REASONING OF ADHESIVE SYSTEM CHOICE FOR TREATMENT OF PATIENTS WITH INCREASED TOOTH WEAR

Wrz 19, 2018 | 2018 / 06, Praca oryginalna |

Słowa kluczowe: adhesive system | increased tooth wear | morphological features of structure

Wybór systemu klejącego w leczeniu pacjentów
z problemem nasilonego ścierania się zębów

Iryna M. Tkachenko, Victor V. Kovalenko, Petro M. Skrypnikov, Yaroslav Y. Vodoriz

THE HIGHER STATE EDUCATIONAL ESTABLISHMENT OF UKRAINE, UKRAINIAN MEDICAL STOMATOLOGICAL ACADEMY, POLTAVA, UKRAINE

Abstract

Introduction: Perceiving the high prevalence of direct composite restoration technique usage for the rehabilitation of patients with increased tooth wear, as well as during the sanitation of oral cavity before indirect methods of rehabilitation, there is a necessity in more detailed reasoning of adhesive system application for treatment of dentition with increased tooth wear.

The aim: The purpose of our work was to study the microstructure and chemical compound of hard tissues of teeth on background of increased tooth wear with the presence of a carious process with the application of adhesive systems of 5th and 7th generation.

Materials and methods: The researche of teeth with physiological and increased tooth wear with the presence of carious process in the amount of 40 pcs. was carried out with the help of a raster electron microscope (SEM) Mira 3 LMU (Tescan, Czech Republic) with a maximum resolution of 1 nm and a maximum increase of 1 000 000. Elemental composition of the local area was determined using the X-max 80mm2 energy dissipation spectrometer (Oxford Instruments, UK), integrated into a raster electron microscope.

Results: The number of enamel prisms per square area in the case of increased tooth wear is 19 per 100 microns on average and 22.65 per 100 microns in carious teeth.

Conclusions: Greater permeability is observed in the adhesive system of 7th generation (Adper Easy One), which allows it to be recommended for usege in the cases of severe caries and increased tooth wear.

Wiad Lek 2018, 71, 6, -1134

INTRODUCTION

INCREASED TOOTH WEAR,
ITS ETIOLOGY AND PREVALENCE

Tooth wear is an irreversible physiological process which means the gradual loss of hard tissues of teeth during their function as a part of masticatory apparatus. However, under certain conditions this process can be pathologically accelerated (heredity, metabolic disorders, neurodystrophy and endocrine disorders, accompanied by an imperfections in structure of

POLSKIE TOWARZYSTWO LEKARSKIE

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STYGMATYZACJA OSÓB Z DEMENCJĄ

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MEDICALIZATION IN THE MODERN BRITISH AND AMERICAN ENGLISH: STRUCTURAL AND NARRATIVE ANALYSIS

JAK UNIKNĄĆ KONSEKWENCJI SERCOWO-NACZYNIOWYCH ZESPOŁU OBTURACYJNEGO BEZDECHU SENNEGO?

ВРАЖЕНІСТЬ НАСЕЛЕННЯ ЗАКАРПАТСЬКОЇ ОБЛАСТІ АЛКОГОЛЕМ ТА НАРКОТИКАМИ

PODSTAWOWE STANDARDY PRAWNE WYKONYWANIA ZAWODU LEKARZA

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enamel and dentine, diseases of the gastrointestinal tract, occlusion, occupational hazards, and functional overload of teeth) [1]. According to various authors, the prevalence of this disease varies from 4% to 57% at a young age and reaches 91% in mature people [2,3].

METHODS OF TREATMENT OF THE INCREASED TOOTH WEAR

Rehabilitation of patients with the increased tooth wear implies identification and elimination of etiological factors, as well as restoring the lost volume of hard tissues of teeth. Indirect ceramic and metal restorations [4,5] are supposed to be the most effective methods of treatment, due to their high mechanical strength, precision level of teeth' anatomy restoration as well as their occlusive relationships. However, despite all positive qualities, the most common method of treatment is direct composite technique because of its relative low cost, simplicity and speed of application [6].

THE QUESTION OF ADHESIVE SYSTEM CHOICE

Nowadays, the most common adhesive systems used in practice are the 5th generation ("total etch") and the 7th generation ("self-etching") system. According to Yarova SV application of the 5th generation of adhesives for treatment of caries has more augmented chance of postoperative sensitivity (32% higher) than the usage of 7th generation of adhesive systems [7]. Taking into account this fact and also understanding high prevalence of direct composite restoration techniques usage for the rehabilitation of patients with increased tooth wear, as well as during the sanitation of oral cavity before indirect rehabilitation, there is a necessity in more detailed reasoning of adhesive system application for treatment of dentition with increased tooth wear.

THE AIM

Taking into account the forementioned, the purpose of our work was to study the microstructure and chemical compound of hard tissues of teeth on background of increased tooth wear with the presence of a carious process with the application of adhesive systems of 5th and 7th generation and advising their application for treatment of patients with increased tooth wear.

MATERIALS AND METHODS

The researche of teeth with physiological and increased tooth wear with the presence of carious process in the amount of 40 pcs. was carried out with the help of a raster electron microscope (SEM) Mira 3 LMU (Tescan, Czech Republic) with a maximum resolution of 1 nm and a maximum increase of 1 000 000. Elemental composition of the local area was determined using the X-max 80mm2 energy dissipation spectrometer (Oxford Instruments, UK), integrated into a raster electron microscope.

The technique of morphological study of enamel and dentine of carious teeth with physiological and increased tooth wear was as follows: the teeth were washed in running water, cleaned from dental plaque, dried with filter paper and milled (Fig. 1).

After the selection of the study sites, markings were made in the dentine zone and the enamel zone on order to fix the size of the enamel prisms and dentin tubules (Fig. 2).

Upon completion of the study on the determination of the diameter of enamel prisms and dentine tubules their number was calculated according to the method proposed by Tkachenko I.M. [8] by obtaining a series of digital images of enamel and dentine of the tooth and studied with varying power of magnification. The quantity of prisms per square area predetermines the density of enamel, which, in its turn, has influence on permeability, hardness, tissue resistances it was stated before. The number of dentine tubules characterizes the density of dentine and the features of trophic processes that occur in dentine [9].

Having established the fact of changes in the morphology and chemical composition of dentin and enamel in carious teeth accompanied by physiological or increased tooth wear, the next task of our work was to study the peculiarities of relation between selected resin-based light curing composited and the generation of adhesive systems with hard tissues of the studied teeth. As an adhesive system, we used a self-etching adhesive system of the 7th generation Adper Easy One (3M Espe) and the 5th – generation Single Bond 2 (3M Espe) [10].

All prepared teeth with with resin-based composite restorations were divided into groups depending on the features of the structure of hard tissues of teeth (a group of teeth with physiological wear, a group of teeth with increased tooth wear) and on the subgroups within each group, depending on the type of sealing material and the selected adhesive system. To adequately evaluation of relationships between filling materials and hard tissues of teeth, we performed the preparation of studied teeth from occlusal surfaces, according to Black's preparation of Class I cavities.

All data obtained during our investigation was statistically processed in the SPSS program for the purpose of detecting correlation links (Pearson criterion).

RESULTS

Data on the number of enamel prisms, the intervals between them, the number of dentine tubules and their diameter at caries and increased tooth wear is given in the Table I.

Comparing the density of of the enamel prisms allocation of the studied teeth, we have noted that the number of prisms per square area in carious teeth and in the teeth with increased tooth wear have certain differences, which may suggest to have different values of enamel resistance in the cases of caries and increased tooth wear. The number of enamel prisms per square area in the case of increased tooth wear is 19 per 100 microns on average and 22.65 per 100 microns in carious teeth [11]

Evaluating the data within each group, we can note that the quantity of prisms in the enamel of teeth has a direct correlation with the intervals between them ($p = 0.0017$). Associating the structure of enamel and dentine, we also have the opportunity to establish direct relationship between the number of enamel prisms and the number of dentine tubules ($p = 0.0421$), as well as the relationship between the diameter of the dentinal tubules and the intervals between enamel prisms ($p = 0.0268$).

Thus, the structure of enamel and dentine has peculiarities of morphological structure at different clinical states of hard tissues of teeth. This feature can be associated with a decrease on enamel density, which is associated with a decrease of enamel prisms quantity in the case of increased tooth wear as well as augmentation of interprismatic distance.

The indicated features of enamel and dentine during carious process and increased tooth wear determine different endurance to the masticatory charge, therefore, in our opinion, the reason of determining the amount, ratio and distribution of microelements at different clinical states of hard tissues of teeth becomes reasonable [12].

Data on the peculiarities of the chemical structure of enamel and dentine with caries on the background of physiological and increased tooth wear is given in Table II.

Evaluating the obtained data we can state that the amount of such an element as calcium has the potential differences in the structure of enamel and in the structure of dentine in carious teeth with physiological and increased tooth wear, that means its amount varies in different types of pathology and determines their development.

The ratio of microelements in enamel and dentine in carious teeth with physiological and increased tooth wear is shown in Fig. 3.

In the structure of enamel with caries and increased tooth wear, some elements like sodium, phosphorus and calcium have an important role as the change in their number causes changes in the structure of hard tissues of teeth, which has a direct relationship with the morphological features of their structure.

Studying correlations between morphological structure and chemical structure in investigated groups of teeth, we must state the following: in the group of carious teeth with physiological wear there is a direct correlation of quantity of enamel prisms with intervals between them, the intervals between the enamel prisms are correlated with the amount of carbon ($p = 0,03$), the amount of oxygen correlates directly with the amount of sodium ($p = 0,01$) and has inversed relationship with the amount of phosphorus ($p = 0,003$) and the amount of calcium ($p = 0,0001$), phosphorus and calcium that have a direct strong correlation between each other, in most cases and depends on resistance of hard tissues of teeth while magnesium is directly correlated with the level of carbon ($p = 0.02$).

During the investigation and analysis of the microelementary structure of dentine an inversed relationship of intertubulular dentin quantity with the level of carbon ($p = 0,02$), direct correlation of the diameter of dentin tubules with the level of phosphorus and the amount per square area ($p = 0,03$). There is a strong correlation between the level of carbon and magnesium in dentine.

DISCUSSION

Assessing the state of enamel and dentin in carious teeth with increased tooth wear we note the following: the number of enamel prisms has a direct correlation with oxygen ($p = 0.03$), carbon has a strong invered relation with the level of calcium in enamel ($p = 0.0004$), calcium, as well as in carious teeth with with physiological wear, has a strong correlation with the level of phosphorus ($p = 0.0001$), which level depends on the amount of chloride compounds in the enamel. Also, the amount of magnesium has a strong relationship with the amount of sodium, which was not noted in the study of carious teeth with physiological wear.

In the study and analysis of the microelementary structure of dentine it was found the direct relationship between the amount of the intertubulular dentin and the number of enamel prisms in the enamel (p = 0.03) and the number of enamel prisms with the amount of sodium and carbon (p = 0 , 04). The diameter of the dentin tubules is correlated with the amount of calcium in dentine (p = 0.03) and depends on the presence of magnesium (p = 0.01).

The relationships as well as the mutual influence of various components of the system on each other have proved the difference in the processes that occur primarily in enamel and dentine and highlight the features of interactions in teeth with carious process and increased tooth wear, both on the basis of correlation bonds and morphological the structure. The fact of dependence of morphology and chemical composition of dentine on the features of structure of enamel proves the relationship between these histological formations.

Thus, due to the statistical processing of data and the detection of correlations between the morphology and chemical structure of enamel and dentine in carious teeth with increased tooth wear, we have found strong direct and inversed relationships, grace to which we can predict the development of changes in pathological conditions in enamel and dentine.

The results of the determination of chemical structure of hard tissues of teeth, depending on the type adhesive system used, showed that in the study of specimens where the adhesive system of the 5th generation (Single Bond 2) was used, we have noted the following: on the edge of enamel and the filling material and the area within 5 μm from the boundaries of the material there is an augmentation of the amount of calcium, the amount of phosphorus has no significant differences both as on the boundary with the filling material and on the distance within the enamel. On the edge of enamel and the filling material and the distance of 5 μm from the border with the material there are no significant changes in the amount of calcium, but there are significant differences in the amount of phosphorus from 293.00 ± 1.47 to 451.00 ± 1.96. The amount of oxygen is increased to 1029 ± 2.40. That means that the difference in chemical parameters in different parts of the enamel with the application of the 5th generation of adhesive system (Single Bond 2) in carious teeth with increased tooth wear indicates a different degree of permeability of the system in the enamel, and in particular that different amount of microelements in the contact zone with enamel is formed after its etching and contacts with the adhesive system. The distance between the filling material and enamel in the experimental subgroups does not have a significant difference and equals, respectively, 10.75 ± 0.48 and 12.00 ± 0.41.

Studying the components of dentine in the same subgroups, we note a significant difference in the amount of calcium and phosphorus in the area with adhesive material, increased amount of oxygen and carbon. A significant increase of calcium and phosphorus in natural teeth is observed in the dentin site at a distance of 5 μm from contact with the 7th generation of adhesive system a significant raise of values of calcium and phosphorus to the numbers 112.5 ± 0.87 and 153.50 ± 1.26 respectively, and to the values of 181.00 ± 1.22 and 239.25 ± 2.69 in the teeth with an increased tooth wear comparing to the values at the contact area with adhesive system. The higher permeability to the microelements in this subgroup shows a significant increase in the amount of barium (an element from the resin-based composite material), both in the areas adjacent to the adhesive system and on the distance of 5 microns – 33.0 ± 1.21 and 12.75 ± 1.03 respectively. More active processes of exchange in dentine are caused by an increased amount of carbon in the investigated areas 386.00 ± 2.2 and 266,75 ± 2.5 respectively.

The distance between the filling material and the dentine has a significant difference in the distance values between the filling material and hard tissues of teeth and better with the application of the following adhesive system was found in the subgroup of carious teeth with increased tooth wear with parameters 43.5 ± 0.65 and 15.25 ± 0.48 respectively. That means that the permeability of the dentine for the Single Bond 2 adhesive system is higher in the subgroup with increased tooth wear, which ultimately has influence on the reduction of the distance between dentine and composite resin. In the investigation of adhesive system of 7th generation (Adper Easy One) on carious teeth with increased wear, the following changes were detected: for the enamel the amount of calcium and phosphorus has the maximum values for the all indices of this area for which can be explained by the peculiarities of the application of adhesive system without smear layer elimination. The amount of fluoride in the investigated subgroup where the 7th generation of adhesive system was used comparing to the subgroups where the 5th generation of adhesive system was used has a significantly higher value 77.00 ± 1.83 and 101.25 ± 9.4 with significant differences between the subgroups of simply caries teeth and carious teeth accompanied by the increased tooth wear, which causes higher permeability of enamel in the case of increased wear. Significant changes at the limit of 5 microns from the applied adhesive in the enamel area have not been noted, calcium and phosphorus parameters were stable, the amount of fluorine and barium on the studied areas have no significant differences. Due to the greater permeability of the enamel in the group with increased wear and caries the distance between the enamel and resin-based composite is 14.41 ± 0.41, and in the subgroup without the increased tooth wear is 21.5 ± 0.65.

In the study of the dentine zone in these subgroups, we also have the opportunity to note the increase in the amount of calcium and phosphorus in relation to the all studied materials. The

distance between dentine and resin-based composite in the subgroups is 24.00 ± 0.58 and 8.75 ± 0.48 respectively. That has a significant difference in values and proves the relation of the morphological structure, particularly dentine, and the peculiarities of dentin permeability.

Thus, after conducting the study of chemical structure of enamel and dentine of carious teeth with physiological and increased tooth wear applying various adhesive materials, we can state the following: when considering the morphology of the enamelin the carious teeth a direct correlation type of the number of enamel prisms with the number of interprismatic intervals (at p = 0.001) is noted.

The intervals between the prisms, according to the statistical processing, have an inverse relation with the amount of magnesium (p = 0,025). Thus, more intervals between the prisms the smaller amount of magnesium in the enamel, which in its turn will affect the resistance of the enamel. The intervals between the prisms also have a reverse correlation with the amount of phosphorus and carbon (p = 0.001).

The amount of carbon in enamel has a direct correlation with phosphorus and magnesium (at p = 0.001). The amount of oxygen has a strong direct correlation with calcium and phosphorus (p = 0.0001), which have a direct strong correlation type. In dentine study, the diameter of tubules has a direct correlation with the amount of phosphorus (p = 0.002), the amount of intertubulular dentine depends on the amount of carbon with high significance (p = 0.0001) with the amount of magnesium. The quantity of enamel prisms has a direct correlation with the gap between the resin-based composites and enamel (p = 0.003).

Studying enamel of teeth with increased tooth wear we note the direct dependence of number of enamel prisms to the amount of oxygen (p = 0.003). Calcium has a direct correlation with oxygen (p = 0.0004) and magnesium directly correlates with the amount of sodium in enamel. In dentine the volume of intertubular dentine is associated with the number of enamel prisms (p = 0.04), and the diameter of dentine tubules is associated with calcium (p = 0,003). The distance between dentine and resin-based composite depends on the amount of phosphorus (p = 0.002). The total number of enamel prisms and dentine tubes is directly related to the amount of carbon (p = 0. 03) and the amount of calcium (p = 0. 0007).

Assessing the differences in the indicators of increased tooth wear and the presence of a carious process, we can note a significant difference in values of sodium, calcium in the area of enamel and magnesium in the area of dentine (p <0.05). Were also observed differences in the area of enamel in the preparation zone with a significant difference in magnesium values between the two groups, at a distance of 5 μm from the preparation zone (in the area of the smear layer) differences in the amount of strontium, magnesium and carbon. In dentine directly in the area of preparation there are reliable differences in the amount of silicon, magnesium and zinc.

CONCLUSIONS

Relying of the results of our research it can be concluded that:

1. Relation of morphological structure of enamel and dentine, both in teeth with carious process and with increased teeth wear exists.

2. Dependence of the structure of enamel and dentine, both in teeth with carious process and with increased tooth wear from their microelement composition.

3. Inhomogenity of the microelement structure of enamel after application of different adhesive systems during conservative treatment. The maximum values of calcium and phosphorus responsible for the resistance of hard tissues are noted after the usage of resin-based composite material and the adhesive system of 7th generation (Adper Easy One), both in teeth with increased wear and carious process.

4. Greater permeability is observed in the adhesive system of 7th generation (Adper Easy One), which allows it to be recommended for usege in the cases of severe caries and increased tooth wear.

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This review article is a fragment of scientific topic of the chair of propaedeutics of therapeutic stomatology “Morphofunctional features of the oral tissue and their influence on the treatment and selection of therapeutic materials”; state registration number No. 0115U001112.

Authors’ contributions:

According to the order of the Authorship.

Conflict of interest:

The Authors declare no conflict of interest.

CORRESPONDING AUTHOR

Iryna M. Tkachenko

Chair of propaedeutics of therapeutic dentistry

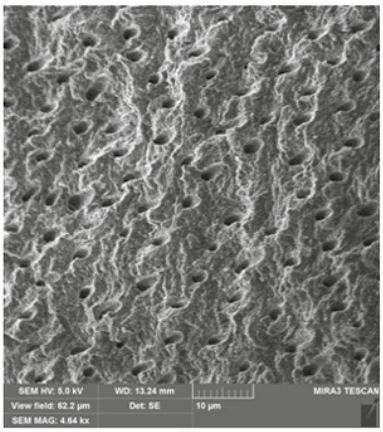
17 Zalizna Street, 36001, Poltava, Ukraine

tel: +380505353181

e-mail: tkachenkoirmix@gmail.com

Received: 20.05.2018

Accepted: 19.07.2018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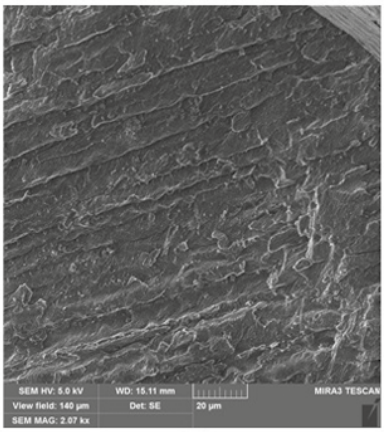
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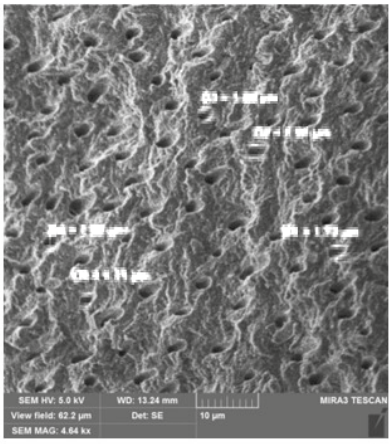
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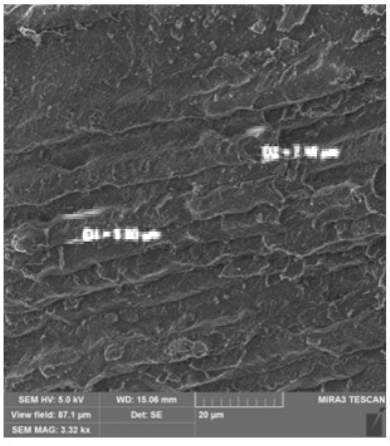
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B

Fig. 1. The studied samples

(A – the structure of the dentine of a tooth with increased tooth wear,

B – the structure of enamel of tooth with increased tooth wear).

Incremental samples 9010x, scale label 10μ, 20μm.
Fig. 2. The studied parts

(A – the dimensions of the diameter of the dentin tubules,

B – the diameter of enamel prisms).

Incremental samples 9010x, scale label 10μ, 20μm.
Table I. Data on the number of enamel prisms, the intervals between them, the number of dentine tubules and their diameter at caries and increased tooth wear is given

Investigated groups	Enamel prisms quantity on 100μm	Interprismatic distance	Dentine tubules quantity on 100 μm	Intertubular distance	Tubular diameter
Group of teeth with physiologic wear (N=20)	22,65-±1,18	0,83±0,05	16,8±0,9	6,83±0,28	1,42±0,08
Group of teeth with increased tooth wear (N=20)	19±0,59*	1,35±0,10*	15,35±0,71	6,75±0,24	1,83±0,37

Notes: * – p <0,05 between the parameters of the studied groups.
Table II. Data on the peculiarities of the chemical structure of enamel and dentine with caries on the background of physiological and increased tooth wear

Parameters of the investigation	Chemical elements							
	C	O	Na	P	Ca	Mg	Cl	Al
Parameters of enamel at physiologic tooth wear (n=20)	5,94±1,61	40,15±1,75	0,75±0,08	18,1±0,40	37,03±1,72	0,24±0,04	0,43±0,08	0,36±0,18
Parameters of dentine at physiologic tooth wear (n=20)	16,97±3,15	42,55±2,71	1,08±0,12	16,2±0,58	33,82±2,82	1,08±0,07	–	–
Parameters of enamel at increased tooth wear (n=20)	7,83±1,03	42,68±1,02	1,1±0,12*	16,96±0,53*	32,1±1,26*	0,28±0,03	0,5±0,13	–
Parameters of dentine at increased tooth wear (n=20)	19,79±1,48*	45,29±1,61	0,96±0,09	16,1±0,52	29,1±1,28*	1,06±0,05	–	–

Notes: * – p <0,05 between the parameters in the area of enamel and dentine in carious teeth with physiological and increased tooth wear.

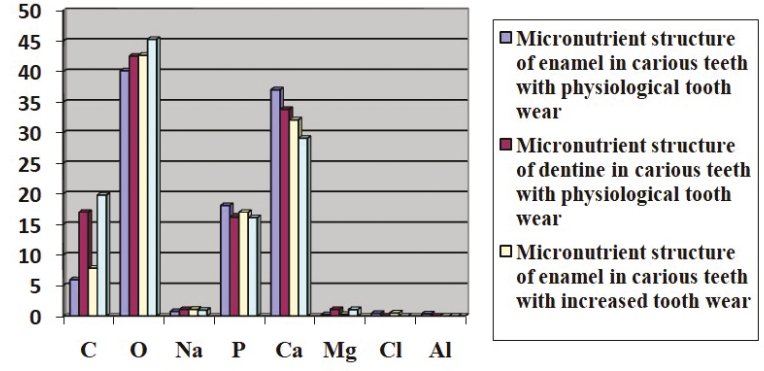

Fig. 3. Features of the chemical structure of enamel and dentine of carious teeth with increased tooth wear.

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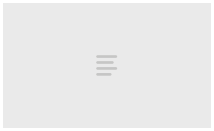
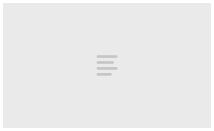


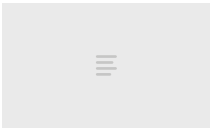
УЛЬТРАМІКРОСКОПІЧНІ ОСОБЛИВОСТІ КЛІТИН ТА СУДИН СЕЛЕЗІНКИ (ЕКСПЕРИМЕНТАЛЬНЕ ДОСЛІДЖЕННЯ)

26 sierpnia 2018



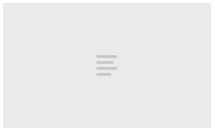
PREVENTION OF VENTILATOR-ASSOCIATED PNEUMONIA IN NEWBORNS

16 lipca 2018



CURRENT VIEW ON THE STRUCTURE AND FUNCTION OF THE FRONTAL SINUS: LITERATURE REVIEW

19 września 2018



PODSTAWOWE STANDARDY PRAWNE WYKONYWANIA ZAWODU LEKARZA

19 września 2018