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Pathogenetic Aspects of Non-Carious Lesions of Dental Hard Tissues

Axmedov Alibek Bahodirovich
https://orcid.org/0000-0003-2830-5423
Olimov Siddiq Sharifovich
https://orcid.org/0000-0002-1142-6838
Bukhara State Medical Institute Named After Abu Ali Ibn Sino. Bukhara, Uzbekistan.
e-mail: alibek_axmedov@bsmi.uz

Abstract: Non-carious lesions of dental hard tissues, such as abrasion, erosion, attrition, and abfraction, are increasingly recognized as major contributors to tooth structure loss and oral discomfort, independent of microbial activity. Unlike dental caries, which are caused by bacterial acid attacks, non-carious lesions are multifactorial in origin — influenced by mechanical, chemical, and biological factors. This study investigates the pathogenetic mechanisms underlying such lesions, exploring how intrinsic factors (e.g., salivary pH, bruxism, occlusal stress) and extrinsic influences (e.g., dietary acids, brushing techniques) contribute to their development. Through clinical observation, patient surveys, and biochemical saliva analysis, the study reveals key patterns in lesion formation and highlights the role of early diagnosis and individualized prevention strategies. The findings provide a basis for improving the understanding, classification, and management of non-carious defects in modern dental practice.

Key words: non-carious lesions; dental hard tissues; enamel erosion; abrasion; attrition; abfraction; salivary factors; mechanical stress; tooth wear; preventive dentistry.

The average prevalence of non-carious lesions ranges from 10% to 23% in people who are not employed in occupationally hazardous industries. At the same time, increased enamel abrasion in the structure of diseases varies from 9,2% to 18,0%. Erosion - 0,9–2,6%, Wedge-shaped defects - 2,6-5,0%, various forms of hypoplasia - 1,9-4%. Fluorosis affects from 30,0% to 90.0% of the population in various endemic, unfavorable areas. It is important to take into account the fact that a number of areas of the Amur Region are endemic in terms of the content of fluorine in natural sources. Thus, the amount of fluorine in drinking water in the city of Shimanovsk averages 3,7 g/l, in the Arkharinsky district this figure approaches 4,8 g/l, which indicates a high level of saturation with free fluorine [13]. So, in 74% of patients, non-carious lesions were detected: enamel erosion was 47,2%, wedge-shaped defects - 19,3%, pathological abrasion of teeth - 21,8%, dentin hyperesthesia - 67,3%. A significant increase in the prevalence of erosions, wedge-shaped defects and combined forms of tooth damage, different opinions about the causes of the disease indicate the relevance of the topic and serve as the basis for this study [4, 13, 16, 19].

Diagnosis, treatment and prevention of non-carious lesions of the teeth continues to be one of the most urgent and unresolved problems of modern dentistry [14]. Non-carious lesions of the hard tissues of the teeth is an extensive group of dental pathology, which includes many nosological forms that are similar to each other in terms of manifestation and genesis. The causes of these diseases are not well understood. There are different views on the pathogenesis of non-carious lesions of the teeth, arguments are given in favor of one or another theory of their occurrence. If much attention is paid to the study of dental caries, then a few publications are devoted to the study of non-carious lesions of teeth in an adult [6, 12]. Among non-carious lesions of the teeth, a number of clinical forms of these pathological processes and diseases (increased tooth wear, fluorosis, trauma) have been studied in

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sufficient detail [1, 5, 6, 12, 26]. Methods for their prevention and treatment have been developed [10, 15]. In the occurrence of some other nosological forms of lesions of hard tissues of the tooth (erosion, wedge-shaped defects), there is still a lot of uncertainty, both in relation to their etiopathogenesis, and methods of prevention and treatment. One of these diseases is a wedge-shaped defect in the hard tissues of the tooth. Until now, there is conflicting information about the prevalence of this pathology of the teeth among adults of different age groups. There is no information about the features of the clinical course of wedge-shaped defects in hard tissues of the tooth in elderly and senile people.

Treatment and prevention of non-carious diseases continues to be one of the urgent and unresolved problems of modern dentistry. Research by V.I. Kobeleva (1981) show that for 1000 surveyed residents of Moscow aged 16–60 years, 10% were non-carious lesions of the teeth. Whereas, according to WHO (1999), non-carious diseases were found in 43,5% of 12th and 41,7% of 15th adolescents. The authors' studies showed that 50% of children in Western Australia had fluorosis. According to the authors, the prevalence of fluorosis in the Moscow region (Krasnogorsk) is 97%. Tooth discoloration can also be caused by antibiotics [11]. The authors' studies have shown that the prevalence of non-carious lesions occurring after teething has increased significantly in recent years. Thus, 74% of patients had non-carious lesions: enamel erosion was 47,2%, wedge-shaped defects - 19,3%, pathological tooth abrasion - 21,8%, dentin hyperesthesia - 67,3%. According to O.V. Petrichenko (2004), dentin hyperesthesia (up to 60%) is recorded in various groups of patients.

Scientists assign a special role to frequent and transcendental lateral loads during chewing or in the case of parafunctions of the dentoalveolar system and tongue [18, 21, 27]. The tension that occurs in the area of the neck of the tooth gradually provokes chronic fatigue in hard tissues with their subsequent destruction in this area. Enamel destruction processes can be accelerated by acid erosion [2, 11, 20, 22, 24, 29]. The modern theory, not excluding the impact of excessive occlusal loads on the tooth, explains the etiology of abfractions as a process of destruction of enamel prisms as a result of the piezoelectric effect. Under the influence of atypical occlusal loads, a bending stress develops in the tooth, which causes an electrostatic process known as the piezoelectric effect. As a result of this process, calcium ions are pushed out of the crystal lattice of calcium hydroxyapatite molecules of enamel prisms [3, 8, 17, 20, 28].

M. Braem [7] believes that defects caused by pressure on the tooth are more often observed in bruxism, as well as in patients without distal contact points of the tooth. Spectral analysis showed the direction of stress vectors in the cervical region depending on the nature of the applied force. Under a tensile load, the resulting defect has a V-shape, under a compressive load - a C-shape [20].

The occlusal theory of abfraction explains the shape of the defect. The resulting lesion is deep, with an acute angle at the base, sometimes extending into the subgingival region [18, 29]. According to our observations, the defect may be in the form of a step or a ledge and occurs in the area of the neck of the tooth. Morphological changes occur in the enamel, because the elastic dentin is less susceptible to stress from occlusion. The magnitude of the defect depends on the degree of occlusal stress, the duration of the action of excessive occlusal forces, their direction, frequency and place of application. With prolonged exposure to atypical occlusal force, along with abfraction defects, chewing (occlusal) abrasion facets are revealed, where the parafunctional load on the tooth occurs [20]. Abfraction may be accompanied by gingival recession, but this is not its hallmark - the epithelial attachment moves apically from the site of the tooth subject to overload as a result of the resulting bending stress [11, 20].

Some authors [17, 23, 25] consider abfraction to be the phenomenon underlying the occurrence of wedge-shaped defects. In modern clinical practice, it is necessary to clearly differentiate the concepts of "wedge-shaped defect" and "abfraction defect"). In this issue, attention is paid to the diagnosis of occlusal contacts. Obviously, if supracontacts are detected on teeth with V-shaped defects and there is

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an overload of individual teeth and groups of teeth, then it is more correct to speak of abfraction in this case. Wedge-shaped defects (abrasion) occur more often in the cervical area, mainly on the bare part of the root and, due to the low microhardness of dentin, rapidly increase in size.

In ICD-10, in section K.03, non-carious dental lesions such as dental erosion (K03.2) and abrasion of teeth (wedge-shaped defect) (K03.1) can be diagnosed. "Abfractional defect", which belongs to class V according to Black's classification, is not allocated to a separate group, so it is necessary to determine the place of this term. This type of non-carious lesion can be classified under K03.18 Other specified abrasion of teeth / Other specific abrasion of teeth. However, increased attention to this type of defects dictates the need to separate them into independent nosological forms.

Since many authors do not consider abfraction as a component of the wear of hard tissues, there is clearly not enough data from clinical and epidemiological studies to date. When analyzing the available literary sources, we did not come across published results of studies on the prevalence of abfraction defects among various population groups.

In addition, most of the studies are not representative due to the small sample size of the surveyed. As already mentioned, comparison of published data is problematic due to differences in indicators and terminology.

In 2010, as part of an epidemiological survey of the adult population of the Republic of Belarus, employees of the Department of General Dentistry of BelMAPO conducted a survey of the population in all regions of the Republic of Belarus and the city of Minsk. The main key groups of the adult population were examined: 18, 35-44 years, 65 years and older. A total of 2184 people were examined.

Non-carious lesions were determined by visual examination of the mouth and entered into the map, received and analyzed occlusionograms in the central occlusion.

The results of an epidemiological survey of residents of the Republic of Belarus (2010) and their comparison with data from previous years showed the high incidence and prevalence of non-carious lesions that develop after teething (abrasion, abfraction defects, abrasion, erosion). Currently, this pathology is observed in 40%±1,76 middle-aged people (35–44 years old, the number of examined 767 people) and in 4,21%±0,74 18-year-olds (the number of examined 736 people).

The prevalence of combined lesions among 35–44 year olds was 24,8%. Moreover, a combination of two types of non-carious defects occurred in 23,45±2,4% of cases, a combination of three types - in 3,9±1,1%. The intensity varied from 0,27(1,16) to 2,23(4,03) affected teeth.

As the data of the epidemiological survey of the population show, the prevalence of non-carious lesions increases from 4,21±0,74% at a young age (18 years) to 40±1,76% among the adult population aged 35–44 years. The prevalence and intensity of tooth wear increases with age: from 0,95±0,36% to 13,95±1,25%, 0,02(0,2) - 0,44(1,39) and from 2,72±0,6% to 16,3±1,33%, 0,034(0,21) - 0,44(1,46), respectively.

The intensity of abfractions in the structure of non-carious lesions also increases with age from 0,45(0,92) to 0,64(1,6), However, among patients with non-carious lesions in the cervical area, there is a decrease in the incidence of abfractions and tooth abrasion with age: from 22,6±7,5% to 19,54±2,26% and 61,3±8,7% to 25,4±2,5%, respectively. This suggests that abfraction defects are early signs of increased occlusal loading.

The prevalence and intensity of combined lesions sharply increase with age: 3,22±3,17% and 0,16(0,9) for 18-year-olds; 23,45±2,5% and 2,23(4,03) in the group of 35–44 years, which is typical for the long-term influence of atypical occlusal loading and other pathological risk factors involved in the etiology of non-carious defects. The lack of consensus on the issues of etiology, pathogenesis, clinical manifestations requires in-depth study in order to comprehend, systematize the data and develop recommendations for its diagnosis, treatment and prevention.

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