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Saliva and caries – a literature review

Dental caries has been known to humans for thousands of years. It is considered to have a multifactorial, not yet fully explained, etiopathogenesis and is a social disease on the one hand and, on the other hand, one of the most frequently occurring human infections. The facilitating and conducive factors for the disease are cariogenic bacteria, carbohydrates supplied in food, dental tissues susceptibility as well as time and frequency of the influence of pathogenic factors on these tissues (4, 10, 11, 16). It should also be stressed that saliva may play an important role in caries etiopathogenesis. Due to the fact that oral cavity is the natural environment providing basic protection for the hard dental tissues, parodontium and mucous membrane, it is treated as a wet biotope. Moss even claims that saliva is for dental enamel what blood is for the body cells and as a cell is dependent on the blood stream providing it with nutrients, removing the catabolites and protecting it so the enamel depends on saliva playing a similar role (11, 14, quoted after 20, 21).

Whole saliva is a secretion consisting of a mixture of outputs from parotid, submandibular and sublingual salivary glands, small glands situated in the mucous membrane of the oral cavity and gingival crevice fluid. Not stimulated, resting saliva, contains 99.4% of water and 0.6% of organic and inorganic substances; the value of salivary pH is in the range of 6.2 and 7.6. The main inorganic components are sodium, potassium, calcium and magnesium cations as well as phosphate, carbohydrate, carbonate, fluoride and chloride anions, while the most important organic elements of saliva are proteins. According to Schenkels, there are three groups of proteins in saliva. They are histatine and PRPs (proline rich proteins) that only occur in saliva, lysozyme and immunoglobulins occurring in many body fluids and proteins derived from sources other than salivary glands, for example blood serum (7, 8, 11, 20, 23).

Saliva plays various roles, facilitating protection and proper functioning of human organism. It protects hard and soft oral cavity tissues from dryness, mechanical, thermal or chemical irritation; it accelerates the process of cleansing oral cavity from alimentary debris; facilitates forming and swallowing of food morsels; inhibits the process of demineralization and accelerates the process of remineralization of hard dental tissues; it buffers organic acids produced by dental plaque bacteria; it prevents loss of mineral elements from dental tissues as well as contributes to inhibition of adhesion of bacteria; allows for the initiation of carbohydrates digestion; cooperates in receiving gustatory stimuli as well as in sensing touch and warm and cold temperature; facilitates removing organic and inorganic toxins from the organism; participates in regulating water and electrolyte balance. It also possesses antibacterial, antiviral and antifungal properties (7, 8, 11, 13, 20).

The fact that saliva contains organic and inorganic elements has made it an object of past and current laboratory and clinical studies. The reason for arousing so much interest is the observation that, on the one hand, its composition depends on the changes taking place in the oral cavity and, on the other hand, it may reflect a series of processes occurring in the whole organism. Thus, saliva is

being more and more frequently treated as biological material suitable for diagnostic, screening and epidemiological studies. Saliva is also used for determining the risk of occurrence of dental caries. Denny et al. have observed a correlation between the number of decayed teeth or dental surfaces and the, genetically determined, presence of oligosaccharides in saliva. The authors found out that oligosaccharides present in salivary glycoproteins are responsible for acceleration of the process of bacterial colonization of dental surfaces, but also for agglutination and removal of bacteria from oral cavity, which protects hard dental tissues from caries development. In order to estimate the risk of occurrence of caries, microbiological salivary tests are also performed. They allow for the evaluation of CFU of *Streptococcus mutant* and *Lactobacillus acidophilus* bacteria, which determines the susceptibility of human organism for the occurrence of dental caries (6, 11, 27).

As we stated before, saliva is characterized by properties protecting human organism from occurrence and development of dental caries. There are several factors taking part in these protective processes. They include salivary flow rate, buffer ability, the activity of inorganic and organic antibacterial components of saliva, involving both immunoglobulins and other proteins, as well as the more and more frequently mentioned integrated antioxidant defense system (8, 11).

Oral cavity is constantly exposed to the influence of adverse environmental factors and saliva is the first secretion to come in contact with exogenous substances. Thus, the salivary function of dilution and excretion of substances adversely influencing human organism is considered to be especially significant. Consequently, saliva secretion disorders, particularly decreased secretion as a result of systemic diseases, medicines or head and neck radiotherapy, contribute to the occurrence of not only oral cavity pathologies but also adversely influence the health state of the whole organism. The most frequent direct results of decreased secretion of saliva are: acceleration of the development of caries, changes in the ecosystem of oral cavity micro-organisms and occurrence of oral mucosa infections and their complications. It seems obvious that the salivary flow rate plays an important role in defense against adverse environmental factors. The importance of the physicochemical characteristics of saliva (e.g. viscosity, surface tension) should also be stressed as it also plays a role in protecting hard dental tissues from caries (1, 11, 24).

Salivary buffer system is one of the mechanisms protecting human organism from environmental hazards. The salivary buffer system facilitating neutralization of acids produced by bacteria in the oral cavity contains bicarbonate buffer (it is thought that it is responsible for 90% of buffer capacity), inorganic phosphates and proteins. However, it must be stressed that Lussi et al. made a significant observation that the higher the buffer capacity of food and fluids supplied to the organism, the longer the time within which saliva can neutralize the acids contained in these products (8, 11, 15, 18).

Considering the influence of inorganic compounds on the development of caries it can be stated that the most important role is played by calcium as well as inorganic phosphates and fluorine compounds. It was observed that in people in whom the concentration of calcium in saliva is higher, the cariogenic process is less active. In case of inorganic phosphates, not only do they play a role in the buffering process but also in keeping the normal structure of dental tissues. However, it should be pointed out that phosphates constitute an important nutritious factor for oral cavity bacteria. Since 1950s fluorides are considered to be extremely significant in caries prevention. Fluorides also occur in saliva, but only 1/1,000 of fluoride compounds consumed with food are secreted by salivary glands. Nevertheless, it is worth while noticing that the concentration of fluoride compounds in gingival crevice is similar to the one in blood serum, so the concentration of fluorides in microenvironment of the gingiva is similar to the concentration found in blood serum (quoted after 11, 24, 28).

Analyzing the role of organic components of saliva in the process of either preventing or inhibiting dental caries development, it must be stressed that both immunoglobulin and non-immunoglobulin proteins play a key role. Immunoglobulin G present in saliva constitutes the main antibody of

secondary response, characterized by the ability to penetrate to dentinal tubules damaged by caries, as well as stimulating the classic path of complement activation. IgM, in turn, plays a significant role in primary response and, like IgG, it stimulates the classic path of complement activation. Finally, salivary IgA constitutes the main element of preventing mucous and serous membranes infections, participates in intracellular defense and stimulates the alternative path of complement activation. sIgA occurs in two subclasses – IgA1 and IgA2. IgA2 in its dimeric form is a subclass dominating in secretions. According to Epstein T-cell dependent production of IgA in blood serum and in secretions constitutes a marker of immunological defense at mucous junctions (quoted after 9, 11, quoted after 19).

Taking non-immunological compounds protecting hard dental tissues from caries, into account we should mention a few compounds playing an important role, among others, lysozyme, lactoferrine, α1 proteinase inhibitor, sialoperoxidase and myeloperoxidase. Lysozyme has properties facilitating hydrolysis of bonds present in bacterial cell wall, activating bacterial actolyzines and binding itself with nucleic acids of microorganisms. It was also observed that together with the DMF_s value increase the level of lysozyme in saliva decreases, so there is a significant correlation between the level of lysozyme and caries. Lactoferrine, in turn, is a protein characterized by high affinity to iron, depriving microorganisms of this important growth factor. Apolactoferrine can cause *Streptococcus mutant* agglutination. Sikorska et al. also concluded that there is a significant relationship between the decayed surface index and levels of lactoferrin, sIgA and α1 proteinase in saliva and salivary flow rate. The results indicate that immunological and non-immunological elements of defense system of the host cooperate with one another, although the mechanisms of this cooperation are not clear. Both myeloperoxidase and peroxidase stimulate production of subthiocyanate and hypochlorite – compounds with bacteriostatic and bactericidal properties. Recently, Kimoto et al. observed that carbonic anhydrase VI is an enzyme not only facilitating acid neutralization in dental plaque, but also penetrating deep into it. Nonetheless, it should be underlined that not all proteins present in saliva are unambiguously involved in hard dental tissues protection against caries. For example, matrix metalloproteinases are salivary enzymes playing an important role in caries development. It is thought that they take part in the process of destroying organic dentinal matrix. Acidous pH is necessary for activation of these enzymes, however, even in case of neutralization of acids present in the oral cavity, matrix metalloproteinases continue their destruction of previously demineralized dentine. Studies by Chaussain-Miller et al. also revealed that the process of degradation of small integrin-binding ligand n-linked glycoproteins can potentially accelerate both the process of releasing and activating of matrix metalloproteinases (quoted after 3, 5, 11, 15, 17, 25, 26).

The integrated system of antioxidant protection, providing dynamic balance between prooxidants and factors with antioxidant properties, plays an extremely significant role in organism protection from the influence of adverse factors and in keeping systemic homeostasis. It also seems that it plays a role in dental caries prevention. However, it should be stressed that interactions occurring between the components of the integrated antioxidant defense system, as well as the fact that so far not all the compounds with antioxidant properties have been identified, we cannot unambiguously conclude how important role it plays in caries etiopathogenesis. But, on the basis of available literature, it was found that total antioxidant level in saliva increases with higher activity of dental caries (3, 12, 22, 28).

To sum up, it can be stated that saliva constitutes an important factor in caries etiopathogenesis. It also seems that thanks to the studies of particular components of saliva and their interactions, as well as their influence on hard dental tissues, it should be possible to develop modern prophylactic, diagnostic and therapeutic methods, beyond the ones based on Anusavice maxim of "drill, fill and bill" (2). Most of all it should be possible to create modern anticarious preparations containing

certain elements of saliva, facilitating dental plaque control as well as to develop a caries preventing vaccine.

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SUMMARY

Dental caries has been known as a multifactorial, social disease considered as one of the most frequently occurring human infections. Saliva may play an important role in caries ethiopathogenesis because of its buffer system, inorganic and organic substances and integrated system of antioxidant protection. In this literature review the role of saliva in protecting human organism from caries was dicussed.

Ślina i choroba próchnicowa – przegląd literatury

Próchnica zębów uznawana jest za schorzenie wieloprzyczynowe, będące nie tylko chorobą społeczną, ale także jedną z najczęściej występujących chorób infekcyjnych. Ślina może odgrywać istotną rolę w procesie etiopatogenezy procesu próchnicowego, biorąc pod uwagę jej pojemność buforową, nieorganiczne i organiczne składniki śliny, jak również zintegrowany system obrony antyoksydacyjnej. W artykule przedstawiono przegląd literatury dotyczącej roli śliny w zapobieganiu wystąpieniu i rozwoju procesu próchnicowego.