Changes in Zinc Concentration in Oral Environment as a Risk Factor of Periodontal Disease

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Abstract

The Zinc (Zn) concentration was determined from salivary gland of Wistar King A (WKA) rats. The salivary glands are divided into sub-lingual, sub-mandible and parotis. The Zn concentration was determined within 15-60 minutes of restraint stress. Concentration of Zn in sub-mandible, parotis and sub-lingual glands was significantly higher (p<0.001) than in the control group. Further more at. Zinc concentration in sub-mandible gland at 30 min restraint stress was increase (p<0.001), and decrease significantly at 49 min by restraint stress. By the way, Zn concentration in parotis gland was increase significantly (p<0.0001) after 60 min restraint stress. The results suggest that Zn is linked to oral saliva under physiological stimuli, and that Zn accumulates in the salivary gland during salivary enzyme activity.

Introduction

The prevalence of periodontal disease in Indonesia has almost reached 100%. Understanding the biological factors that influence the pathogenesis of periodontal disease could help to prevent the problem. The tooth surface consists of mainly of proteins and minerals. The periodontal disease is indicated by a close relationship with mineralized and non mineralized deposits on external surface of teeth.

The essential mineralized dental plaque can cover the external surface of teeth is called dental calculus. In the prevailing view, until 1960, dental calculus is the major causative factors of periodontal disease. Its pathogenicity is attributed to its rough outer surface, which mechanically irritates the adjacent tissues. The irritates tissues with the initial damage to the gingival margin in periodontal disease is due to immunological and enzymatic effects of the microorganism in the dental plaque. There may also be loosely held covering of material alba, shed bacteria, desquamated epithelial cells, and blood cells derived from the crevicular area. Poor oral hygiene, lack of adequate masticatory function, and tooth malposition can contribute to an increased rate and extent of dental calculus deposition. The tightly adherent calcified deposit, classified as supragingival calculus, is formed on the clinical crowns of the teeth above the free gingival margin. Another form of calcified deposit from sub gingival plaque mineralization is called subgingival calculus, which is not formed from direct extension of the supragingival calculus. It is located on the root surface below the free gingival margin and extends into the periodontal pocket. The subgingival and supragingival plaque are primarily responsible for inflammatory changes in the gingival and supporting tissues, which generate the gingival crevicular fluids.

The dental calculus is a biological apatite as well as enamel and dentin of the teeth. A review study on dental calculus composition has revealed that the dental calculus lacks homogeneity regarding its density, distribution in the mouth, and crystal structure. The gross distribution of dental calculus varies depending whether it is subgingival, supragingival or tooth-to-tooth location. These variations may influence the elements incorporated into calculus formation because of various oral biochemical environments. For example, gingival exudates will influence...
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sub gingival calculus, and its proximity to salivary gland ducts will produce different biochemical environments. Another study has elucidated that the presence of essential trace elements had a close relation with the formation of dental calculus synthesized during precipitation. Also, the presence or absence of some elements, such as alkaline earth, may affect the apatite's nuclei crystallization or bacterial proliferation and their activities on the surface of dental calculus.

Zn is a common trace element in dental calculus which have a strong relationship with periodontal disease process. Zinc plays an important role as an essential trace element in many biological functions. The four-fold higher content of Zn in sub gingival calculus has been related to the fact that Zn level in serum is higher than in saliva. Saito has reported that the changes of Zinc concentration in whole blood have a strong relation with diabetes mellitus disease. The correlation between diabetes mellitus and the severity of periodontal disease are well known. Diabetes mellitus has been one of the major systemic predisposing factors that affect a periodontal tissue. Recent study elucidated that periodontal disease had relationship with stress and delayed wound healing of connective tissue and bone. In addition, acute necrotizing ulcerative gingivitis (ANUG) has strong correlation with psychologic stress. Various stresses such as starvation, infection, psychological and inflammatory stresses induce changes of essential trace elements in human and animal.

Following the main problems mentioned above, the hypothesis is that the presence of zinc in dental plaque, serum, and saliva have some influence in dental calculus formation, which induces periodontal disease.

There have not been any studies on the changes of zinc as causative factors in periodontal disease. This study will investigate the effect of stress on the changes of zinc level in salivary gland of WKA rat.

Result

Effects of restraint stress on zinc, in sub lingual, sub mandible and parotids gland are indicated in Figure 1, 2, and 3.

Figure 1: Dynamic of zinc in sub mandible Gland of WKA Rats after Restrain Stress

Figure 2: Dynamic of Zinc in Sub lingual Gland of WKA Rats after Restrain Stress

Experimental procedure

After preparing the acrylic restrainer. The rats were put into the acrylic restrainer in 15, 30, 45, 60, 75, 90, 105 and 120 minutes. Further the rats anesthetized by ether, put the blood from the heart to glass reaction. Put serum, after blood centrifuging in 20000 gravitate. After that, cut all salivary glands including to sub lingual gland, sub mandible gland, and parotids to each dishes.

Determination of zinc concentration in salivary gland after stressed by acrylic restrainer.

Samples were prepared of sub lingual, sub mandible, parotids of WKA rats. X-Ray Fluorescent was used to determine zinc concentration. The differences value of Zn concentration was analyzed by student's T-test, and P values less than 0.05 was considered to be significant.

Figure 1: The rats in acrylic restrainer in from 15-20 minutes
Figure 3.
Dynamic of Zinc in Parotis Gland of WKA Rats after Restrain Stress.

![Graph showing zinc concentration in parotid gland](image)

N = 15  Mean ± SE  ++++ p<0.0001

Figure 3 shows the dynamic of Zn concentration in parotid gland was significantly increase (p<0.0001) after 60 min restraint stress.

Discussion

The present investigation showed that zinc concentrations in specific region of salivary gland affected by restraint stress and that differences in these concentrations vary with the duration of restraint stress. The increase zinc concentration caused by relatively short-term restraint stress.

It has been reported that zinc, copper and iron are both important in many activities of certain proteins in saliva. Four important proteins found in saliva are bacteriostatic or bacteriocidal. They are lysozyme, lactoferrin, salivary peroxidase and secretory immunoglobulin A(Ig A),

Lysozyme activity is depressed by the presence of iron and copper. On the other hand, lactoferrin combines with iron and copper to protect the lysozyme action, while at the same time depriving bacteria of some of their essential simply of those two metals. These activities indicate that there was disturbance in the activity of lysozyme and lactoferrin. On the other hand, the levels of zinc, in sub mandible gland saliva was decreased. This is it inhibit this activity of lysozyme and lactoferrin.

The decreasing of iron, copper and zinc will inhibits the activity of lactoferrin and lysozyme. Depriving of lysozyme activity will elevate the capability of bacteria to use glucose.

By the way, the level of concentration of zinc in parotids was increase within 60 min, this condition indicates that Zn-binding protein is stimulates the parotids gland saliva to secrete carbonic anhydrase in parotids gland. Whereas the function of carbonic anhydrase is related to control the taste and smell function. While the increasing of copper and iron concentration level in parotids gland will activate the lactoferrin and lysozyme activity.

The results suggest that the changes in the trace element of zinc, copper and iron in the saliva from salivary gland of sub lingual, sub mandible, and parotids gland may be closely related to the processes of enzyme activations induced by mild physiology stimuli, and that the metabolism of these metals in differently regulated according to the functional role of each element in the salivary gland system.

References