THE INFLUENCE OF DIET ON THE FORMATION OF NON-CARIOUS HARD DENTAL TISSUES LESIONS – LITERATURE REVIEW

WPŁYW DIETY NA POWSTAWANIE UBYTKÓW TKANEK TWARDYCH ZĘBÓW NIEPRÓCHNICOWEGO POCHODZENIA – PRZEGLAD PIŚMIENNICTWA

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ABSTRACT

In this paper, the attention was paid to improper dietary habits and their influence on the non-carious lesions formation, especially teeth erosions. The factors predisposing for erosion development are mainly chemical ones. The most common cause is attributed to the frequent consumption of acidic products and beverages, especially fruit juices, carbonated drinks, such as Cola, as well as raw fruits, especially citrus. This condition mostly affects young people. The ongoing process of erosion can lead to significant, irreversible destruction of the hard dental tissues and result in teeth hypersensitivity to thermal, chemical and the mechanical stimuli. The acidic environment accelerates the damage of the teeth caused by mechanical factors, that is why dental hard tissue loss associated with erosion is almost always complicated by other forms of tooth wear such as abrasion, at¬trition and demastication. Therefore, it is viewed that necessary preventive measures should be undertaken to avoid the development of pathological processes mentioned above. The authors presented recommendations for the patients with risk of dental erosion occurrence.

KEYWORDS: diet, fruit juices, tooth erosion.

STRESZCZENIE

W pracy zwrócono uwagę na problem wpływu niewłaściwych nawyków żywieniowych na powstawanie ubytków twardych tkanek zęba pochodzenia niepróchnicowego, zwłaszcza erozji zębów. Ubytki erozyjne tworzą się pod wpływem działania czynników chemicznych. Najczęstszą przyczyną ich występowania jest zbyt częste spożywanie kwaśnych produktów i napojów, tj. soki owocowe, napoje gazowane typu Cola jak również owoców, zwłaszcza cytrusowych. Problem ten dotyczy zwłaszcza ludzi młodych. Postępujący proces erozyjny może doprowadzić do znacznej, nieodwracalnej destrukcji twardych tkanek zębów oraz do nadwrażliwości na bodźce termiczne, chemiczne i mechaniczne. Kwaśne środowisko przyspiesza uszkodzenie zębów spowodowane czynnikami mechanicznymi, dlatego z erozją zębów mogą współwystępować inne rodzaje ubytków pochodzenia niepróchnicowego, tj. abrazja, atrycja i demastykacja. Dlatego konieczne są działania profilaktyczne niedopuszczające do rozwoju wymienionych procesów patologicznych. Autorzy przedstawili zalecenia dla pacjentów, u których stwierdza się ryzyko rozwoju erozji zębów.

SŁOWA KLUCZOWE: dieta, soki owocowe, erozje zębów.

In the recent years, the interest in so-called healthy lifestyle has increased in western societies. Many people who want to keep favorable appearance, well-being and a good health for a long time, undergo various types of diets to assist in achieving this goal. In many countries, consumption of fresh fruits, vegetables, flavored drinks, fruit juices, sport and energy drinks has raised. These changes have increased the risk of the hard dental tissues loss of non-carious origin, especially the erosion type.

The teeth erosion (erosio dentinum, denta erosion, erodere, erosi, the former name erosines atypice) is a chronic, painless, irreversible loss of hard dental tissues unrelated to the action of bacteria and mechanical factors [1]. This process occurs as a result of exposure to chemical factors i.e. acids and / or chelating agents.

The current term “biocorrosion”, unlike the corrosion, stands for the chemical, biochemical and electrochemical activity onto the body tissue, i.e. enamel and dentin. Biocorrosion includes endogenous and exogenous, acidic and proteolytic, chemical degradation of the enamel and dentin, as well as the piezoelectric electrochemical actions onto the dentine collagen [2].

In the early stage, dental erosions form in the enamel shallow, wide facets, whose width is significantly greater than depth. If not stopped at this phase, this

process is followed by a gradual exposure of dentin and an increasing destruction of hard dental tissues. In most advanced cases, it can result in pulp exposure [3]. The enamel band along the oral and facial gingival margin remains intact, which is probably due to an acid-neutralizing effect of the sulcular fluid. In 1996, Lussi proposed a simple classification for the clinical evaluation of dental erosions advancement [4] :

Evaluation of buccal surfaces:

score 0 – no erosion present, the enamel surface has smooth, silky-glazed, shiny appearance;

score I – the loss of enamel surface is present; enamel along the gingival margin remains intact, changes result in developing a concavity in enamel, with the width exceeding its depth, this allows to differentiate the latter from abrasive defects caused by teeth brushing; dentine is not involved;

score II – distinct defect, involves dentine of < ½ of the tooth surface;

score III – distinct defect, involves dentine of > ½ of the tooth surface.

Evaluation of buccal and occlusal surfaces:

score 0 – no erosion present, the enamel surface has smooth, silky-glazed, shiny appearance;

score I – initial erosion, rounding of the cusps and restorations edges on occlusal surfaces rising above the level of the adjacent tooth surfaces and occlusal fissures; the loss of enamel surface; dentine is not involved;

score II – severe erosion, more advanced changes than in stage I, dentinal involvement, in severe cases the whole occlusal morphology disappears.

The erosive change is distinctly demarcated from healthy enamel in case of the causative agent elimination. As a result of the closure of the dentinal tubules with mineral deposits, dentine in the lesion becomes dark yellow or brown. Non-distinct borders of the erosive lesion are characteristic for active change, still being exposed to the action of acids, so in that case the dentin is not discolored [5, 6].

In the macroscopic examination, enamel and dentin within erosive lesions are hard and it can be a differentiating feature with the dental caries. Dental erosion may result in teeth hypersensitivity to thermal, mechanical or chemical stimuli, but sometimes, especially in early stages, it may give no immediate symptoms.

The localization of these defects depends on the source of acidic substances. In the case of endogenous acids action, during reverse regurgitation into the mouth, erosive lesions are present at occlusal and buccal surfaces of the posterior teeth and the palatal surfaces of all upper teeth. Patients at risk for this kind of the hard dental tissues damage are those suffering from gastro-esophageal reflux, persistent vomiting, anorexia, bulimia and alcoholism. If the source of harmful action are exogenous acids, at the greatest risk of erosive lesion development are labial surfaces of the upper incisors. Extrinsic factors can be associated with the work environment (e.g. in some branches of industry, particularly chemical and metal), leisure (frequent swimming in the swimming pools with chlorinated water), taken medications with a low pH value and dietary habits. Among the external factors, diet plays the most important role. Excessive intake of fresh fruits, especially citrus fruits, apples, berries, fruit juices, carbonated drinks of the cola type, fruit teas, salad dressings, as well as effervescent tablets containing vitamin C may lead to enamel demineralization and consequently, to the development of erosions [6–9]. The erosive potential of consumed food products depends on its titratable acidity ("the buffering capacity"), pH value, type of acids, their adhesion to the tooth surface, chelating properties, as well as the concentration of calcium, phosphate and fluoride. It is believed that a greater destructive effect of solid foods have acidic soft drinks, especially at low temperature. The risk of erosion development increases with the frequency of acidic fluids introduction in to the mouth [9–14]. The clinical research results indicate that the pH value of 5.0 is the critical value, below which enamel demineralization starts and consequently, the process of erosion is initiated. Although the formation of erosive lesions was shown with solutions at pH 6.3, it required large volumes of solutions as well as the long action time [15, 16].

The demineralization process is caused by the ions concentration imbalance between the enamel hydroxyapatite and the oral cavity environment. After the exposure to the acidic solution, for example: after citrus fruit or juices digestion, calcium ions contained in saliva are bounded by chelating compounds, such as citrates. The decrease of ionized calcium concentration in saliva results in the release of calcium ions from enamel hydroxyapatites and consequently, in the dissolution of hard dental tissues. This process continues until a new balance between ions concentration is set [17].

Enamel demineralization proceeds in a linear manner in the pH values ranging from 6,3 to 2,9 and the rate of hard tissue loss rises rapidly with a decrease of pH [18].

In the literature, there are many scientific research papers confirming the relationship between dental erosion and frequent consumption of acidic products, especially sweetened carbonated drinks, fruit juices and fruits [3, 19–22]. According to Johansson the development of erosive changes can be affected not only by the frequent consumption of acidic beverages, but also their prolonged detention in the mouth before swallowing [21].

What seems to be interesting is the fact that the yogurt or another milk-based food of pH below 5 have hardly any erosive effect. This is due to its high calcium content, which makes it supersaturated with respect to hydroxyapatite [23].

Prevalence studies of dental erosion were conducted by a number of scientific research centers in Poland and other countries [3, 24–34]. Results have shown great diversity in erosions prevalence. Mungia et al. observed a low, 5.5% prevalence of erosions among 12–17 year old adolescents in the U.S. Erosive changes were not advanced and limited to the enamel. The authors of this study did not show a strong relationship between the prevalence of dental erosion and diet [25]. However, most reports suggest frequent occurrence of this type of hard dental tissue damage, especially among young patients. Dugmore and Rock have observed 59.7% prevalence of erosions in 12 -year-old British children [34]. High prevalence was noted by Kaczmarek et al. in 36.1% of Polish 15-year-old adolescents [30]. Detailed results of dental erosion prevalence obtained by different authors are summarized in **Table 1**.

Among the various models of so called "healthy lifestyle" and diets, the attention should be paid to recently very popular vegetarian diet, which eliminates intake of meat. There are several varieties of vegetarianism. Veganism is one of the complete elimination of all products of animal origin, and thus not only meat, but also milk, milk-based products and eggs. The extreme form of veganism is a fruitarianism, whose adherents eat only raw vegetables and fruits. Less radical and, therefore, more common types of a vegetarian diet are lacto-vegetarianism and lacto-ovo-vegetarianism accommodating consumption of dairy products, and in the latter eggs as well. Some vegetarians also include fish in their diet [35].

Patients on a vegetarian diet, which includes the consumption of large amount of fresh fruits and vegetables, are thought to be at high risk of dental erosion development [36–38].

A study conducted in Finland showed that the products of high erosive potential, such as vinegar, fruit or drinks with low pH were consumed by vegetarians more often than people on traditional diet: the percentage of people who consumed these products daily was 30% and 8% respectively [36, 37]. Similar habits were found among Polish vegetarians. Statistically significant the more frequent consumption of raw fruits and vegetable salads were observed. There was also more frequent consumption of fruit juices and teas, but in case of beverages there was no statistically significant difference. Carbonated beverages were consumed significantly more frequently among patients having a diversified, traditional diet [38]. More frequent consumption of acidic foods by vegetarians was found in Sweden [39, 40] and the United Kingdom [41].

In the above cited Finnish studies, among vegetarians there was observed very high prevalence of erosive changes: up to 76.9%, from which advanced changes with dentine exposure of more than 1/3 of tooth surface comprised of 30.8%. None of the patients who consumed traditional foods had dental erosion [36]. In Poland, the prevalence of these changes was also higher in the vegetarians group, but the difference was not statistically significant. The percentage of vegetarians with teeth erosion was 39.1% and non-vegetarians 23.9 % accordingly. The mean number of teeth with erosion per patient on meatless diet was 1.7, and 0.6 for the control group and the difference was statistically significant. In these studies, the severity of erosive changes was similar for the two compared groups. The majority (about 60%) of erosive lesions were classified as initial, limited only to enamel (score I of Lussi's classification). Remaining erosive changes were classified as score II by Lussi's: erosions with exposed dentin, not exceeding more than ½ of the tooth surface. More advanced defects were not observed in any subject. In both groups, 70 % of erosive lesions were active changes with diffused borders separating them from healthy enamel. This clinical picture denotes that erosive agent has not been eliminated [38].

Some researchers have not found greater consumption of acidic products by individuals on the meatless diet [42, 43], as well as higher prevalence of dental erosion in this group [41].

Although the effect of acidic food on the formation of dental erosions is very well known and has been documented in numerous publications, it should be remembered, that this process is modified by many factors. The action of erosive agents onto the hard dental tissue, does not have to cause a tissue damage. An important role may play the degree of hard dental tissues mineralization, the influence of the soft tissues surrounding the teeth, especially the lips, cheeks and tongue, occlusion, the composition and properties of saliva, as well as mechanical factors. In some individuals dental erosions can be idiopathic and in this case etiologic factor cannot be established [44, 45].

The saliva plays a significant role in maintaining the oral cavity homeostasis. The flow rate of saliva is an important host factor and can be affected by several physiological, pathological and psychological factors. The normal unstimulated flow rate should be about 0.33 - 0.55 ml/min and after stimulation about 1, 5 - 2,3 ml/min [46]. Reduction in the salivary flow rate results in decreased food acids neutralizing action and in con-

sequence the increased risk of erosions development. Järvinen et al have found that the unstimulated salivary flow rate of 0.1 ml/min or lower, increases the risk of erosion five times [47]. Of relevance is also saliva pH and buffering capacity [48]. Protective effect of the proteins contained in saliva onto hard dental tissues is suggested [49]. Calcium and phosphate ions play an important role in the remineralization and demineralization of hard dental tissues [17].

The hard dental tissue loss is faster in a low pH environment when it comes to interaction of chemical and mechanical factors. In practice, this is often the case, when the teeth are toothbrashed immediately after acidic food intake. The incorrect horizontal tooth brushing technique, cleaning with applying too much force and the application of highly abrasive dentifrice increase the damage to the enamel and dentin [44].

Due to the rapid destruction of dental hard tissues subjected to different mechanical interactions in an acidic environment, it should be noted that frequent consumption of acidic foods not only promotes the formation of erosion, but also other types of non-carious lesions such as attrition, abrasion and the demastication.

A common cause of the abrasive lesion formation is a process involving foreign objects or substances repeatedly introduced in the mouth and contacting the teeth. This is often, as mentioned previously, a result of using toothbrush with too stiff bristles, incorrect brushing method with the use of abrasive dentifrice, improper use of interdental brushes. Therefore, this type of teeth wear is frequent among individuals with a good oral hygiene. The formation of abrasive lesion is promoted by gingiva recessions exposing root cementum as well as the lack of contact between the enamel and root cementum in the neck region of the tooth causing the dentin exposure [50]. Abrasive lesions are localized in the cervical area of the tooth and have wedge shape. Hara et al demonstrated that the cementum and dentin, as less mineralized tissues, are more susceptible to abrasive factors than enamel. The acidic environment accelerates the destruction, since the critical pH for these tissues is higher than that of enamel and it is of 6,2-6,7 [51]. In clinical practice it is the coexistence of non-carious erosive and abrasive lesions is often found, especially during the simultaneous action of the chemical and mechanical factors.

In such conditions, lesions with characteristic futures for abrasion and erosion can develop with a predominance of one component, depending on the predominance of mechanical or chemical agent, what sometimes causes great diagnostic problems. The diagnosis must therefore be preceded by a detailed clinical interview of potential destructive agents [52].

In the studies of individuals on vegetarian diet not only an increased incidence of dental erosions was observed but also dental abrasion: the latter was found in 26.1% of cases, and in the control group in 10.9% of patients. The mean value of abrasive lesions, as well as erosive changes, was significantly higher among vegetarians. Since in this group of patients more frequent consumption of certain acidic products was found, it can be concluded that the concomitance of mechanical and chemical factors increases the risk of both: erosion and abrasion of the teeth [38].

Attrition is a process of wearing away dental hard tissues as a result of tooth-to-tooth contact between opposing teeth. This is a physiological process, but in some circumstances it may cause excessive, pathological destruction. Demastication, however, is the process of the tooth wear caused by the contact with food. Some authors have suggested a tendency to consume very large quantities of hard foods by vegetarians [42]. The frequent consumption of hard, raw products may cause significant damage to the teeth. The clinical picture of attrition and demastication is similar, and the diagnosis is established on the basis of the clinical interview. Likewise in these cases, an acidic environment accelerates the destruction of hard dental tissues [6].

Presented results show, that nowadays in many countries including Poland, there is a high risk of non-carious lesions development, especially dental erosions. This is due to worldwide trends towards the frequent consumption of carbonated drinks such as Cola, fruit juices, raw fruits including citrus, as well as energy drinks. All of these products have a high erosive potential and consumed frequently are the main cause of teeth wear. The problem concerns especially young people. Permanent teeth at this age are immature, less mineralized than in adults, and thus particularly vulnerable to harmful environmental factors. If the unfavorable eating habits are maintained, with the time this may lead to excessive, irreversible hard dental tissues destruction among these individuals. Huew et al. have found erosive changes in as much as 40.0% of 12 - year-old children, of which 32.5% affected only the enamel, 8% were exposing the dentine and in 0.3% of cases pulp was exposed [3].

Therefore, it seems essential to educate the society regarding dental erosions, to eliminate negative habits as well as implement pro healthy attitudes.

Dietary recommendations for the patient should include [6]:

- the reduction of dietary intake of acidic beverages and foods,
- limiting the consumption of acidic foods to main meals,

- consumption of the pH neutral food at the end of the meal (for example: cheese), not the fruit
- fast drinking of acidic beverages, or drinking using a straw,
- limiting contact time of drinking acidic beverages with teeth,
- rinsing the mouth with water or a solution of sodium carbonate immediately following the drinking of acidic beverages, it will accelerate the clearance of acids and help return the oral pH to neutral,
- replacement of soluble vitamin C tablets for swallowing tablets,
- the use of tooth brushes with soft or medium bristles,
- the use of low-abrasive (RDA <40) dentifrice with fluoride and sodium bicarbonate,
- avoiding brushing teeth immediately after an acidic meal,
- the replacement of horizontal teeth brushing technique with vertical technique,
- rinsing the oral cavity twice a day with low concentrated, containing stannous fluoride mouth rinses (0.025–0.05%),
- twice a week application of fluoride gel at a concentration > 1%,
- the use of sugar-free chewing gum,
- avoiding or reducing frequent intake of very solid foods.

Professional prophylaxis in the dental office should include:

- oral hygiene instructions,
- application of fluoride preparations,
- reconstruction of advanced lesions using adhesive materials,
- monitoring of the lesions development (preferably preparing plaster models from the lesions impressions every six months).

Summing up, the above mentioned simple recommendations, plays an important role in the prevention of the non-carious lesions development. Therefore, it seems essential to educate dental professionals, emphasize the need of early and precise diagnosis with the detailed clinical examination and patient interview focused on the risk factors predisposing to teeth wear development. Initial changes are usually asymptomatic, thus can be easily overlooked in a clinical examination. The early diagnosis and rapid implementation of preventive measures can protect patients from severe and irreversible damage of dental hard tissues caused by dietary factors.

Table 1. The results of dental erosion prevalence obtained by different authors

Author	Year	Country	Children and adolescent		Adults	
			age (years)	%	age (years)	%
Kaczmarek et al.[30]	2012	Poland	15	36.1		
Wierzbicka et al.[28]	2012	Poland			18	42.3
Wierzbicka et al.[27]	2011	Poland	15	24.7		
Huev et al. [3]	2011	Libya	12	40.8		
Okunseri et al. [32]	2011	USA	13–15 16–17	39.6 44.5	18–19	55.5
EL Aidi et al. [33]	2010	Netherlands	11	30.4		
Mungia et al. [25]	2009	USA	12–17	5.5		
Correr et al. [26]	2009	Brazil	12	26		
Kaczmarek and Sołtan [29]	2008	Poland			38.8 (mean age)	25.8
Dugmore and Rock [34]	2004	United Kingdom	12	59.7		
Arnadóttir et al. [24]	2003	Iceland	15	21.6		
Waszkiel [31]	2000	Poland			18–20 25–30	15 19.44

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The manuscript accepted for editing: 25.06.2014
The manuscript accepted for publication: 27.08.2014

Funding Sources: This study was not supported.
Conflict of interest: The authors have no conflict of interest to declare.

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