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THE STUDY OF ORAL FLUID DYNAMIC PARAMETERS ON THE BACKGROUND OF PATHOLOGICAL AND PHYSIOLOGICAL DENTAL ABRASION

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ABSTRACT

Introduction: Violation of oral fluid mineralization processes, which is determined by the mineralization potential of saliva, is associated with changes in the physicochemical parameters of the oral fluid, particularly its viscosity.

The aim of our study was to study mineralization potential and types of microstallation of oral fluid as one of the factors of influence on the cariesogenic situation in the oral cavity of patients with physiological or pathological tooth abrasion.

Materials and methods: During the examination of patients' oral cavity, a comprehensive assessment of tooth hard tissues was performed in order to of study activity and prevalence of the processes occurring in them.

Results: Assessing the physico-chemical parameters of oral fluid in patients of the first experimental group, we obtained the following results: the viscosity of saliva in subgroups was 2,17 ± 0,87 for subgroup #1, 1,78 ± 0,57 for subgroup #2, and 2,15 ± 0,86 for #3 subgroups, which did not have a significant difference between the indices within the group. During the research, the number of independent structures of oral fluid in subgroups 1-3 was 1.67 ± 0.86, 1.67 ± 0.77 and 1.57 ± 0.85.

Conclusions: Thus, we have established that the mineralizing function of saliva changes when the cariesogenic situation in the oral cavity arises,. This leads to destabilization of the crystalline structure of the oral fluid and indicates the relationship between its structural and mineralizing properties.

KEY WORDS: abrasion of tooth hard tissues, mineralizing potential of oral fluid, microcrystallization of oral fluid

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INTRODUCTION

Saliva is a complex biological fluid that performs tooth mineralization after their erruption and provides the optimal composition during their function [1; 2]. Despite many factors contributing development of dental caries, biological environment of the oral cavity (i.e. oral fluid, which constantly changes its characteristics: quantitative and qualitative composition, mechanisms of protection, etc.) remains the main etiological factor of caries appearance. Violations of the physico-chemical properties of the oral fluid are associated with general and local factors and affect the oral cavity. Thus, those violations contribute to the development of diseases of tooth hard tissues [3].

Recently the understanding of demineralization and remineralization processes of tooth structures, depending on the features of the manifestation of physiological and pathological abrasion and the emergence of carious process, was significantly reconsidered [4]. This concept involves not only treatment of caries using different methods of preparation and bioactive restoration materials, but also early diagnosis of risk factors for the development of caries and their correction. One of the major risk factors is a violation of the oral fluid properties.

An important role in maintaining homeostasis of solid dental tissues belongs to the mineralization function of saliva. The study of the mineralizing properties of the oral fluid by assessing the nature of its microcrystallization in conditions of various external and internal environmental influences remains a relevant research method in terms of diagnosis and prediction of pathological conditions of the organs of the oral cavity.

The composition of the oral fluid plays a major role in the development of a number of the oral cavity diseases, particularly in the development of tooth caries [5]. Violation of oral fluid mineralization processes, which is determined by the mineralization potential of saliva, is associated with changes in the physicochemical parameters of the oral fluid, particularly its viscosity.

THE AIM

The aim of our study was to study the viscosity, mineralization potential and types of microstallation of oral fluid as one of the factors of influence on the cariesogenic situation in the oral cavity of patients with physiological or pathological tooth abrasion.

MATERIALS AND METHODS

During the examination of patients' oral cavity, a comprehensive assessment of tooth hard tissues was performed in order to of study activity and prevalence of the processes occurring in them. The intensity of the carious process was determined according to the DMFT index of teeth (total number of decayed, missing and filled teeth in one surveyed). Evaluation of hygienic condition of oral cavity was performed with a Fedorov-Volodkina's index.

Patients with carious teeth were divided into two groups The first clinical group consisted of 53 patients with chronic advanced caries on the background of physiological abrasion. The second clinical group consisted of 65 patients with chronic advanced caries on the background of pathological abrasion of tooth hard tissues. The classifications of the caries according to its severity and progression have been used. In order to verify the form tooth of abrasion, the classification of Moldovanov (1992) was used [6]. For a more accurate diagnosis the form of abrasion, its prevalence and type of abrasion were also precised.

As filling material we used glass-ionomer cement VITREMER (by 3M). Patients treated with this filling material were assigned to subgroup #1 of the 1st group (21 patients) and to the subgroup #2 of the 2nd group (20 patients). We also used material CHARISMA (by Heraeus Kulzer) as a light curing composite resin material. This material was used in the combination with adhesive systems of 5th generation (Single Bond 2 by 3M) and 7th generation (Adper Easy One by 3M) [7,8] . Depending on the type of adhesive system and the diagnosis of the pathology pathients were assigned to the following subgroups: subgroups #2 of the 1st group (18 patients), subgroups #2 of the 2nd group (23 patients), to subgroups #3 of the 1st group (14 patients), and to subgroups #3 of the 2nd group (22 patients).

The viscosity of the oral fluid was studied according to Redinova`s technique [9]. Mixed saliva was collected in sterile glass test-tubes immediately at the beginning of the study. Then we calibrated 1ml medicine dropper with distilled water with measuring the volume of water that flowed out of it during 5 seconds (Vw.). Having it mounted vertically and filled with 1 ml of saliva we measured the volume of oral fluid that flowed out of the medicine dropper over a period of time (Vs). The viscosity of saliva was determined in relative units according to the formula: Vs = Vw · Vw / Vs (where V w is the volume of water ejected from the dropper (ml); Vs - the volume of saliva that leaked from the dropper (ml); Vw - water viscosity. The average Vs value approaches to 1.46 with significant deviations (1.03-3.74). The Vs value exceding 1.46 is a dangerous prognostic indicator for the emergence and development of carious process.

The mineralization potential of the oral fluid (MPOF) was evaluated by the nature of its microcrystallization (MC) [4]. The principle of this method implies the ability of the crystalline substance to form crystals of various forms and different orientations in all dimensions after drying. A portion (0.2-0.3 ml) of mixed saliva was taken from the flor of the oral cavity with a sterile pipette. At least 3 drops of saliva were applied on a slide glass, pre-treated with alcohol. Drying procedure was carried out at room temperature. The dried glass were packed in containers and sent to the laboratory for research. The structure of crystallograms was evaluated macroscopically (quantity of crystallization centers and the character of the image) and microscopically (structure and changes of crystals).

The structure of saliva samples was studied with an optical microscope «Leica DLMS-LS» (Germany) and camera «Nikon DM v.581-80. Primary scanning of entire surface of the drop was performed under the small magnification. Secondary scanning of certain areas with different morphology was performed under the large magnification. Selected areas of crystallographs were photographed and saved.

Determination of microcrystallization types was performed according to the following types of MC. Also, whole surfaces of drops were reexamined in order to determine the mineralization potential of the oral fluid (MPOF). The formula: MPOF = Σ MC / 3 (where MPOL - mineralization potential of oral fluid, recorded in points, Σ MC - sum of microcrystallization types of oral fluid).

Microcristalisation evaluation was carried out according following schema: I type was characterized by a clear pattern of large elongated crystallographic structures, merged together and had a tree or fern-shaped form, located mainly in the center of the drop. Organic part was placed along the periphery in a small amount. This type of microcrystallization received 5 points; II type had a separate dendritic crystalloplasty structure in the center of the drop, smaller comparing to the I type. A large number of crystalline structures of irregular shape were placed on the periphery. This type received 3 points; III type had crystals of different shapes, which were placed evenly in the form of a mesh in the field of . A lot of organic part was still in the field of view. III type received 2 points; Type IV had a large number of isometrically placed irregular structures throughout the drop surface; 1 point. V type did not recieved any points due to the absence of crystals in the field of view.

Analysis was performed regarding to the total area of the drop of saliva [4], expressing in ponts the crystallization level: 1 point - very low, 2 points - low, 3 points - satisfactory, 4 points - high, 5 points - very high, which corresponded I, II, III types by. Leus and Dubrovna [6].

All work was conducted in accordance with the Declaration of Helsinki (1964) and was approved by the Ethical Committee of the academy.

RESULTS AND DISCUSSION

Assessing the physico-chemical parameters of oral fluid in patients of the first experimental group, we obtained the following results: the viscosity of saliva in subgroups was 2,17 ± 0,87 for subgroup #1, 1,78 ± 0,57 for subgroup #2, and 2,15 ± 0,86 for #3 subgroups, which did not have a significant difference between the indices within the group. During the research, the number of independent structures of oral fluid in subgroups 1-3 was 1.67 ± 0.86, 1.67 ± 0.77 and 1.57 ± 0.85. Depending on the characteristics of independent struc-

Table I. Viscosity and degree of oral fluid mineralization of patients from the experimental groups (M ± m).

Parameters	Groups	Quantity of patients	Results recieved	Possible fault
Saliva viscosity (μ)	I	53	1,95 ± 0,73	≤ 0,05
	II	65	2,25 ± 0,91*	
Quantity of independent structures	I	53	1,64 ± 0,81	≤ 0,05
	II	65	2,4 ± 0,58*	
Mineralizing potential of oral fluid	I	53	2,37 ± 1,42	≥ 0,05
	II	65	2,58 ±0,69	
I type of microcristalization	I	53	0,54±0,74	≥ 0,05
	II	65	0,84±0,59	
II type of microcristalization	I	53	0,64 ± 0,48	≥ 0,05
	II	65	0,64 ± 0,62	
III type of microcristalization	I	53	0,67 ± 0,47	≤ 0,05
	II	65	1,13 ± 0,56*	
IV type of microcristalization	I	53	0,82 ± 0,51	≥ 0,05
	II	65	0,41 ± 0,49	
V type of microcristalization	I	53	0	≤ 0,05
	II	65	0,046 ± 0,21*	

Notes: * - the reliability of the difference between the values of p≤0,05

Table II. DMFT and hygienic indices results.

Indices	Subgroups	Quantity of patients	Results, M ±m
DMFT	1	21	14,38±4,74
	2	18	12,06±3,78
	3	14	12,79±4,02
Hygienic index	1	21	1,91±0,20
	2	18	1,82±0,17
	3	14	1,84±0,18

tures, the mineralizing potential of oral fluid for subgroup 1 was 2.38 ± 1.42, for the subgroup 2 - 2.23 ± 1.47 and for the subgroup 3 - 2.38 ± 1.42, which is a satisfactory prognostic sign for the emergence of a carious process (Table I).

When comparing the viscosity of saliva, we noticed a significant difference in the rates among patients in groups I and II. The mineralizing potential of the oral fluid also has a significant difference in the groups.

The hygienic state of the oral cavity according to the Fedorov-Volodkina`s index was mostly determined as satisfactory or unsatisfactory. The condition of hygiene of the oral cavity, assessed as a good one, was seldom. Patients who were already divided into groups had practically the same level of oral hygiene 1.86 ± 0.189 for patients in group I and 1.83 ± 0.13 for patients in group II with p ≥ 0.05. (Table II).

The mineralization potential of the oral fluid also had a significant difference in the studied groups:

WE should also note that:

- viscosity of saliva has a correlation with DMFT index in groups (p = 0.001);
- DMFT and hygienic indices are influenced by the type of microcrystallization. The III type has a correlation with the DMFT index (p = 0.005), GI (p = 0.007) and with viscosity (p = 0.001) and the number of independent structures (p = 0.001);
- IV type of microcrystallization has a strong correlation with viscosity (p = 0.007), the number of independent structures (p = 0.0078) and with mineralizing potential of the oral fluid (p = 0.0001). A connection was also established between structures of IV type and I and II type of crystallization;
- The V type of microcrystallization of the oral fluid correlates with the values and indices of type II and III (p = 0.0009 and p = 0.0008 respectively).

Therefore, I and II types of microcrystallization are predominant in caries resistant patients, type III is more typical for patients with a tendency to formation of carious cavities. Even in the case of pathological tooth abrasion in patients of the II experimental group, the III type of microcrystallization was more prevalent.

Mineralizing potential of oral liquid in patients from experimental groups depends on the number of independent structures in the patients of the I group (2.37 ± 1.42) and 2.58 ± 0.69 in patients of the II group (p ≤ 0.05) .

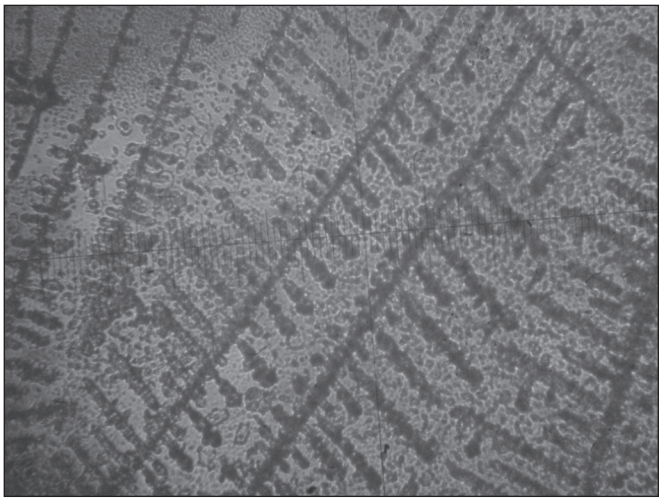

Fig. 1. Microphotography of an independent structure and I type of of the patient from II group with DMFT = 3. Patient V., 32 years.

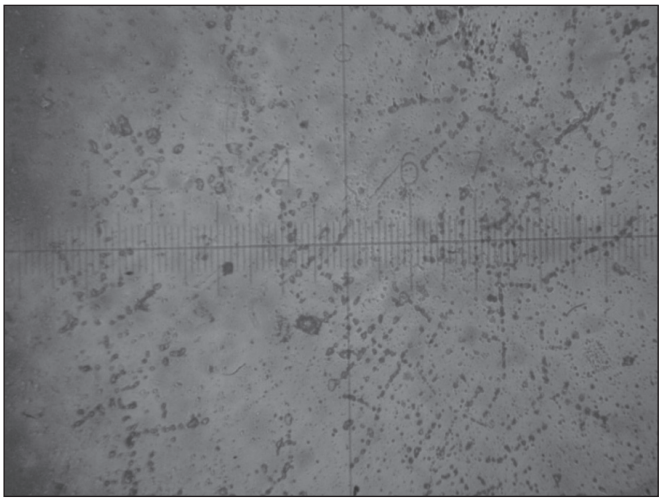

Fig. 2. Microphotography of the oral fluid structure of the patient N., 40 years of age, group I, subgroup 3 with I-II microcrystallization type structures (in the center of the experimental site).

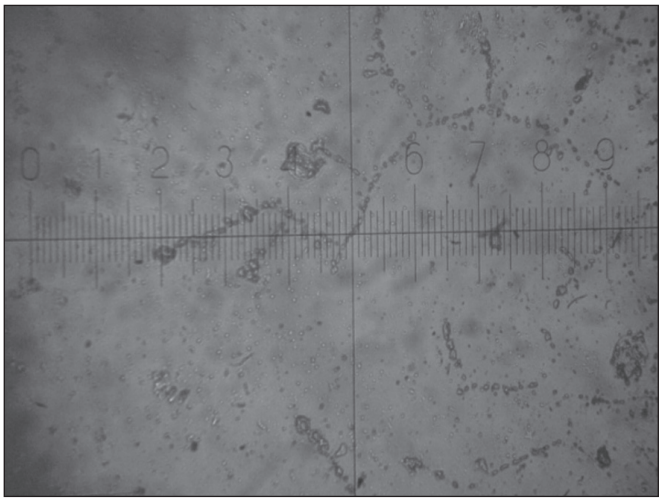

Fig. 3. Microphotography of the oral fluid structure of the patient N., 40 years of age, group I, subgroup 3 with I-II microcrystallization type structures (on the periphery).

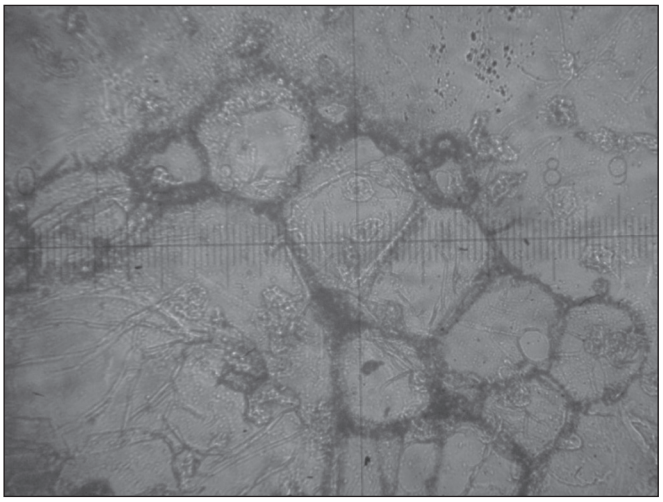

Fig. 4. Microphotography of an independent structure of the third group of dried oral liquids of the patient of group II. Patient V., 26 years old. Independent structure III with "cellular" structures are visible.

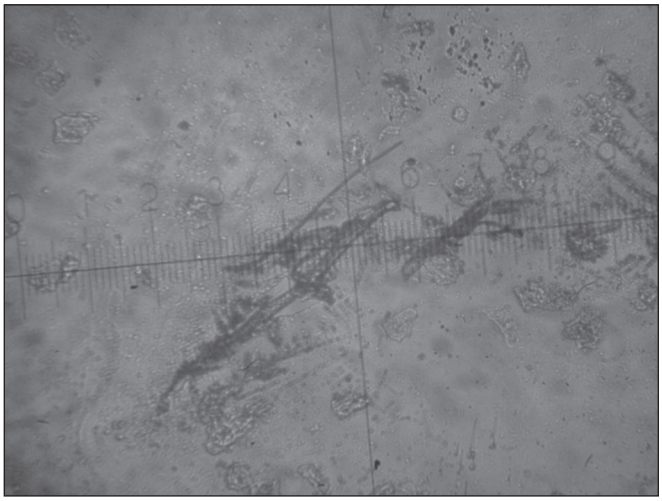

Fig. 5. Microphotography of an independent structure of the third group of dried oral liquids of the patient of group II. Patient V., 26 years old. Independent structure III with "filamentary" structures are visible.

Type I of microcrystallization was typical for patients with low DMFT I and II group (Fig.1).

Type II of microcrystallization was characterized by separate dendritic crystalloplasty structures in the center of the drop, smaller comparing to the first type. A large number of crystalline structures of irregular shape were located along the periphery. In the study, we have the opportunity to note the different density of crystalline structures throughout the surface of the sample (Fig.2-3).

III type had crystals of different shapes, which were placed evenly in the form of a mesh across all the field of vision. A lot of organic part was also present. In this type of microcrystallization, a strong correlation between DMFT, hygienic indices and type of microcrystallization was also detected (Fig.4-5).

All characteristics are interrelated and exist in one complex. Changes of one parameter may result in other changes of another. Therefore, it was quite interesting

to study oral fluid microcrystallization in patients of the above-mentioned groups and to establish differences between the presence of different structures in these patients.

Thus, a significant difference in the presence of structures I, II, II , V and the mixed structure I + II in patients of II group ($p < 0,05$). Also, a differenc in mass fractions in oral fluid samples of structures I, II, III, and V was revelaed. During the study of microcrystallization data of patients of I Group the prevalence of type III structures and mixed structures of type I + II was determined.

Comparing data of groups I and II we found a difference in the values of the indicators of structure I and the mixed structures I + II, I + II + III, I + II + IV and also I + II + V, which may lead to the influence of various factors on the ratio and formation of mixed structures, as well as the peculiarity of processes occurring in the oral liquid for the manifestation of the carious process in the physiological and pathological tooth abrasion.

CONCLUSIONS

Thus, we have established that the mineralizing function of saliva changes when the cariesogenic situation in the oral cavity arises,. This leads to destabilization of the crystalline structure of the oral fluid and indicates the relationship between its structural and mineralizing properties. In this aspect, we recommend an integral assessment of the morphology of tooth hard tissues and oral fluid in order to choose the restorative material and the features of defect of tooth hard tissues restoring in the case of physiological and pathological abrasion.

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Conflict of interest:
The Authors declare no conflict of interest.

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