

ANALYSIS OF EFFECT OF CALCIUM, PHOSPHOROUS & ALKALINE PHOSPHATASE ON DENTAL CARIES IN PATIENTS OF DIABETES

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ABSTRACT

Analysis of this study was carried out to role of calcium, phosphorous and alkaline phosphatase in dental caries on the patients of diabetes. Total of 200 subjects of either sex, aged >30 yrs were selected. Decayed, missed and filled teeth were used as indices for scoring the dental caries and were distributed into 4 groups as 30-40 (Group-I) 41-50 (Group II), 51-60 (Group III) and more than 60 (Group IV), while the control subjects had dmft index equal to or less than 3. Serum was collected and Calcium, phosphate, fluoride and alkaline phosphatase were analyzed. Patients of dental caries showed significantly decreased levels of calcium, phosphate, fluoride ($P < 0.001$) and significantly increased level of alkaline phosphatase ($P < 0.001$) were observed in groups I, II, III and IV as compared to controls. i.e. the diabetic patients are more prone to develop dental caries with calcium, phosphorus levels decreases and alkaline phosphatase level increases. but in diabetic females with dental caries serum phosphorus levels are very low in comparison to diabetic male. The mean dmft index value for the PKU children (4.18) was found to be relatively high as high as compared to the other two groups. No statistically significant difference was found in the mean DMFS values between the children and adolescents in the three groups. Children with PKU possess a higher caries rate in their primary dentition, they show a higher risk of developing periodontal disease.

Keywords: Dental caries, Serum calcium, Phosphorous, Alkaline phosphatase

INTRODUCTION

A number of studies have been dedicated to the investigation of oral health in diabetics. The majority of these studies have been focused on the relationship between periodontal disease and diabetes and fewer on dental caries and diabetes. Although the risk of developing periodontal disease in diabetics is well established, the association of dental caries and diabetes is still debated. It is, however, difficult to interpret the significance of the results in relation to children's a large amount of the studies regarding oral health in diabetics have been carried out with type 2 diabetic adult patients.

Dental caries is an infection, bacterial in origin, that causes demineralization and destruction of the hard tissues (enamel, dentin and cementum), usually by production of acid by bacterial fermentation of the food debris accumulated on the tooth surface. If demineralization exceeds saliva and other remineralization factors such as from calcium and fluoridated toothpastes, these hard tissues progressively break down,

producing dental caries (cavities, holes in the teeth). The bacteria most responsible for dental cavities are the mutans streptococci, most prominently *Streptococcus mutans* and *Streptococcus sobrinus*, and lactobacilli. If left untreated, the disease can lead to pain, tooth loss and infection. Today, caries remain one of the most common diseases throughout the world. The systemic effects of periodontal diseases have been of increasing interest during the past two decades. Periodontitis is an inflammatory response to a bacterial challenge and represents a portal of entry for periodontal pathogens, bacterial endotoxins, and proinflammatory cytokines. Thus, the local oral inflammatory disease, periodontitis, may induce and perpetuate a systemic inflammation that may aggravate systemic diseases such as cardiovascular disease, pulmonary disease, rheumatoid arthritis and diabetes mellitus. Heterogeneous epidemiological data about the prevalence of periodontal diseases are available in the dental literature. Due to the advanced age of the subjects examined in the present study, the following epidemiological data predominantly focus on the prevalence of chronic periodontitis in adults and older subjects.

The findings of present study, it can be concluded for adults that the adequate level of calcium, phosphate and fluoride is responsible for the significant deposition of these minerals in plaque which greatly reduces the developmental caries in the adjacent enamel i.e. the diabetic patients are more prone to develop dental caries with calcium, phosphorus levels decreases and alkaline phosphatase level increases. but in diabetic females with dental caries serum phosphorus levels are very low in comparison to diabetic male. The mean dmfs index value for the PKU children (4.18) was found to be relatively high as compared to the other two groups. No statistically significant difference was found in the mean DMFS values between the children and adolescents in the three groups. Children with PKU possess a higher caries rate in their primary dentition. While diabetic children have a lower caries rate in their primary dentition, they show a higher risk of developing periodontal disease. It is, therefore, proposed that both groups of child patients, i.e. PKU and type 1 diabetics be encouraged to seek early dental advice and be incorporated in a meticulous prevention programme. Thus the study is of great practical importance

MATERIALS AND METHODS

A total of 200 subjects of either sex aged >30 years were selected from the department of Medical Biochemistry & dental college of university. All the subjects were free from any systemic illness and were not taking any caries preventive regimen like fluoride toothpaste, fluoride rinses or NaF/calcium tablets. Subjects who gave improper history about missed tooth or suffering from any type of Xerostomia or having any oral inflammatory problems were not included in the study.

Dental examination was done with the assistance of dentist under natural light source. Decayed, missed and filled teeth (DMFT) were used as index for scoring the dental caries. All subjects were distributed into 5 groups (Table-1) each having twenty individuals. Like group 1 with DMFT index 30-40, group 2 with DMFT index 41-50, group 3 with DMFT index 51-60 and group 4 with DMFT index more than 60, while the control subjects have the DMFT index equal or less than 3.

10 mL of venous blood sample was drawn after applying a tourniquet, followed by proper aseptic precautions with a sterile disposable plastic syringe without any anticoagulant. A drop of blood was put on the electrode of pH meter from the novel of syringe carefully for blood pH determination. 0.5 mL of blood was immediately put into sterile bottle containing 0.5 mg of EDTA (Ethylene Diamine Tetra Acetic acid) powder, shaken gently and stoppered. This blood was used within 24 hours for the estimation of lactic acid. The student's "t-test" was used to compare the serum calcium, phosphate and fluoride among the control and diseased groups.

RESULTS AND DISCUSSION

Two hundred individuals were divided into five groups according to their DMFT index (table-1). The distribution of sex is approximately equal in all groups. The base line comparison of mean values of age, DMFT, index and number of brushing per day (Table-2) shows a significant decrease in number of brushing and significant increase in DMFT index in all groups when compared to control.

Table 1: Distribution of control and patients in groups. According to the DMFT index)

Group	DMFT index	Distribution of subjects	Sex	
			Male	Female
Control	<30	40	13	7
Group - I	30-40	40	11	9
Group - II	41-50	40	11	9
Group - III	51-60	40	10	10
Group - IV	> 60	40	10	10

Table no.2 shows the comparison of the mean values of serum pH, calcium, phosphate, fluoride and lactic acid between control and all groups. In group I there is a significantly decreased level of serum, calcium and fluoride and significantly increased level of lactic acid when compared to control subjects ($P < 0.001$). In group II, III and IV serum, calcium, phosphate and fluoride observed decreased significantly and a significant increased in serum lactic acid when compared to control subjects ($P < 0.001$). No significant change is observed in serum pH of all groups when compared to control group.

Table 2: Comparison of serum pH, calcium, phosphate, fluoride and lactic acid between control and groups.

Parameters	Control (n=20)	Group I (n=20)	Group II (n=20)	Group III (n=20)	Group IV (n=20)
PH	7.412	7.407	7.417	7.419	7.418
	+0.005	+0.006	+0.005	+0.004	+0.005
Calcium (mg/dl)	10.275	9.72**	9.1**	8.6**	7.955**
	+0.154	+0.128	+0.127	+0.139	+0.115
Phosphate (mg/dl)	4.22	4.03	3.59**	3.005**	2.295**
	+0.117	+0.099	+0.047	+0.032	+0.059

Fluoride (mg/dl)	4.4 +0.393	2.295** +0.317	1.615** +0.713	0.76** +0.044	0.58 +0.069
Lactic acid (mg/dl)	7.45 +0.413	11.765** +0.809	15.32** +0.695	18.14** +0.794	22.875** +0.956

Values are expressed as mean + SEM., ** P<0.001 as compared to control.

Table 3 shows the intergroup comparison of mean values of serum pH, calcium, phosphate, fluoride and lactic acid. A significantly decreased serum calcium and phosphate and increased lactic acid were observed in group II, III and IV when compared to group I whereas fluoride was significantly decreased in group II and IV when compared to group I. When group III and IV were compared with group II, the decreased serum calcium, phosphate and increased lactic acid were observed. In contrary when group IV compared with group III, significantly decreased level of calcium, phosphate, fluoride and increased lactic acid were observed. In group II serum calcium and phosphate were significantly decreased while lactic acid was significantly increased when compared to group I (P<0.001). In group III and IV serum calcium, phosphate and fluoride were decreased significantly while lactic acid was increased significantly when compared to group I (P<0.001). In group III serum calcium and phosphate were significantly decreased and lactic acid is significantly raised when compared to group II (P<0.05).

Table 3: Inter group comparison of serum pH, calcium, phosphate, fluoride and lactic acid.

Parameters	Group I (n=20)	Group II (n=20)	Group III (n=20)	Group IV (n=20)
PH	7.7407 +0.006	7.417 +0.005	7.419 +0.004	7.418 +0.005
Calcium (mg/dl)	9.72 +0.128	9.1** +0.127	8.6**† +0.139	7.955***††ÅÅ +0.115
Phosphate (mg/dl)	4.03 +0.09	3.59** +0.047	3.005***†† +0.032	2.295***††ÅÅ +0.059
Fluoride (mg/dl)	2.295 +0.317	1.615 +0.713	0.76** +0.044	0.58**Å +0.069
Lactic acid (mg/dl)	11.765 +0.809	15.32** +0.69	18.14**† +0.794	22.875***††ÅÅ +0.956

Values are expressed as mean + SEM. * P < 0.05, ** P < 0.001 as compared group I vs. all groups. † P < 0.005, †† P < 0.001 as compared group II vs. III and IV. Å P < 0.02, ÅÅ P < 0.001 as compared group III vs. IV.

Both dental cavity (periodontitis) and diabetes mellitus are frequent chronic diseases and generate enormous costs for the public health care system. Numerous studies, review articles and meta-analyses indicated a mutual influence between periodontitis and diabetes mellitus. The mechanisms, whereby diabetes may negatively influence periodontal health, are primarily based on the impaired local immune defense and a reduced renewal of the periodontal tissues. Moreover, higher levels of advanced glycation end products (AGE) can be found in the dental cavity of diabetics compared to non-diabetic subjects. The interaction between AGEs and collagen generates highly stable collagen macromolecules, that are resistant to physiologic enzymatic degradation. Hence, the renewal of all periodontal tissues is effectively compromised in diabetic subjects, especially when glycemic control is poor.

These phenomena explain in part why diabetic patients are three times more likely to develop periodontitis than non-diabetic subjects.

The role of serum calcium, phosphate and fluoride & pH in dental caries has been the point of interest since the mid of this century by many oral hygienist in the field of oral biochemistry. The early work of Stephan regarding the estimation of salivary pH had showed that the pH of saliva remained below the critical level of 5.5 in dental caries of diabetic patients, than the caries free people. Another study carried out by Abelson and Mandel demonstrated that the saliva exert its major influence on caries initiation by means of plaque formation rather than by direct contact on the tooth surface, they showed that plaque pH fall was greater in caries susceptible subjects. However this study did not show any significant change in the blood pH with the progression of disease.

The study carried out by previous workers revealed that the calcium ions are present normally in dental plaque bound to matrix and other proteins attracting phosphate and fluoride as counter ion, other phosphate and fluoride occurs intracellularly. All three ions occur as an inorganic mineral in serum and are in continuous exchange phase with the saliva over the dental plaque. This is responsible for the "pool" or "reservoir" of calcium, phosphate and fluoride in dental plaque and also maintains their saturation. These observations are quite identical with our study as levels of serum calcium, phosphate and fluoride are significantly low in dental caries patient in comparison to the control.

Our study quite clearly gives the information that there is significant fall in serum calcium, phosphate and fluoride as the disease process advances. This observation is in complete agreement with the study carried out by Pearce explained that salt dissolution is governed by the concentration of calcium, phosphate and OH^- ions in the surrounding fluid. These results are also supported by the research study of previous investigators who explained the process of caries on the basis of ionic product and solubility product. They explained that these ions are the main constituent of the enamel apatite lattice. The study carried out by Murray on "fluoride in caries prevention" observed that the crystals formed in the presence of fluoride dissolved more slowly in acid as they have lower intrinsic rate of dissolution, particularly of F^- are taken up during remineralization and the crystals formed in the presence of F^- are large, dense and more perfect. Another observation made in this study was that, the rate of remineralization was raised in the presence of F^- in early carious lesion at those time when the pH has risen so that remineralization is the dominant process and he also demonstrated the antibacterial property of F^- as it has a tendency to bind with the active metal of enzyme system e.g. in case of enolase, an enzyme that require magnesium (Mg^{++}) which can be inhibited up to 100% by F^- with the level of 95 ppm in the solution.

It is concluded that calcium, phosphate and fluoride deposited in plaque greatly reduces the development of experimental caries in the adjacent enamel because it tends to maintain the saturation of plaque fluid with respect to enamel mineral at low pH. The findings of present study, it can be concluded for adults that the adequate level of calcium, phosphate and fluoride is responsible for the significant deposition of these minerals in plaque which greatly reduces the developmental caries in the adjacent enamel i.e. the diabetic patients are more prone to develop dental caries with calcium, phosphorus levels decreases and alkaline phosphatase level increases. but in diabetic females with dental caries serum phosphorus

levels are very low in comparison to diabetic male. And also the results of the present research for children's showed that the mean dmfs index value in the group of children's suffering from PKU was statistically significantly higher than in the healthy children and the diabetic children. A statistically significant difference in the dmfs Index value was found between the three groups. The mean dmfs index value for the PKU children (4.18) was found to be relatively high as compared to the other two groups. No statistically significant difference was found in the mean DMFS values between the children and adolescents in the three groups. : Children with PKU possess a higher caries rate in their primary dentition. While diabetic children have a lower caries rate in their primary dentition, they show a higher risk of developing periodontal disease. It is, therefore, proposed that both groups of child patients, i.e. PKU and type 1 diabetics be encouraged to seek early dental advice and be incorporated in a meticulous prevention programme. Thus the study is of great practical importance

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