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## **MECHANISMS OF DEVELOPMENT OF PATHOLOGICAL TOOTH WEAR IN THE AGE GROUP UP TO 40 YEARS**

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### **Резюме**

Представлены результаты комплексных клинико-экспериментальных исследований, направленных на определение механизмов развития патологического стирания твердых тканей зубов в возрастной группе до 40 лет. Изучены минеральный состав и гистологическое строение эмали и дентина при физиологическом, патологическом и замедленном стирании зубов. Проведены клинико-лабораторные исследования, включающие ультразвуковые денситометрию и остеометрию, биохимический анализ минерализующей функции слюны, определение ацидогенной микрофлоры и *Helicobacter pylori* в полости рта. Для подтверждения рабочей гипотезы стирание зубов было воспроизведено в эксперименте. Полученные результаты имеют практическое значение для диагностики, лечения и профилактики заболевания.

**Ключевые слова:** патологическое стирание зубов, патогенез.

### **Summary**

The article presents the results of comprehensive clinical and experimental studies aimed at determining the mechanisms of pathological abrasion of hard dental tissues in the age group up to 40 years old. The mineral composition and histological structure of enamel and dentine by physiological, pathological and detained dental abrasion have been studied. The clinical and

laboratory research including ultrasonic osteometry and densitometry, biochemical analysis of mineralization function of saliva, determination of acidogenic microflora and *Helicobacter pylori* in the oral cavity have been performed. In order to confirm the working hypothesis, the dental abrasion was reproduced in the experiment. The obtained results are of practical importance for the diagnosis, treatment and prevention of the disease.

**Key words:** pathological dental abrasion, pathogenesis.

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Pathological tooth wear behaves to those paradoxical diseases which prevalence is swiftly increased on a background of an absence of effective diagnostic and therapeutic measures. Thus the current of the process is characterized early displaying, progressing, and increasing of intensity of defeat that causes considerable violations in a maxillofacial vehicle in default of timely adequate interference [1, 2]. Probable decision of arisen problem has been a deep study of mechanisms of development of this pathology which results can be used as a basis to create new methods of early diagnostics and preventive treatment.

The order of lead-through of our research was determined by next positions. At first the age of examined persons was limited by 40 years because of the obedience to the tendency of the disease to the «rejuvenation» and successfulness of early preventive measures. Secondly the study of structural features of hard tooth tissues was conducted in parallel with another mineralized tissue of organism – a bone. Thirdly we took into account the modern presentation of pathological process as an erosive-abrasive destruction of enamel and dentine. Fourthly for the first time the research of pathological tooth wear was carried out relatively detained one which observed at the periodontal diseases. We considered that both types of tooth wear were opposite variants of disturbances in hard tissues of teeth and compared them with physiological one which was taken for a norm.

In general **the purpose of the presented work** we formulated as the clinical-experimental research of mechanisms of pathological tooth wear in the age group up to 40 years.

**Materials and methods.** As the object of the study of mineral composition and histological structure of enamel and dentine it was taken crowns of 45 human permanent teeth of different functional groups equally, extracted according to indications and partly sectional material, among which 15 had physiological wear, 15 – detained one and 15 – pathological one (the

generalized form, the initial degree). The method of atomic-emission spectrology was applied for measuring of mass maintenance of chemical elements. Preparations for microscopic study were got after fixing of teeth during a month in a 5% solution of neutral formalin. Further the dental crowns were cut transversally using diamond disks. Thin microsections were prepared by the moist abrasion and polishing.

The experimental wear was produced in the 120 human permanent teeth with intact crowns and 40 ones with pathological tooth wear *in vivo* due to the vibration process in abrasive mediums with different pH. For the teeth of the first group it was used solution of artificial saliva with neutral pH (7,0), in the second one - with alkaline pH (8,0), in the third one - with sour pH (6,0). The teeth of the fourth group (pathological tooth wear *in vivo*) were subjects to wear in a neutral medium. Intensity of loss of hard dental tissues was determined by weighing.

The clinical-laboratory investigations were conducted for 91 persons whom average age was  $37,0 \pm 3,1$  years. It was formed three groups of the same type and equivalent on age-dependent and sexual composition which were different in the form of tooth wear (physiological, detained, pathological). In research we didn't include patients with generalized somatic diseases, endocrine pathology, oncology, blood diseases and other ones, which influenced on bone metabolism substantially. Stomatological status was described by traditional clinical methods.

The structural-functional state of bone tissue was characterized by the results of the ultrasonic osteometry and densitometry. The indexes of bone mineral density were determined with the use of ultrasonic osteometer "ЭОМ-01И" and ultrasonic densitometer "Achilles+" (BMD). In addition the estimation was carried out on the T-criterion which was calculated on the standard (automatic) program of densitometer in the sizes of SD from the peak bone mass for persons of this age and sex. The size of SD on the T-criterion under -1 was

interpreted as a norm, from -1 to -2,5 – as an osteopenia, -2,5 and more - as an osteoporosis [3].

The analysis of mineralization function included measurement of the maintenance of inorganic calcium, phosphorus and magnesium in the mixed saliva using the photoelectrochromometer “ФЭК-56”. Besides the pH-value (pH) was determined by the ionometer “Эксперт-001” [4].

Taken out on empty stomach saliva served as a material for a bacteriologic examination. It was sowed on differential-diagnostic selective mediums. Authentication of the selected clean cultures was carried out according to the morphological, culture and biochemical signs. For the microscopic exposure of *Helicobacter pylori* in the oral cavity the samples of saliva were received and centrifuged under 3000 cycle/minute during 5 minutes. The samples of dental plaque and scrapes from the mucous membrane of tongue were also got. The smears were fixed in a 96% ethyl alcohol and painted with azure-eosin by Gimze [5, 6].

The obtained results were processed by the methods of variation statistics using MS Excel 2003 [7].

**Results and discussion.** The study of mineral composition of enamel and dentine at physiological, detained and pathological tooth wear did not expose reliable differences in the level of such structural elements, as calcium (accordingly  $39,7\pm 0,5\%$ ,  $39,7\pm 0,7\%$ ,  $39,8\pm 0,7\%$ ,  $p>0,05$ ), phosphorus (accordingly  $31,7\pm 0,8\%$ ,  $30,9\pm 0,7\%$ ,  $31,8\pm 0,8\%$ ,  $p>0,05$ ), strontium (accordingly  $0,20\pm 0,02\%$ ,  $0,18\pm 0,02\%$ ,  $0,15\pm 0,02\%$ ,  $p>0,05$ ), zinc (accordingly  $0,21\pm 0,02\%$ ,  $0,22\pm 0,02\%$ ,  $0,15\pm 0,01\%$ ,  $p>0,05$ ). The analysis of concentration of other macroelements allowed registering the difficult process of their redistribution. The maintenance of silicon at physiological tooth wear equaled  $0,02\pm 0,006\%$ , at detained one –  $0,02\pm 0,005\%$ . Otherwise in the group of pathological tooth wear its level rose to  $0,04\pm 0,009\%$  ( $p<0,05$ ). At the same time at physiological tooth wear the contents of titan was  $0,003\pm 0,001\%$ , at

detained one –  $0,003 \pm 0,001\%$ , at pathological one –  $0,01 \pm 0,003\%$  ( $p < 0,05$ ). In teeth with pathological wear the reliable increase of level of manganese was registered as  $0,015 \pm 0,003\%$  against  $0,005 \pm 0,001\%$  for the groups of physiological and detained tooth wear ( $p < 0,05$ ). The concentration of copper in teeth with pathological wear was  $0,011 \pm 0,001\%$  against  $0,006 \pm 0,002\%$  at physiological one and  $0,005 \pm 0,001\%$  – at detained one ( $p < 0,05$ ). The maintenance of lead in teeth with pathological wear exceeded this index in groups with physiological and detained ones twice (accordingly  $0,004 \pm 0,001\%$  comparatively with  $0,002 \pm 0,001\%$ ,  $p < 0,05$ ).

The contents of magnesium at pathological tooth wear was certainly less than at physiological and detained ones (accordingly  $0,84 \pm 0,01\%$  against  $1,05 \pm 0,02\%$  and  $1,15 \pm 0,02\%$ ,  $p < 0,05$ ). On the further the calculations of correlations between the level of calcium and magnesium in mixed saliva and hard dental tissues proved the association between these indexes at all forms of tooth wear. Moreover the detained tooth wear was characterized increasing level of magnesium in saliva as compared to physiological one ( $15,0 \pm 0,9$  mg/l against  $11,9 \pm 0,9$  mg/l,  $p < 0,05$ ). While at pathological tooth wear this index diminished ( $7,2 \pm 1,1$  mg/l). By the way of the regressive analysis we determined the critical concentration of magnesium in saliva which was indicative on propensity to pathological tooth wear and equaled  $7,9$  mg/l.

According to the results of morphological study there was only demineralization of superficial layers of enamel at pathological tooth wear. In the peripheral dentine there was total hypermineralization on a background of general dystrophy of Korph' fibers. The superficial dental layers were more mineralized at the detained tooth wear comparatively to physiological one, but increase of dentine density had a focal character.

From the data of the study of structural-functional state of bone tissue it was set the enhanceable mineral bone density both in mandible and peripheral areas of skeleton at the patients with pathological tooth wear as compared to the

groups of physiological and detained ones. Vice versa the detained tooth wear was characterized by the destructive changes in an alveolar bone and phenomenon of osteopenia in the whole skeleton. Thus the average index of mineral bone density (BMD) in the group of physiological tooth wear was  $0,61 \pm 0,22 \text{ g/sm}^2$ , detained one –  $0,57 \pm 0,20 \text{ g/sm}^2$  and pathological one –  $0,63 \pm 0,23 \text{ g/sm}^2$  ( $p < 0,05$ ), that corresponded fully to the speed of ultrasound along mandible, which was evened  $3465 \pm 30,0 \text{ m/s}$ ,  $3100 \pm 32,7 \text{ m/s}$  and  $3563 \pm 37,2 \text{ m/s}$  accordingly ( $p < 0,05$ ), and also along proximal areas of elbow bones ( $3187 \pm 29,7 \text{ m/s}$ ,  $3060 \pm 36,4 \text{ m/s}$ ,  $3290 \pm 38,0 \text{ m/s}$ ,  $p < 0,05$ ). Prevalence of the phenomenon of osteopenia in skeleton according T-criterion under physiological tooth wear was  $23,3 \pm 7,7\%$ , detained one –  $28,6 \pm 8,5\%$ , pathological one –  $18,2 \pm 6,7\%$  ( $p > 0,05$ ). The obtained results allowed concluding about the increase of mineral density of hard tissues in an organism at pathological tooth wear. Probably disturbance of structure of enamel and dentine takes place from outside, due to violation of salivary function of mineralization.

Indeed at the pathological tooth wear the biochemical analysis of the mixed saliva showed diminishing of pH on  $11,4 \pm 4,0\%$  from the level of physiological tooth wear ( $p < 0,05$ ) which was registered in the absence of reliable changes of maintenance of calcium and phosphorus. That was able to cause the disturbance of processes of remineralization and erosive defeat of enamel which became vulnerable to the abrasion. Simultaneously at the patients with detained tooth wear under periodontal diseases there was  $3,5 \pm 2,3\%$  growth of salivary pH ( $p > 0,05$ ). It could improve the mineralization properties of saliva because of increase of hydroxyapatite supersaturating degree, nevertheless in the end it resulted forming dental plaque and progressing inflammatory-dystrophic signs in the periodontium.

The effect of the experiment confirmed the role of acid factor in development of pathological tooth wear. It was set that the wear of dental

crowns increased in a sour medium comparatively with neutral and alkaline ones (the loss of hard tissues was  $40,0 \pm 5,6$  mg against  $21,2 \pm 4,8$  mg and  $23,6 \pm 5,0$  mg accordingly,  $p < 0,05$ ). Diminishing of pH-value promoted tooth wear, while alkalization didn't influence on the process. More intensive wear of teeth with pathological wear *in vivo* under neutral pH ( $36,1 \pm 5,9$  mgs,  $p > 0,05$ ) was explained by abnormal structure of enamel and dentine.

In search of source of surplus acid at pathological tooth wear we paid attention to oral microbiocenosis – acidogenic *Streptococcus* which produced 90% general acid and *Helicobacter pylori* which vital functions was related to the sour environment. From results of the conducted research we didn't set statistically reliable differences between the amount of *Streptococcus* in patients with physiological, detained and pathological tooth wear and on a sexual sign. The general pool of *Streptococcus* in saliva at physiological tooth wear was  $(1,9 \pm 0,5) \cdot 10^7$  CFU/ml, at detained one –  $(1,1 \pm 0,4) \cdot 10^7$  CFU/ml, at pathological one –  $(1,8 \pm 0,4) \cdot 10^7$  CFU/ml ( $p > 0,05$ ). Thus the bacterioscopic study specified on an absence of communications between the amount of oral acidogenic microflora and form of tooth wear, that denied the substantial role of microbial factor in the progress of erosive-abrasive loss of hard dental tissues.

At the same time for patients with pathological tooth wear by comparison to the groups of the detained and physiological ones *Helicobacter pylori* infection was more frequent on the mucous membrane of tongue ( $30,3 \pm 8,0\%$  against  $14,3 \pm 6,6\%$  and  $10,0 \pm 5,5\%$ ,  $p < 0,05$ ) and in saliva ( $15,1 \pm 6,2\%$  against  $10,7 \pm 5,8\%$  and  $6,7 \pm 4,6\%$ ,  $p < 0,05$ ). It means that *Helicobacter pylori*, exposed in scrapes from the tongue, can be used as a marker of pH decrease in oral cavity, which assisted the excessive abrasion of enamel. Similar localization of microorganism testified the regurgitation of gastric content because of gastroesophageal reflux. The current of erosive-abrasive process in enamel and dentine for such patients had progressive character.



**Conclusion.** Generalization of the results of the clinical-laboratory investigations has allowed creating the own working conception of pathological tooth wear's genesis among persons younger 40 years old. Its scientific novelty consists of our expansion of the process' description as «wear + abrasion + erosion». We have complemented it by such a determinative as the structural state of hard tissue of tooth and periodontium in particular the mineral density of alveolar bone. We have supposed their decision value in pathogenesis of the disease.

Primary poor stability of periodontal tissues or its secondary violation caused by inflammatory-dystrophic processes can increase mobility of teeth. Sliding diminishes wear of occlusal surfaces. On the contrary in the case of hardy periodontium the masticatory loading is mainly given on hard dental tissues that results rapid tooth wear. This process has a latent long current and there is an abrasive wear in its basis.

The progressive character of the disease is given by erosive component conditioned caused different etiologic factors (gastro-intestinal pathology, general metabolic acidosis etc.). The deficit of magnesium plays the important role even under the sufficient calcination. Here it's necessary to consider as a scray reaction on acidosis of organism of different genesis, because one of functions of hard tissues (bone and dental) is maintenance of homoeostasis of biological mediums (blood and saliva).

In practice during the examination of patients with pathological tooth wear under age 40 years the primary attention has to be spared «erosive component» which determines progressing current of disease. In anamnesis it's needed to exclude gastro-intestinal pathology, industrial harmful factors, abuse of the refined carbohydrate food and acid drinks etc. The biochemical study of saliva directed on establishing the level of acidity and the maintenance of magnesium and microscopic revealing of *Helicobacter pylori* infection in oral cavity are effective methods of early diagnostics of progressing current of

erosive-abrasive loss of enamel and dentine. The pathogenetic treatment of disease has to include the traditional chart of remineralization complemented with the preparations of magnesium. The treatment has to add the reception of polyvitaminic complexes and the rational balancing feed which foresees the removal of acid food overload.