. Opravina [Actual problems of dentistry of the Arctic region, current trends and prospects of diagnostics, treatment and prevention of dental diseases: materials of I Arctic forum / editor A.S. Opravin], Arhangel'sk: Izd-vo Severnogo gosud. med. univer. [publishing house of the Northern state medical university], Arkhangelsk, 2015, P. 137-138.
6. Rumyantsev V.A., Borinskiy Yu.N., Belyaev V.V. Soderzhanie ftorida v pitevyih vodah i napitkah i ego svyaz s profilaktikoy kariesa i flyuoroza zubov [Content of fluoride in drinking waters and drinks and its connection with prevention of caries and dental fluorosis]. Stomatology, 2009, No5, P. 59-63.
7. Ushnitskiy I.D. Kliniko-fiziologicheskie aspektyi sostoyaniya organov i tkaney polosti rta u naseleniya Respubliki Saha (Yakutiya) : dis. … d-ra med. nauk: 03.00.13; 14.00.21 [Clinical-physiological aspects of condition of organs and tissues of oral cavity among population of the Republic of Sakha (Yakutia): thesis . … doctor of medical sciences: 03.00.13; 14.00.21]. Arkhangelsk, 2001, 262 p.
8. Ushnitskiy I.D. Stomatologicheskie zabolevaniya i ih profilaktika u zhiteley Severa [Dental diseases and their prevention among inhabitants of the North]. Moscow: Science, 2008, 172 p.
9. Vilova T.V. Kliniko-fiziologicheskoe obosnovanie formirovaniya kariesvospriimchivosti zubov u naseleniya Arhangelskoy oblasti : avtoref. dis. … d-ra med. nauk : 03.00.13, 14.00.21 [Clinical-physiological basis of

formation of caries susceptibility among population of Arkhangelsk region: thesis abstract. … doctor of medical sciences: 03.00.13, 14.00.21]. Arkhangelsk, 2001, 38 p.

10. Vusataya E.V. Mediko-sotsialnyie aspektyi stomatologicheskoy zabolevaemosti vzroslogo gorodskogo naseleniya i puti ee profilaktiki v sovremennyih usloviyah : dis. … kand. med. nauk [Medical-social aspects of dental incidence of adult urban population and methods of its prevention in modern conditions: thesis . … candidate of medical sciences]. Ryazan, 2007, 219 p.
11. Yavorskaya T.E. Sravnitelnaya harakteristika effektivnosti sredstv, primenyaemyih dlya profilaktiki kariesa zubov u detey: avtoref. dis. … kand. med. nauk [The comparative characteristic of efficiency of the methods applied to prevention of caries of teeth among children: thesis abstract. … candidate of medical sciences]. Omsk, 2013, 141 p.
12. Zyiryanov B.N. Karies zubov u korennogo i prishlogo naseleniya Kraynego Severa Tyumenskoy oblasti, mehanizmyi razvitiya i profilaktiki: avtoref. dis. … d-ra med. nauk: 14.00.21 [Caries of teeth among indigenous and alien people of Far North of the Tyumen region, mechanisms of development and prevention: thesis abstract… doctor of medical sciences: 14.00.21]. Omsk, 1998, 47 p.
13. Masotti S., Onisto N., Marzi M. Dento-alveolar features and diet in an Etruscan population (6th-3rd c. B.C.) from northeast Italy / S. Masotti, N. Onisto, M. Marzi [et al.] // Archives of Oral Biology, 2013, Vol.58, №4, P.416-426.
14. Lawrence H.P. Oral health interventions among indigenous populations in Canada / H.P. Lawrence // Int. Dent. J, 2010, Vol.60, №3 (Suppl. 2), P.229-234.
15. Marico R. Acculturation and dental health among Vietnamese living in Melbourne, Australia / R. Marico // Community Dent. Oral Epidemiol, 2001, Vol.29, №2, P.107-119.
16. Vigild M. Dental health status and use of dental health services among adults in Denmark // Danish Dent. J., 1996, Vol.100, P. 215-222.

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