Role of Serum Magnesium in Dental Caries

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Objective: Minerals have been studied for their effects on the process of dental caries. A number of mineral ions such as calcium, phosphate, sodium, magnesium, fluoride and potassium can check, prevent and even re-mineralize the early lesion if present in reasonable amounts. This study investigated the role of serum magnesium in patients with dental caries.

Design: Experimental study.

Setting: College of Medicine, Qassim University, Saudi Arabia.

Methods: Total 112 subjects were selected, A detailed oro-dental examination was carried out according to the guidelines provided by professional dentists in a well illuminated examination room. All the patients were divided into 4 groups as per decayed, missed, filled teeth (DMFT) index. Following the institutional ethical criteria and getting the informed consent from all the subjects, venous blood samples were collected and processed for serum magnesium estimation.

Results: The patient's groups with high DMFT index showed significantly high levels of serum pH and significantly low levels of serum magnesium as compared to controls. These findings suggested that the suitable serum pH is regarded as one of the main protective factors against dental caries.

Conclusion: Optimum level of serum magnesium may be responsible for continuous supply of magnesium to arrest the demineralization and reduces the occurrence of dental caries. It can therefore, be concluded that the adequate levels of serum pH and serum magnesium need to be maintained to reduce the progression and development of dental caries.

Minerals have been studied for their effects on the process of dental caries[1]. Dental caries is persistently a major public health issue in most civilized countries, affecting 60–90% population of all age groups[2]. The prevalence of tooth decay or dental caries is frequent in humans, being the second most common disorder and is the main cause of tooth extraction and tooth loss[3]. Suitable nutrition is supreme for good general and dental health because food comprises of minerals that create the main structure of a tooth[4]. There are several minerals and vitamins having a role of strengthening the teeth. Calcium, magnesium, zinc, and vitamin D are interrelated for keeping the bones healthy[5]. A number of mineral ions such as calcium, phosphate, sodium, magnesium, fluoride and potassium can check, prevent and even remineralize the early lesion if present in reasonable amounts[6,7]. The dietary deficiency of magnesium, calcium and phosphorus has been found associated with loose teeth. In magnesium deficiency, the alveolar bone is brittle[8,9]. Magnesium promotes dental health by its antimicrobial nature as well as its ability of reducing oral inflammation. In the lack of magnesium, calcium absorption by teeth is hampered, salivary glands cannot work properly, the immune system cannot activate vitamin D, reduction in synthesis of glutathione, an effective antioxidant that prevents inflammation of and gums and teeth[10,11].

Magnesium is an essential nutrient, its adequate amount in diet is essential for maintaining the physiologic functions of various organs[12,13]. A large number of transporters and enzymes need magnesium as cofactor for their activation[13]. Magnesium is crucial in the synthesis and metabolism of parathyroid hormone (PTH) and vitamin D[11,14].

Teeth are constantly at risk of demineralization because of their location in the mouth[10]. The main feature of dental caries is demineralization, which is slowed by adequate levels of serum minerals[15,16].

Magnesium is resistant to tooth decay as concentration of magnesium has been found higher in healthy enamel than in decayed enamel[17,18]. Magnesium is necessary for the activity of calcium and phosphorus in preventing caries[18]. Researchers concluded that optimum consumption of magnesium has significant impact to reduced dental cavities in the case group[19].

Reduction in dietary intake of magnesium has been associated with periodontitis and dental caries[20,21]. A balanced diet is help full in maintaining healthy teeth, particularly when it is rich in magnesium[17]. Serum magnesium levels are significantly associated with healthier teeth and results indicated that nutritional magnesium supplementation may improve dental health[22,23].

Many researchers concluded that magnesium supplements could prevent tooth loss and reducing costs for dental treatment[22].

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Magnesium is a direct competitor of intracellular calcium[24]. Similarly, taking calcium and phosphorus in absence or low intake of magnesium can lead to dental caries[18,25]. The inverse relation has been found between caries prevalence and daily intake of calcium, phosphorus, magnesium in children by dental examination[26,27]. In this study, role of serum magnesium was assessed in the patients of dental caries

METHOD

Study area: The study was conducted at Departments of Biochemistry, Liaquat College of Medicine and Dentistry and Fatima Jinnah Dental College, Pakistan during August 2013 to October 2015 and the results obtained were validated in the Qassim University Medical Clinics

Specimen selection: A total of 112 subjects aged 11-45 years were selected from the outpatient Department of Dentistry, Jinnah Postgraduate Medical Centre and from the Outpatient Department of Fatima Jinnah Dental Hospital Karachi, Pakistan. The subjects were free from all types of systemic illness and were not currently using any minerals supplements or caries preventive measures like fluoride toothpaste or mouth wash. Any Subjects who gave ambiguous history about missing teeth or suffering from any type of or having any oral inflammation or Xerostomia of any origin problems were discarded from the study. The specimen's validation was performed in the University Clinics of Qassim University, Saudi Arabia using the few dental patients at dental clinics of Qassim University, KSA.

Oro-Dental Examination: A detailed oro-dental examination was carried out according to the guidelines provided by professional dentists in a well illuminated examination room. The problem of dental caries was measured by using Decayed, missed and filled teeth (DMFT) index14. All subjects were distributed into 5 patients' groups and a control, as described below: Group 1: with DMFT index 4-8; Group 2: with DMFT index 9-16; Group 3: with DMFT index 17-24 and; Group 4: with DMFT index more than 25; Control subjects have the DMFT index equal to or less than 3.

Approximately 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 nozzle of syringe carefully for blood pH determination. The blood in the syringe was covered, labeled and transferred in an ice box to the laboratory. Blood sample was centrifuged for 15 minutes at 3000 rpm. The hemolyzed samples were discarded. The supernatant layer of serum was then separated and poured in labeled glass bottles and stored at -20 °C until analyzed.

Serum magnesium levels were estimated by following a pre-described method24. Briefly, a protein free filtrate was prepared by mixing 0.2 mL serum with 1.8 mL TCA (5% w/v), standard magnesium solution (25 mmol/L) was also treated in the same manner. One mL filtrate was taken in separate tube, 1.5 mL of Titan yellow (0.05%) and 0.5 mL of NaOH (4N) was added. A blank was prepared by taking 1 mL of deionized water and treated similarly as test and standards. The color intensity was measured in comparison to blank at 540 nm after 15 minutes using Shimadzu spectrophotometer UV 120–01. The spectrophotometer was calibrated by using a series of standard solutions containing varying concentrations of magnesium (0.05–0.3 mmol).

Statistical analysis: Statistical significance and difference from control and test values evaluated by Student's t-test, p-values of 0.05 was considered significant. All statistical analyses were done by using statistical package for social sciences (SPSS) version 14.0 for Windows (Chicago, IL. USA).

RESULT

Total 112 subjects were selected and divided into 5 groups according to their DMFT index as described in Table 1. The distribution of male and female patients and controls are also provided.

Table 1: Distribution of control and patients in groups

Group	DMFT index	Distribution of subjects	Gender	
			Male	Female
Control	≤3	22	14	8
Group 1	4-8	22	12	10
Group 2	9-16	23	12	11
Group 3	17-24	24	12	12
Group 4	≥25	21	11	10

The comparison of baseline data including age, DMFT, index and number of tooth brushing per day shows a significant decrease in number of brushing and significant increase in DMFT score in all groups when compared to control in Table 2.

Table 2: Comparison of baseline data of the control and patients

Group	Age (years)	DMFT Index	Brushing (No. of times per day)
Control(n=22)	23.9±1.623	1.35±0.208	2.05±0.05
Group 1 (n=22)	27.75±1.680	6.3±0.291*	1.6±0.11*
Group 2 (n=23)	28.25±1.769	12.15±0.099*	1.05±0.135*
Group 3 (n=24)	31.7±1.818*	19.8±0.47*	0.5±0.114*
Group 4 (n=21)	31.95±1.59*	26.95±0.364*	0.15±0.08*

*P<0.05 as compared to control

Table 3 shows the levels of serum pH and magnesium in patients' groups as compared to control subjects. The groups 2, 3 and 4 patients have significantly higher levels of serum pH and significantly low levels of serum magnesium as compared to controls. This simply shows a negative correlation between serum pH and magnesium levels in patients with high DMFT index.

Table 3: Comparison of baseline data of the control and patients

Group	Serum pH	Serum Magnesium (mmol/L)
Control (n=22)	7.403±0.003	1.42±0.23
Group 1 (n=22)	7.406±0.005	1.30±0.63
Group 2 (n=23)	7.416±0.005*	1.27±0.53*
Group 3 (n=24)	7.418±0.003*	1.29±0.21*
Group 4 (n=21)	7.417±0.004*	1.29±0.21*

*P<0.05 as compared to control

DISCUSSION

Although magnesium deficiency is not widely appreciated as a factor in the pathogenesis of human diseases, magnesium is a significant component of body mineral content as well as a principal intracellular cation involved in many metabolic processes. It is the intent of this study to correct the impression that magnesium deficiency is unusual and rarely a clinical problem; in fact, it is viewed as a potential factor in the pathogenesis of many clinical disorders involving the cardiovascular, skeletal, and renal systems. It stretches reason a bit, however, to consider that magnesium deficiency could be involved in so many different disease processes, development and progression.

While some epidemiological studies seem to indicate that a high intake of magnesium should be associated with a low prevalence of dental caries, the results of experimental studies are mainly equivocal.

Magnesium is probably not bound to the apatite lattice of dental enamel or dentine, or it is bound to a small degree only. It is mainly located in the hydration layer of the apatite crystallites. In the dental caries process, it is preferentially dissolved together with the carbonate of the mineral phase. It is not known to what extent feasible dietary changes can modify tooth magnesium content during pre-eruptive tooth development[28].

Animal experiments indicate that the elevation of dietary magnesium alone after tooth eruption has no definite capacity to modify the occurrence of dental caries. When fed in combination with small fluoride supplements in the diet magnesium and fluoride may support each other in preventing various calcium salt imbalances such as dental caries, arteriosclerosis and nephrocalcinosis. Although some recent in vitro findings indicate that extra magnesium in the fluid environment of cariogenic streptococci may protect them against the inhibitory action of fluoride, such magnesium changes do not seem possible in the human mouth under present or envisaged dietary conditions[29].

A number of studies have now established that it is magnesium, not calcium that forms the kind of hard enamel that resists decay. And no matter how much calcium you take, without magnesium only soft enamel can be formed. If too soft the enamel will lack sufficient resistance to the acids of decay[24].

For years it was believed that high intakes of calcium and phosphorus inhibited decay by strengthening the enamel. Recent evidence, however, indicates that an increase in these two elements is useless unless we increase our magnesium intake at the same time. It has even been observed that dental structures beneath the surface can dissolve when additional amounts of calcium and phosphorus diffuse through the enamel at different rates. Thus milk, poor in magnesium, but high in the other two elements, not only interferes with magnesium metabolism, but also antagonizes the mineral responsible for decay prevention[25].

The findings of the current study also suggested that the suitable serum pH is regarded as one of the main protective factors against dental caries. Optimum level of serum magnesium may be responsible for continuous supply of magnesium to arrest the demineralization and reduces the occurrence of dental caries.

CONCLUSION

It can therefore, be concluded that the adequate levels of serum pH and serum magnesium need to be maintained to reduce the progression and development of dental caries. This study also concluded new avenues in the research field of role of serum magnesium in dental caries like age, sex, dietary pattern, nutritional supplements, and effects of other systemic disorders.

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