REVIEW ARTICLE

CONTENTS

Extrinsic black staining of teeth: a review

Inessa I. Yakubova[1], Volodymyr Ostrianko[2], Yurii Skrypnyk[1], Roman Volovodovskiy[1]
[1]PRIVATE HIGHER EDUCATIONAL ESTABLISHMENT «KYIV MEDICAL UNIVERSITY», KYIV, UKRAINE
[2]SHUPYK NATIONAL HEALTHCARE UNIVERSITY OF UKRAINE, KYIV, UKRAINE

ABSTRACT

Aim: Discovering of the prevalence, causes and consequences of the Extrinsic black staining(EBS) of teeth in pediatric population

Materials and Methods: Upon completion of the scientific search, the review included 47 scientific articles from the electronic databases, reference lists of articles, and selected textbooks in the time interval from 1976 to 2023.

Conclusions: The results show that EBS is a possible protective factor against early childhood caries. Dental plaque and gut microbiome may be related to EBS in the temporary dentition. The literature suggests a decreased caries prevalence in the presence of EBS which associated with low incidence of caries in children. The nature of the black pigmentation is suggested to be a form of bacterial plaque with an insoluble ferric salt. Tabaco smoke, food and antibiotics that can be also a risk factors for EBS. There are some clinical and localization features that dentist have to pay attention for. Many diseases of various systems and organs are directly related to black plaque.

With this review, we wanted to encourage dentists to identify the problem in childhood and collaborate in a multidisciplinary team to improve treatment efficiency and speed up the selection of the right tactics for the most person-centered approach to avoid worsening the problem in adulthood.

KEY WORDS: dental plaque, black stain, systematization of colored dental plaques, the class of diseases

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INTRODUCTION

The topic of teeth staining is often given insufficient attention by scientists and dentists, especially in the pediatric field. According to the International Classification of Diseases (ICD-11), deposits on the teeth (code DA08.4), in particular, the extrinsic black staining (EBS) of teeth, belong to the Diseases of the hard tissues of the teeth (DA08) of the class: Diseases or disorders of the orofacial complex of Chapter XIII. Diseases of the digestive organs [1]. Plaque can be different in colors, including black, green, orange, brown, etc. EBS is another problem in pediatric dentistry, along with dental caries [2, 3]. The accumulation of EBS leads to a visual discoloration of the teeth, which usually causes aesthetic problems and is a common problem for patients. EBS is a common problem affecting patients, often causing aesthetic concerns. Its unattractive appearance, which is common in children, can have a negative impact on a child's self-esteem [4]. EBS of teeth prevalence varies from 2.4 to 18% [2,3,5-7], at the same time, the research amoung adults is few [8].

AIM

Discovering of the prevalence, causes and consequences of the extrinsic black staining of teeth in pediatric population.

MATERIALS AND METHODS

The search strategies included electronic databases, such as Pubmed, Cochrane Library and Science Direct, reference lists of articles, and selected textbooks. Articles and textbooks used in this study were mainly reached by using the following keywords: «pediatric», «dental plaque», «black stain», «colored dental plaque». Upon completion of the scientific search, the review included 47 scientific articles in the time interval from 1976 to 2023.

REVIEW AND DISCUSSION

PREVALENCE

On the continent of Eurasia, in its European part, the prevalence of black plaque was 7.54% in children

aged 4-11 years (n=1100) in the city of Valencia (Spain) [3], 3.1% at 6-year-old children (n=3272) in Oviedo (Spain) [7], 6.3% at 6-12 years old (n=1086) in Potentsa (Italy) [3], 2.4% at 3-5.5 years old ochildren (n=950) in Thessaloniki (Greece) [9], high prevalence of up to 19.9% among school-age children from Switzerland (aged 7-15 years) [10].

At the Asian part of Eurasia the prevalence of a EBS was 16% at children of 10–12 years old (middle age 11,7±1,1 years) (n=1748) [3], 18% at children of 6-12 years old (middle age 9.4±1.9 years) (n=1472) in Udaipur (India) [11], 9.9% at children (middle age 4.55 years) (n=1937) in Shanghai (China) [5].

On the continent South America prevalence of a EBS is 3.5% at children of 5 years old (n=1120) of (n=1120) [6] and 14.8% at children of 6-12 years old (n=263) in Pelotas (Brazil) [12], and 4.16% at the children of 3-10 years old (n=433) in Rosario (Argentina) [3].

In our studies, EBS was diagnosed in 2.94 to 4.55% of 6 to 17 year olds (n=562) m. Kyiv, Ukraine [5].

We found that there is no apparent sex predilectio n [5, 13].

ETIOLOGY

The cause of EBS is not entirely understood. Ultrasound examination suggests that this stain is caused by a certain type of plaque with a tendency to calcification [13, 14]. Its microbial composition is believed to consist of chromogenic bacteria such as *actinomyces* and *prevotella melaninogenic* [12, 15]. The microbiome was characterized by various microbial biomarkers, such as *Pseudomonas fluorescens, Leptotrichia sp.*_HMT_212, *Actinomyces sp.*_HMT_169 and *Aggregatibacter sp.*_HMT_898 in the plaques from the BTS group. Functional analysis of microbial species suggested the existence of a hyperactive metabolic state on the surfaces of teeth with black plaques and showed that trivalent iron, ferrous iron complex transport system, and iron (III) transport system were more abundant in the plaque samples [16]. Higher numbers of *Lautropia* and *Pesudopropionibacterium* species were observed in the EBS group compared to the non-EBS group ($p<0.05$). *Lactobacillus* species were found in the feces of the EBS group. The results show that EBS is a possible protective factor against early childhood caries. Dental plaque and gut microbiome may be related to EBS in the temporary dentition [17].

Given the changes in the oral microbiome in EBS, when comparing the intestinal and oral microbiomes using 16S rRNA sequencing, it was shown that bacteria inhabiting the oral cavity are capable of penetrating the intestine and modulating intestinal dysbiosis [18, 19]. This may suggest a relationship between oral dysbiosis and intestinal dysbiosis and is closely related to the manifestation of inflammatory bowel disease and colorectal cancer [20, 21], thus, by a feedback mechanism, intestinal dysbiosis contributes to the demineralization of hard tooth tissues, thereby ensuring the formation of caries [22]. In addition, it was shown that a greater similarity of taxonomic units (OTUs) (n=378) among fecal samples was found between the EBS group and the healthy group, but 124 OTUs were unique to the EBS group. In addition, children with both caries and EBS showed an alteration in the gut microbiome, as the same microbial pattern was present in both plaque and fecal samples, suggesting a link between the oral and gut microbiome. In conclusion, the EBS group had a high OTU richness but lower uniformity compared to a group of healthy volunteers [23, 24]. There were only a few significant differences in α- and β-diversity, but potential organisms in the microbiota associated with EBS and caries in children were identified. In particular, the most common genera in plaque in patients with EBS were *Streptococcus*, *Actinomyces*, and *Leptotrichia* [25, 26]. The most common genera in the plaque of patients with caries were *Streptococcus, Leptotrichia, Actinomyces* and *Porphyromonas*.

Patients with EBS had a characteristic composition of the oral microbiome dominated by *Actinomyces* (10.82%), thus associating their presence with the appearance of colored biofilms on children's teeth [27, 28], while it was determined that the microbiome in the EBS group was characterized by various microbiome biomarkers, such as *Pseudomonas* species.

Agathobacter gram-positive anaerobes synthesizing butyrate to modulate anti-inflammatory functions of the gut were more common in the caries group than in EBS. *Escherichia* and *Shigella* species were associated with activation of proinflammatory status through the IL-6 signaling pathway and the pyrin domain of the NLR family, which has a positive correlation with chronic and persistent infections with adhesive and invasive characteristics [29, 30]. It was found that the enrichment of the oral microbiome with *Escherichia* and *Shigella* species correlated with patients who had EBS without caries than in the control group among children who had both caries and EBS [23, 24].

These results show that children with both caries and EBS may have gut dysbiosis and peripheral inflammation. Thus, the need for further research is obvious. The literature suggests a decreased caries prevalence in the presence of EBS [31] which associated with low incidence of caries in children [6, 32, 33].

It has been suggested that black stain on teeth is associated with low levels of dental caries in children

with temporary teeth. However, it remains questionable whether black stain has a protective effect against dental caries or whether children at low risk of caries are more likely to develop black stain because their oral microbiome favors the microorganisms that form black stain [34].

RISK FACTORS AND ENVIRONMENTAL IMPACT

The nature of the black pigmentation is suggested to be a form of bacterial plaque with an insoluble ferric salt, most likely ferric sulphide, which is formed by the reaction between the hydrogen sulphide produced by the bacteria and iron in the saliva or gingival exudate [13]. It is perhaps for this reason that some studies suggest an increased prevalence in EBS with the consumption of particular vegetables, dairy products and fruits high in iron [3].

In a study conducted among schoolchildren, 5 students were scraped for black spots and analyzed for trace elements. The trace elements were analyzed using inductively coupled photospectrometry (ICP). Out of the 5 scrapings, 3 showed the presence of iron ions of approximately 2.56%, calcium ions of 17.15% and magnesium ions of 0.72%, while the remaining 2 samples showed calcium ions of 14.86%, magnesium ions of 0.82% and no iron ions [35].

There are a profeccional impact that can cause EBS. The characteristic EBS of teeth in iron factory workers is well documented [36]. The effect of manganese and silver on the formation of EBS. The combustion products of coal tar in smokers penetrate into the pits and fissures, soaking enamel and dentin with tobacco juice. A number of other metals, such as potassium permanganate, can produce other dark colors of EBS ranging from purple to black when used in mouthwashes [32]. Black and red plaque. The use of betel leaves and nuts is commonly seen in adults and children in the Eastern Hemisphere, where betel leaves and nuts are used as stimulants. Sometimes a black and red coating may occur. The use of betel leaves and nuts is commonly seen in adults and children in the Eastern Hemisphere, where betel leaves and nuts are used as drug stimulants [37].

Poor dental care and consumption of certain beverages or food can be associated with discoloration or staining of teeth. In the literature there was a case of a linezolid (powerful antimycrobal and antimycobacterial drug that used in the short- and long-term treatment regimens of multidrug resistant tuberculosis and mycobacteriosis) black dental hyperpigmentation. Tooth discolorations of linezolid that have been mostly reported in children. There are two types of tooth discoloration. The stains that are present on the outer surface of the teeth and can be removed manually are known as extrinsic stains, whereas those which are deposited within the enamel of the tooth during its development are known as intrinsic stains. The teeth discoloration found with linezolid are of extrinsic type and reversible (i.e., they can be removed with extensive cleaning) [38, 39]. The characteristic EBS of teeth in people using iron supplements is well documented [36]. The dark brown to black discoloration was observed in people taking iron supplements, and oral iron salts in liquid form could cause the teeth to appear greenish black [40]. Artificially induced caries increased the structural porosities of the teeth and led to greater iron uptake and, consequently, higher discoloration. The maximum structural changes and subsequent staining occurred in the ferrous sulfate group followed by ferrous ammonium citrate, ferrous fumarate, and ferrous gluconate. Therefore, it is mandatory to consider implementing a uniform global policy for improving the quality of the iron supplements and the benefit of their considerable effects, although there is no scientific evidence that they play a key role in dental prevention [41].

Also, drugs can cause the teeth discoloration. In the operational study Jun Wang and all analyzed 1188 AE were reported from 2004 to 2021 The top reported drug was tetracycline (n=106), followed by salmeterol and fluticasone (n=68), amoxicillin (n=60), chlorhexidine (n=54), and nicotine (n=52). Cetylpyridinium (PRR=472.2, ROR=502.5), tetracycline (PRR=220.4, ROR=277), stannous fluoride (PRR=254.3, ROR=262.8), hydrogen peroxide (PRR=240.0, ROR=247.6), and chlorhexidine (PRR=107.0, ROR=108.4) showed stronger associations with tooth discoloration than the remaining drugs. Of 625 AE reports involving 25 drugs with positive risk signals, tooth discoloration was mostly reported in patients aged 45–64 (n=110) and ≤18 (n=95), and 29.4% (192/652) of the reports recorded serious outcomes [38].

CLINICAL AND LOCALIZATION FEATURES

EBS affects both temporary and permanent dentition [4]. The EBS is tightly adhered to the enamel surface and cannot be removed with a probe [2].

Studies show that the places of the highest prevalence are the lingual surfaces of the mandibular teeth [4]. This is probably due to its close proximity to the mandibular salivary glands and the role of saliva in the etiology of black staining [5]. Also it affects cervical third of the tooth crown [4] and buccal and lingual surfaces [4, 5].

Usually EBS follow the gingival margin [3, 4] does not extend to the proximal areas [13]. Sometimes black plaque covers the entire surface of the tooth. It can be deposited in the form of streaks on the tooth along the gum margin or spots on the vestibular and lingual surfaces [2].

CLASSIFICATION

EBS can be classified based on the surface area of the tooth affected [6]: score 1 corresponds to the presence of pigmented dots or thin lines with incomplete coalescence parallel to gingival margin; score 2 corresponds to continuous pigmented lines and limited to half of the cervical third of the tooth surface; score 3 corresponds to the presence of pigmented stains extending beyond half of the cervical third.

The classification of stained plaque was published in 2020 [2], a systematization of stained plaque was proposed, which takes into account the color of plaque, its localization, the degree of cariogenicity and the presence of classes of diseases (according to the international classification of diseases 10 revision - ICD 10).

MANIFESTATIONS OF PLAQUE IN OTHER DISEASES

The occurance of EBS is described in pediatric population with some infectious and parasitic diseases (ascariasis) [2], blood disorders (iron deficiency anemia) [7], with endocrine, nutritional and metabolic diseases (malnutrition) [42], mental and behavioral disorders (autism spectrum disorders) [2], disorders of expressive speech, mild mental retardation, general underdevelopment of speech, mental retardation [2], onychophagia [43], hearing and mastoid bone dieseases (infectious processes in the internal or middle ear) [2], with respiratory diseases (influenza and pneumonia [44] acute tonsillitis, bronchial asthma, chronic rhinitis [2, 7] breathing through mouth disorders [43]), with diseases of the digestive system (enterocolitis, functional disorders of the intestine, unspecified ones) [2, 7], maxillofacial abnormalities (malocclusion due to sucking on the tongue, lips or finger and maxillofacial anomalies) [43], with skin diseases (allergic contact dermatitis) [2].

In the study [2], black plaque was observed in 8 out of 19 (42.11%) children with respiratory diseases, in 6 out of 19 (31.58%) children with parasitic diseases, in 5 out of 19 (26, 32%) of children with diseases of the digestive system, and in 3 of 19 (15.79%) children with diseases of the blood and hematopoietic organs.

CARIESOGENITY IN PATIENTS WITH DENTAL PLAQUE

The assessment of dental plaque cariogenicity was carried out according to the procedure proposed by J.L. Hardwick, E.B. Manly [45]; the acid activity was determined with the use of the colorimetric method of indicator's color changing from yellow to pale orange (0-30%); from pale orange to red (40-60%); from red to dark red (70-100%); methylene red was used as a color indicator for dental plaque. One percent of glucose solution was applied for several minutes on the tooth enamel; 0.1% aqueous solution of methylene red was applied on the surface of lower incisors. The results of staining were interpreted in the following way: the indicator was positive if the color of the stained plaque changed to red; the indicator was negative if the color did not change.

When black plaque was stained with methylene red, the color of the indicator did not change, so these types of plaque can be considered as having a low degree of caries susceptibility. After removing black plaque, the surface of the tooth enamel underneath was shiny, without damage or traces of demineralization. After professional cleaning of teeth, patients with black plaque were observed to re-form after two months [44].

Also, black dental plaque should be considered dense in consistency.

CONCLUSIONS

External black plaque is a common problem among patients that begins in childhood and continues into adulthood, causing aesthetic discomfort and certain difficulties in social interaction. Correct diagnosis of EBS is essential to provide appropriate advice on oral hygiene and subsequent treatment of this external staining. It can often indicate an aesthetic concern of the patient or parents of a pediatric patient, and simple dental procedures, including professional oral hygiene, can significantly improve the patient's self-esteem.

The dentist should be careful to avoid iatrogenic damage to immature tooth enamel in pediatric patients with an overbite when attempting to remove the stain.

There is a clear correlation between black plaque and concomitant conditions and caries susceptibility, which requires careful attention of the dentist to patient management and detailed history taking. With this review, we wanted to encourage dentists to identify the problem in childhood and collaborate in a multidisciplinary team to improve treatment efficiency and speed up the selection of the right tactics for the most person-centered approach to avoid worsening the problem in adulthood.

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CONFLICT OF INTEREST

The Authors declare no conflict of interest

CORRESPONDING AUTHOR

Inessa I. Yakubova
Kyiv Medical University
2 Boryspilska St., 02099, Kyiv, Ukraine
e-mail: yakubova.inessa@gmail.com

ORCID AND CONTRIBUTIONSHIP

Inessa I. Yakubova: 0000-0003-2780-2460 A B D E F
Volodymyr Ostrianko: 0000-0001-6525-7526 A B
Yurii Skrypnyk: 0000-0003-1196-8204 B F
Roman Volovodovskiy: 0009-0002-1554-3318 A F

A – Work concept and design, B – Data collection and analysis, C – Responsibility for statistical analysis, D – Writing the article, E – Critical review, F – Final approval of the article

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