Ultrastructural Changes of the Initial Lesion at Early Childhood Caries

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Abstract

Despite evident reduction of caries in many countries, where complex programs for prevention are carried out, the prevalence of Early Childhood Caries (Caries infantile) expresses continual growth trend. ECC is often found under the name connected with the manner of feeding and nutrition of children such as “Baby bottle Syndrome” or “Baby bottle caries”. The aim of the research is to determine precisely the ultra-structural changes in the enamel substance at the initial lesion (white spot lesion), because the changes are of great importance for the preventive aspect of this early childhood disease.

The experiment evaluated the ultra-structural changes of the teeth enamel in primary teeth with circular caries in its starting stage of development-initial caries lesion. The patients (age 6) with deciduous teeth already in the phase of resorption, were chosen carefully. We extracted 10 maxillary incisors with initial lesion, and 20 healthy mandibular incisors, as a control group. Examination of the surface was made with scanning electronic microscope (JSM 5300, JEOL), at the Institute for biomedical research of the Faculty of Medicine in Nis (Serbia). During the analysis of experimental samples, the enamel surface at the initial lesion, was observed. Demineralization of enamel surface happened at the place of initial lesion. Prismatic ridges were rounded and melted, and inter prismatic spaces were expanded.

The results from this research speak in favor of better understanding of ultra-structural changes on the enamel surface, in the initial phase of Early Childhood Caries. This could help in creation of the strategy for its successful prevention.


Keywords: Initial Lesion, Demineralization, Scanning Electronic Microscope.

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Introduction

Despite evident reduction of cavity in many countries with complex programs for prevention, the prevalence of Early Childhood Caries expresses continual growth trend.¹ ² ECC was often associated with the feeding and nutrition of children and named as “Baby bottle Syndrome” or “Baby bottle caries”.³ Sugary liquid drinks (milk and juices) for longer period of time, with the presence of bacteria such as Streptococcus mutans, present very high risk.⁴ ECC today is associated, not only with poor feeding, but with chronic bacterial infection from caries in newly erupted teeth, with immature and hypoplastic enamel. The disease is with multifactorial etiology, and microbial investigations show presence of Streptococcus Mutans and Lactobacillus.⁵ Mother’s poor oral hygiene habit, dietary habit, and activity which increase the possibility of saliva contact between mother and child are often mentioned as possibility of transmission risk.⁶ However recent investigation with PCR method using sequenced primer was performed to identify S. Mutans in children aged 3-5 years old. None of 66 child-mother pairs did not prove the relationship between the presence
of serotype C in mother and S. Mutans in a child.

ECC actually present one or few decayed lesions (cavitated or noncavitated), missing or filled tooth surface on primary teeth in children. The prevalence of this type of caries depending on the epidemiological researches is from 3% up to 45%. Children with ECC have higher risk for developing caries in permanent dentition, they regularly visit emergency services, have restricted feeding activities and poor oral health.

In the Republic of Macedonia, this type of caries is widely spread in pre-school children. In the central area of the City of Skopje, children 18 to 42 months old, have 17, 9% of notified caries presence, which, according to the criteria of the World Health Organization, is estimated as high prevalence.

Negative growth trend of this type of caries, was the reason for many scientist to research its etiology and pathogenesis, therapeutic, and above all preventive aspects. The most important predisposing factor for appearance of this type of caries, is the defect in the structure of substantia adamantine in the primary teeth whose mineralization start in the fourth month of fetal life. Although it has been considered that prenatally formed teeth enamel is homogeneous, with good structure and hardly prone to caries, many factors which rule human body in pregnancy, such as: systematic diseases, infectious and chronic kidney illnesses, diabetes mellitus, nutritive disorders in feeding and similar, could cause the disturbances in teeth enamel structure.

Some authors also revealed that predisposition of childhood caries is higher among malnourished individuals. Hypoplastic defects in tooth enamel structure and abnormal saliva flow in children with low socioeconomic status and malnutrition were proven as high risk factors for dental caries also. Clinical survey of Early Childhood Caries showed that this type of caries goes through several phases in its development. Starting phase of development is the initial form (white spot lesion) or initial lesion at the early childhood caries.

The aim of this research is to determine the ultra-structural changes in the enamel substance at the initial lesion (white spot lesion) at the early childhood caries, because it has great influence in the preventive aspect of the disease.

Materials and methods

We used the primary teeth - maxillary and mandibular incisors of the patients with different gender, 2-6 years old, from the Clinic of Pediatric and Preventive Dentistry, at the Faculty of Dentistry in Skopje. All of the patients were clinically examined, and diagnosed ECC, with starting development phase-initial lesion. Laboratory examinations were made on the separated samples of the teeth in the period of their physiological change. Following groups of experimental samples were made: Testing group with 10 extracted maxillary incisors with initial lesion – white spot (macula alba), and control group with 20 extracted healthy mandibular incisors. The teeth from both groups were kept in pure alcohol (96%) after extraction. Before the analysis, the teeth were dehydrated and covered by a thin layer of gold on the surface, with cathode dispersion technique. Investigation was made with the scanning electronic microscope (JSM 5300, SEM, JEOL, USA), and this procedure took place at the Institute for biomedical research of the Faculty of Medicine in Nis. The enamel surface at the initial lesion was observed and analyzed.

Results

This experimental investigation provided data concerning the changes of the ultra structure of basic tooth enamel in the initial phase of Early Childhood Caries.
Figure 2. Smooth surface appearance with genuine prisms (x5000).

Figure 3. Healthy tooth enamel with tooth brush traces (x2000).

Figure 4. Healthy tooth enamel surface with little plaque (x750).

Figure 5. Initial lesion (x 5000).

Figure 6. Initial lesion (x 100), with starting demineralization and retained areas of healthy cuticle enamel.

Figure 7. Initial lesion (x 5000).
Figure 8. Island of demineralization and healthy enamel cuticle around (x 5000).

Figure 9. Demineralization in wider area, with loss of the prismatic ridges and expanding of inter-prismatic spaces (x5000).

Figure 10. Damaged prisms and expanded inter-prismatic spaces, uneven relief of enamel area (x7500).

SEM images (different magnification) of the healthy and infected demineralized teeth enamel, help us understand the mechanism of its occurrence and development. Normal healthy dental enamel in Figure 1 and 2 (the longitudinal cross section), showed smooth surface appearance with adequate and genuine prisms, together within inter-prismatic space. Teeth brushing in Figure 3, made visible traces of physiological mechanical damage of the teeth enamel, and healthy enamel surface with little plaque is showed in Figure 4. Demineralization started on enamel surface, but still with adequate and genuine prisms together within inter-prismatic space. We can see the teeth enamel with initial lesion on Figure 5, as demineralized surface shown through the uneven and roughened surface of teeth enamel (shrinking of prisms, due to the widening of the prismatic spaces). Initial lesion, with a typical localization of circular cavities (Figure 6) in cervical part of maxillary primary incisor, and starting demineralization with retained areas of healthy cuticle enamel (Figure 7), are typical signs for early stages of this disease. In Figure 8 starting demineralization is presented as island, with healthy enamel cuticle around. Spreading of the disease is shown in figure 9, where demineralization covers wider area with loss of the prismatic ridges and expanding of inter-prismatic spaces, suggesting deeper initial lesion. When the disease spread wider over the teeth surface, in the area of the initial lesion, we can see rounded and melted enamel ridges, with damaged and expanded inter-prismatic spaces. Damaged prisms and expanded inter-prismatic spaces in Figure 10 with uneven relief of enamel area, show dense electron illumination corresponding to extended inter-prismatic spaces.

Discussion

Early caries on the enamel of the primary teeth gives information about metabolic changes that occur in this period. Enamel is made of hydroxyl apatite crystals arranged in prisms which extend from the dentin-enamel junction to the surface. Macroscopically crystals are packed tightly with inter crystalline spaces filled with water and organic material. ECC appears very early in babies from 6 months, it progress rapidly, and often affects all four upper incisors. In the initial phase, ECC is presented like white
demineralized enamel which quickly advances to decay around the gingival margin. Curious lesions are spread on the labial or lingual surfaces of the teeth, or on both sides. The decayed tooth is with yellow or brown cavitated area.

In the developed countries as a result of effective and well timed implementation of the primary preventive measures, the Early Childhood Caries has relatively low prevalence of 3%. In the undeveloped countries, because of lack of information on the adequate way of feeding and no solid oral hygiene, the prevalence of the Early Childhood Caries is up to 45%.

In the Republic of Macedonia in the case of pre-school children this type of caries is also widely spread. In the central area of the City of Skopje, in the case of children of 18 to 42 months, there is 17, 9% of notified caries presence, which according to criteria of the World Health Organization, is estimated high prevalence. Taking into consideration the number of dentists and dental universities, this is overly high prevalence.

The application of the primary preventive measures can successfully prevent the Early Childhood Caries, and parents and the dentists, have the important role in that process, too. Avoiding food high in sugar, leaving baby bottle at 12-18 month of age, dental screening, counseling and preventive procedures are some of the measures and policies for ECC. Best professional preventive method a dentist can use is topical fluoride treatment, when tooth surface is periodically varnished with fluoride solution. Best composition, concentrate of Fluor and capacity for penetration in dental enamel are still investigated. Fidy et al. studied the difference in penetration of Nano-NaF compared to ordinary NaF solution, and found that Nano-solution application can increase the levels of fluoride (0.1289%) and fluorapatite (20.35%) more than NaF application. Both fluoride solutions proved their influence for enamel endurance toward caries.

Diagnosing the disease in the early phase of clinical evolution – white spot lesion is very important, and the implementation of the primary preventive measures can achieve the biological reparation of the lesion and prevent the curious lesion extending and complications. Unfortunately in most cases, the Early Childhood Caries findings are in the advanced phase, and the dentist usually can’t manage the consequences.

Conclusions

Analyzed SEM images and the results of the research, speak in favor of better understanding the ultra-structural changes on the enamel surface, in the initial phase of Early Childhood Caries. It can be concluded that:

- ECC presents multi-factorial enamel disease in early childhood;
- Implementing early hygienic habits at the time of eruption is of great importance;
- Consumption of fluoride supplements, varnishes and fluoride tooth pastes must be provided;
- Children must have healthy sugar free diet;
- A caries risk assessment and parental education for prevention of oral diseases must be implemented.

All above can help in creation of the strategy for successful prevention.

Declarations of Interest

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References


