PRINCIPLES OF CARIES PREVENTION IN CHILDREN WITH DOWN SYNDROME.

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Abstract. Down syndrome is a genetically determined condition caused by a quantitative chromosomal abnormality and is characterized by complex morphological, metabolic, and functional alterations affecting multiple organs and systems. A constellation of somatic features, including immune dysfunction, endocrine imbalance, impaired neuromuscular regulation, and specific craniofacial characteristics, directly influences the development and dynamics of a child's oral health status. Maxillofacial anomalies, masticatory muscle hypotonia, macroglossia, delayed tooth eruption, and structural enamel defects create distinct conditions for the interaction of cariogenic factors within the oral cavity.

Although published data demonstrate variability in caries prevalence among children with Down syndrome, this population is considered clinically significant in terms of dental risk assessment. The heterogeneity of epidemiological findings may be attributed to differences in observation settings, family oral health literacy, accessibility of dental care, and diagnostic criteria. Meanwhile, pathogenetic determinants—such as enamel mineralization patterns, quantitative and qualitative characteristics of saliva, the microbiological profile of dental biofilm, and behavioral limitations—form a multifactorial model underlying caries development.

This analytical review systematizes current scientific evidence regarding the mechanisms of hard tissue demineralization in children with Down syndrome, taking into account biochemical, immunological, and behavioral determinants. Data concerning salivary secretion, buffering capacity, and local immune defense activity are examined, along with the contribution of dietary habits and cognitive factors to the maintenance of a cariogenic environment. Particular attention is paid to the relationship between impaired neuromotor coordination and the effectiveness of individual oral hygiene practices.

Contemporary preventive strategies are summarized, including controlled fluoride therapy, the use of calcium-phosphate and hydroxyapatite-based remineralizing agents, fissure sealing of permanent molars, professional monitoring of initial demineralization lesions, and organizational and educational family-centered support models. The importance of early initiation of preventive measures and individualized programs tailored to the child's clinical profile is emphasized.

Thus, a comprehensive clinical and pathogenetic analysis enables the formulation of a scientifically grounded concept for caries prevention in children with

Down syndrome, aimed at enhancing enamel resistance, stabilizing the oral microbial ecosystem, and developing sustainable oral hygiene skills through active collaboration between families and healthcare professionals.

Keywords: Down syndrome, dental caries, enamel demineralization, oral health status, saliva, immunological factors, prevention, children, remineralization therapy.

Introduction. Down syndrome is the most common chromosomal abnormality caused by complete or partial trisomy of chromosome 21, leading to systemic disturbances in embryonic development and postnatal adaptation. The genetic nature of the disease determines the development of a specific phenotype, including morphological, neurophysiological, immunological, and metabolic changes. These systemic changes have a multifactorial impact on the condition of dental hard tissues, the periodontium, and the oral mucosa.

Patologiya zatragivayet immunnuyu sistemu (defitsit T- i V-kletochnogo zvena, snizheniye funktsional'noy aktivnosti neytrofilov), endokrinnuyu regulyatsiyu (chastyye tireoidnyye disfunktsii), tsentral'nuyu i perifericheskuyu nervnuyu sistemu (kognitivnyye ogranicheniya, motornaya nelovkost'), a takzhe oporno-dvigatel'nyy apparat (gipotoniya myshts). V sovokupnosti dannyye osobennosti formiruyut unikal'nyy klinicheskiy profil' rebonka, kotoryy trebuyet individualizirovannogo meditsinskogo soprovozhdeniya, vklyuchaya stomatologicheskuyu pomoshch' [1,3,6].

In the maxillofacial region, children with Down syndrome exhibit characteristic morphological features: brachycephaly, maxillary hypoplasia, reduced nasopharynx size, macroglossia, muscle hypotonia, and malocclusion. Disruption of the spatial relationships of the dental arches and the functional activity of the masticatory apparatus affects the self-cleaning processes of the oral cavity and the formation of a microbial biocenosis [5,15]. Delayed tooth eruption and variability in the timing of enamel mineralization create additional clinical features requiring dynamic observation [12].

The prevalence of dental caries in children with Down syndrome, according to various studies, varies widely. This variability is explained by population heterogeneity, socioeconomic conditions, family hygiene standards, availability of preventive programs, and differences in dental assessment methodologies [4,18]. At the same time, a combination of morphological and functional factors allows us to consider this category of patients as a high-risk group for dental disease.

The relevance of analyzing preventive strategies is driven by the need to develop a pathogenetically oriented prevention model that takes into account the interaction of biological, immunological, microbiological, and behavioral determinants of the caries process. A modern prevention concept should go beyond standard protocols and be aimed at systemic correction of risk factors [12].

The development of caries in children with Down syndrome occurs in conditions of altered anatomical and functional environment of the oral cavity

[3,5]. Among the most significant morphological factors are: delayed eruption of primary and permanent teeth, which is accompanied by a change in the sequence of occlusal contacts; microdontia and changes in the shape of tooth crowns; enamel hypoplasia of varying severity, including focal and systemic forms; bite anomalies (open, cross, mesial), crowding of teeth; chronic mouth breathing due to muscle hypotonia and adenoid hypertrophy [1,6].

Hypoplasic enamel is characterized by a disruption of the hydroxyapatite crystal lattice, reduced mineralization, and increased porosity. This increases the diffusion of organic acids deep into the enamel prisms and accelerates demineralization [9]. Under conditions of reduced salivary buffering capacity, these processes can progress more rapidly.

At the same time, the presence of interdental spaces and a reduced number of teeth in some cases contributes to reduced plaque retention and facilitates self-cleaning, which partially explains the conflicting epidemiological indicators of caries. Thus, morphological features have a dual effect on cariogenic potential.

Functional impairments of chewing and swallowing also affect saliva distribution and the mechanical cleansing of tooth surfaces. Insufficient stimulation of salivary flow can contribute to a decrease in the remineralizing potential of oral fluid [6].

Saliva is a vital component of the oral cavity's local defense system. It provides mechanical cleansing, buffers acid neutralization, participates in enamel remineralization, and provides immune protection [3]. Children with Down syndrome exhibit changes in the quantitative and qualitative characteristics of saliva.

The rate of salivary flow can vary from moderately reduced to normal, depending on the degree of neuromuscular dysfunction and associated somatic conditions. In some cases, the buffering capacity of saliva exhibits a compensatory increase due to increased bicarbonate content, but these values are unstable [3].

Immunological changes include fluctuations in secretory IgA levels, changes in lysozyme and lactoferrin activity, and changes in the cytokine profile. Deficiencies in cellular immunity and neutrophil dysfunction increase susceptibility to infectious and inflammatory processes.

The microbiological landscape of dental plaque can vary in the proportions of Streptococcus mutans, Lactobacillus spp., and other opportunistic microorganisms. The formation of persistent biofilms in the presence of poor hygiene creates conditions for localized enamel demineralization [12,17].

Thus, changes in the enamel-saliva-microbial biocenosis system form a complex pathogenetic cascade that requires targeted preventive intervention [5].

Cognitive disabilities and delayed psychomotor development limit a child's ability to independently develop oral hygiene skills. Motor clumsiness

makes it difficult to perform precise toothbrush movements, and decreased concentration reduces the duration and effectiveness of brushing.

In most cases, dental hygiene is monitored by parents or guardians. However, family awareness, the frequency of dental visits, and socioeconomic conditions significantly influence the quality of care.

Dietary preferences associated with soft, refined carbohydrate foods, frequent snacking, and the use of syrup-based medications increase the cariogenic load [20]. Furthermore, sensory sensitivity characteristics can influence food choices and the avoidance of hard foods that stimulate salivation [15,17].

Therefore, a preventive model must consider biological, behavioral, and social determinants, ensuring a comprehensive approach to risk factors.

Individualized oral hygiene - The selection of hygiene products should take into account the child's motor abilities. The use of toothbrushes with thick handles, electric toothbrushes with timers, and "hand-in-hand" techniques to help develop motor patterns is recommended. Visual algorithms, pictograms, and behavioral rewards increase compliance [2, 3, 8].

Fluoride prophylaxis - Controlled use of fluoride-containing varnishes, gels, and toothpastes promotes fluorapatite crystallization and increases enamel acid resistance [5]. Individual selection of fluoride concentrations minimizes the risk of fluorosis and ensures optimal remineralization.

Remineralizing therapy - The use of preparations based on calcium phosphate complexes, amorphous calcium phosphate, and nanohydroxyapatite promotes the restoration of the enamel's mineral structure in areas of initial demineralization. Regular use of these agents enhances the protective potential of dental hard tissues [7].

Fissure sealing - Preventive fissure sealing of first permanent molars is an effective measure for reducing the risk of occlusal caries. Given the difficulties of hygienic control during the eruption period, this method has high clinical significance [3].

Interdisciplinary support - Effective prevention is impossible without the participation of a team of specialists: dentist, pediatrician, orthodontist, speech therapist, and psychologist. This integrated approach allows us to consider the child's physical condition and develop sustainable preventative behavior patterns.

Discussion. Analysis of scientific data indicates that caries in children with Down syndrome develops under conditions of a complex interaction of morphological, biochemical, and behavioral factors. It is impossible to consider the cariogenic process in isolation from the systemic characteristics of the body [2,3].

Pathogenetically oriented prevention should be aimed at: increasing enamel mineralization stability; stabilizing the microbial biocenosis; normalizing salivary function; developing stable hygiene habits; correcting dietary factors; and regular professional monitoring [4].

Early prevention—from the moment the first teeth erupt—is especially important, as it is during this period that long-term enamel resistance and behavioral patterns are formed.

Conclusion. Dental caries prevention in children with Down syndrome should be considered as a multi-level system of measures based on a clinical and pathogenetic analysis of the individual's dental status.

The genetically determined nature of the disease, accompanied by morphological, immunological, metabolic and neurofunctional disorders, determines the limited effectiveness of standard preventive protocols used in the general pediatric population.

Morphological features of the maxillofacial region (maxillary hypoplasia, microdontia, occlusal disorders, and variable enamel mineralization times) alter the distribution of masticatory loads and the self-cleaning properties of tooth surfaces. Biochemical characteristics of oral fluid, including instability of buffer capacity and variations in immunological parameters (secretory IgA, lysozyme, and lactoferrin), modify the processes of enamel remineralization and demineralization. Immune dysfunction increases susceptibility to microbial attack and promotes the maintenance of cariogenic microflora.

The variability of epidemiological data indicates the complexity of pathogenic mechanisms rather than a low risk of caries. Despite the possible reduction in plaque retention in the presence of diastemas, enamel hypomineralization and behavioral restrictions increase the likelihood of developing caries. Therefore, children with Down syndrome are considered a high-risk group for dental disease and require a personalized preventive approach.

Individualized programs involve assessing the child's cognitive abilities, hygiene skills, diet, and physical status. The program should include controlled fluoride prophylaxis, remineralization therapy, fissure sealants, professional monitoring of early demineralization lesions, and behavioral risk factor interventions.

Active family involvement and interdisciplinary collaboration among specialists are crucial to effective prevention. Early initiation of preventive measures—from the moment the first teeth erupt—promotes the development of strong dental tissue resistance, prevents the progression of caries, and reduces the need for invasive interventions later on.

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