

## **MODERN APPROACH TO CARIES PREVENTION AT THE POPULATION LEVEL (LITERATURE REVIEW)**

**Zubaydullaeva M.A. (Republic of Uzbekistan)**

**Email: Zubaydullaeva521@scientifictext.ru**

*Zubaydullaeva Maftuna Alisher kizi - master's Student,  
DEPARTMENT OF PEDIATRIC THERAPEUTIC DENTISTRY,  
SAMARKAND STATE MEDICAL INSTITUTE,  
SAMARKAND, REPUBLIC OF UZBEKISTAN*

**Abstract:** *dental caries is a multifactorial disease, in the development of which the quality of oral hygiene plays an important role. The knowledge that caries is a dynamic and reversible process has led to the development of new technologies capable of detecting caries at the earliest stages (before the formation of a cavity), for its timely treatment and prevention. 70 years of experience in the use of fluorides for the prevention of caries has shown their reliability and ability to participate in the remineralization of dental hard tissues, but their effectiveness decreases in an acidic environment of dental plaque (with poor oral hygiene). Daily oral hygiene using a paste with 1.5% arginine, 1450 ppm fluoride and calcium bicarbonate will help stop the development of dental caries and reduce the risk of new cavities, even in poor oral hygiene conditions.*

**Keywords:** *dental caries, microbial biofilm, fluorides, arginine, remineralization, neutralizer.*

## **СОВРЕМЕННЫЙ ПОДХОД К ПРОФИЛАКТИКЕ КАРИЕСА НА ПОПУЛЯЦИОННОМ УРОВНЕ (ОБЗОР ЛИТЕРАТУРЫ)**

**Зубайдуллаева М.А. (Республика Узбекистан)**

*Зубайдуллаева Мафтуна Алишер кизи – студент магистратуры,  
кафедра детской терапевтической стоматологии,  
Самаркандский государственный медицинский институт,  
г. Самарканд, Республика Узбекистан*

**Аннотация:** *кариес зубов - многофакторное заболевание, в развитии которого важную роль играет качество гигиены полости рта. Знание того, что кариес является процессом динамическим и обратимым, привело к развитию новых технологий, способных выявить кариес на самых ранних стадиях (до образования полости), для его своевременного лечения и профилактики. 70-летний опыт использования фторидов для профилактики кариеса показал их надежность и способность участвовать в реминерализации твердых тканей зубов, но их эффективность снижается в условиях кислой среды зубного налета (при*

*плохом уровне гигиены полости рта). Ежедневная гигиена полости рта с использованием пасты с 1,5% аргинином, 1450 ppm фторида и бикарбонатом кальция поможет остановить развитие кариеса зубов и снизить риск появления новых кариозных полостей даже в условиях низкого уровня гигиены полости рта.*

**Ключевые слова:** кариес зубов, микробная биопленка, фториды, аргинин, реминерализация, нейтрализатор.

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Dental caries is a multifactorial infectious disease that can develop at any age of the patient (early age, adolescence and adulthood) throughout life, leading to the demineralization of the enamel with the formation of a carious cavity. According to the conclusion of the World Health Organization (WHO), caries remains a significant problem in most developed countries of the world, affecting 60 to 90% of schoolchildren and the vast majority of the adult population. Dental caries is most common in Asian and Latin American countries, where the incidence of diseases in children and adults is close to 100% [4]. In Russia, the intensity of dental caries is on average 2.5 (KPU index), with a prevalence of more than 80% [3, 15, 26, 35].

The main risk factors for the development of caries are: the role of cariogenic microorganisms in the oral cavity (*Streptococcus Mutans*, *Lactobacilli*, et al), nutrition with a predominance of easily digestible carbohydrates, changes in the properties and composition of saliva, the socio-economic level of the family, dentist attendance and others. In addition to cariogenic factors that constantly and continuously affect the hard tissues of the teeth, leading to the demineralization of the enamel, there are protective mechanisms (composition and properties of saliva, fluorides) that can shift the balance towards the remineralization process. Thus, the carious process can be stopped and even reversed if the integrity of the hard tissues of the teeth is preserved [23, 38].

Clinical studies show that the level of oral hygiene plays a significant role in the development of dental caries. Dental plaque is a complex biofilm that forms over time on the enamel surface, especially in areas that are difficult to reach for a toothbrush (contact surfaces of the teeth, cervical region), as well as on the mucous membrane of the soft tissues of the oral cavity (back of the tongue, mucous membrane of the cheeks, alveolar processes). It has been proven that up to 1000 species of microorganisms colonize in the thickness of dental plaque, depending on its maturity and localization [10, 22, 37]. The species composition of microorganisms in the dental biofilm depends on its location (hard tissues of teeth or mucous membrane), the presence of natural pits and fissures on the enamel (in which "old" plaque is consolidated), the level of oral hygiene, etc. The bacterial composition of the dental biofilm can be relatively stable and contain predominantly non-pathogenic microorganisms, however, the microbial

balance can be disturbed due to significant changes in the environment (for example, a shift in the pH of the environment to the acidic side due to the consumption of foods high in digestible carbohydrates or poor oral hygiene). Such changes lead to the growth of cariogenic microorganisms and the replacement of a “healthy” biofilm with a pathogenic one [15, 16]. Thus, a decrease in the pH value below the "critical" value leads to the leaching of calcium and phosphates from the enamel crystal lattice and the development of demineralization of the hard tissues of the teeth [14, 29].

The process of caries development consists in shifting the balance between cariogenic and protective factors: if cariogenic factors prevail in the oral cavity, then the process of demineralization dominates, if protective, then remineralization starts and the development of caries stops. The alternation of de- and remineralization cycles can occur for a long time before reaching the “end point” - the formation of a carious cavity. The fact that the development of dental caries is a dynamic process and reversible at the initial stages is of particular importance in the treatment and prevention of caries, and early diagnosis of lesions allows timely prevention and treatment of focal demineralization [7, 39].

The topic of caries detection at the earliest stages of development is currently receiving much attention. To replace traditional visual diagnostic methods (drying, vital staining), researchers around the world are increasingly using modern international criteria for assessing the degree of carious lesions (ICDAS II). And also, more accurate hardware methods of caries detection are used, such as: Diagno Dent, based on the method of laser radiation; Diagni Cam, based on the method of digital transillumination fiber optic glow; QLF, based on the method of light radiation, etc. The use of modern techniques improves the process of diagnosing caries and allows not only to identify the lesion long before the formation of the cavity, but also to visually assess the degree of its severity [2, 8, 9, 24, 30].

The fact that dental caries is a dynamic and reversible process is at the heart of caries prevention. For over 70 years, fluorides have been used to prevent caries. Numerous clinical studies have proven that fluorides stabilize demineralization and accelerate the process of remineralization of dental hard tissues. The WHO Expert Committee confirms the importance of regular oral hygiene with fluoride preparations for maintaining oral health at the population level. The use of endogenous and exogenous methods for the prevention of dental caries significantly reduces the growth of caries. According to WHO, fluoridation of drinking water reduces the prevalence of dental caries by 15.0%, the use of fluoride-containing toothpastes and mouth rinses reduces the increase in caries by 24-26%. Fluoride ions promote the incorporation and retention of calcium and phosphate ions in the enamel structure, forming the fluorapatite compound, which is more resistant to acids than tooth enamel. At the same time, there is no reliable data that the use of fluorides is harmful to the body [13, 25].

The recommended concentration of fluorides in drinking water, salt, toothpastes depends on age, the degree of risk of caries development, and the concentration of fluoride in water in a given region, which is important to reduce the likelihood of developing fluorosis. The most accessible and widespread method of fluoride prophylaxis at the mass level is regular daily oral hygiene. Despite the fact that the vast majority of toothpastes for adults on the market are fluoride-containing, the intensity and prevalence of caries is still high.

European, American Dental Associations, Russian Dental Association (StAR), WHO consider it ethical to brush teeth of children with fluoride-containing toothpastes, except for those living in areas with high fluoride content in water [26, 33].

The importance of oral hygiene and parental compliance in caring for children's teeth is shown in the study by A.S. Rodionova. in Volgograd, 2013. The study revealed a low level of compliance of parents of young children ( $n = 596$ ), as only half of the interviewed mothers (standardized indicator 49.5%) provided the necessary hygienic care for their babies' teeth. Consequently, every second child aged 4-35 months did not receive the necessary hygienic dental care. In the course of the study, a low compliance of parents of children of the first and second years of life was registered, to whom oral hygiene after teething was carried out only in 23.3% and 35.4% of cases, respectively; the majority of children (89.8%) began to receive hygienic dental care only after two years; only 16.9% of mothers performed oral hygiene for babies using fluoride pastes [1, 21, 32]. Numerous studies and systematic reviews from the Cochrane database, aimed at identifying the most effective and safe concentration of fluoride in toothpastes for the prevention of dental caries in adults, prove the high effectiveness of two-fold daily oral hygiene with fluoride-containing oral hygiene products with a fluoride concentration of at least 1000 ppm., compared to fluoride-free toothpastes. Toothpastes with a higher concentration of fluoride (1500-5000 ppm) are recommended for patients with a high risk of caries. Hygiene products with a low fluoride content (500 ppm) are prescribed for children under 6 years of age in order to prevent and balance the risk of caries and the risk of developing fluorosis. Numerous studies show that tooth decay is correlated with poor oral hygiene and poor dental cleaning. Considering this fact, it became necessary to create technologies that can not only influence the processes of deirimineralization in the hard tissues of the teeth, but also suppress the pathogenicity of dental plaque on the enamel surface [3, 16, 18].

The new technology is based on the principle of changing the pH of dental plaque by using the arginine deaminase enzyme pathway in arginolytic (non-pathogenic) bacteria. It is argininolytic bacteria that break down arginine to an ammonium base, which is capable of neutralizing plaque acids and stabilizing the microbial balance of dental biofilm [4]. Thus, an increase in the pH of dental plaque creates a favorable environment for stopping demineralization and starting remineralization, maintaining the ecological balance in the microbial

biofilm and providing “healthy microflora” in it [17, 28].

A number of clinical studies involving patients who used arginine-containing toothpaste (study group) showed that the pH of plaque was significantly higher in the study group than in the control group, where patients used toothpaste with 1100 ppm fluoride. An increase in the pH of dental plaque occurs due to the breakdown of arginine and the formation of an ammonium base, which leads to neutralization of the acidity of dental plaque, and calcium and fluoride, which are part of the toothpaste, participate in the process of remineralization of hard tissues in an environment safe from cariogenic acids [27, 35].

Clinical studies using an apparatus for diagnosing caries in the early stages of QLF have shown that the use of toothpaste with 1.5% arginine, 1450 ppm fluoride and an insoluble calcium compound (study group) more effectively stabilizes demineralization and stimulates remineralization of dental hard tissues compared to pastes containing only 1450 ppm fluoride (control group). The analysis of the volume of initial carious lesions (AQ) after 6 months of using the arginine-containing toothpaste was 44.6% less than at the initial examination, while in the control group AQ was 28.9% less than at the initial examination, respectively. The difference in indicators between the new oral hygiene product and the positive control was statistically significant ( $p < 0.001$ ) [28, 30].

Studies of root caries in adults showed that already six months after the start of using toothpaste with arginine, 1450 ppm fluoride and an insoluble calcium compound (study group), root caries stabilized in 93.0% of cases, and only 0.7% progressed lesions, while the use of a toothpaste containing only 1450 ppm fluoride (positive control group) led to the stabilization of root caries in 91.0% of cases, while the progression of caries was noted in 9.0% of cases, respectively. The data obtained between the groups were statistically significant ( $p < 0.001$ ). Thus, arginine-containing toothpaste is much more effective in stabilizing and remineralizing root caries compared to a toothpaste containing only 1450 ppm fluoride [11, 20].

The modern understanding of the development of caries and the knowledge that caries is a dynamic and reversible process has led to the development of new technologies capable of detecting caries at the earliest stages (before the formation of a cavity) for its timely treatment and prevention. The use of fluorides is undoubtedly the main method in the prevention and treatment of dental caries, however, fluorides are not able to affect the acids of dental plaque, therefore, in conditions of poor hygiene, their effectiveness decreases. Understanding this fact has led to the need to create a technology that can supplement the remineralizing activity of fluorides with the ability to influence the pH of dental plaque. Clinical studies using this technique prove its effectiveness in the prevention and stabilization of the carious process. Thus, daily oral hygiene using a paste based on a new technology will help stop the development of dental caries and reduce the risk of new cavities, even in conditions of poor oral hygiene in patients at the population level.

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