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Vitamins and their relations to oral health: A review study

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Abstract: oral disease, a relevant public health problem, is considered a common disease of many people. In this respect, vitamins may be a modifying factor in the progression and healing of the oral diseases and promoting oral and dental health. Vitamins have been recommended as nutrients for prevention and treatment of some pathological conditions, such as cardiovascular diseases, cancer and obesity. Thus, an approach to determine how the different vitamin types could improve oral and dental health is necessary to further understanding of the potential benefits and risks of vitamins supplementation use. For this review of English-written literature which included researches on the relationship of each vitamin with oral and dental health, was conducted.

Keywords: vitamin; gingivitis; oral health; periodontitis; caries.

Introduction

Vitamins may be considered as organic compounds required in the diet in small amounts to perform specific biological functions for normal maintenance of optimum growth and health of the organism(1). The Polish biochemist Casimir Funk in 1912, was isolated a substance (called beri-beri vitamine) that was present in rice bran which could alleviate the deficiency disease beriberi, endemic in many Asian countries. At the time, he assumed that all such essential compounds in the diet contain an amine group, hence, the term vitamine; after that the final“e”was dropped to deemphasize the amine connection(2). Vitamins can basically be classified into the following two categories: (I) Fat-soluble Vitamins -Include Vitamins A, D, E and K (II) Water-soluble Vitamins -Include Vitamins B and C (3, 4).

In the past, dental and oral health dietary approaches have mostly focused in reducing the consumption of “undesirable” dietary components such as refined sugars. However, promoting the consumption of “healthy and curative food” has been increased. This perception of “nutrient as a medicament” has encouraged the search of a growing number of new substances categorized from dietary supplements with the aim of improving human dental and oral health.

Dental diseases is generally considered a common pathology of population, they are influenced by many risk factors, such as genetics, systemic diseases, stress, smoking, alcohol, and hormonal alteration status, therefore the maintenance of oral and dental health becomes today a challenge.

Although a link between dietary changes, caries, and dental development has been observed, the literature provides little insight about this relationship which need more discussion(1).Undoubtedly, many factors are indispensable for the pathogenesis of oral and periodontal disease, but, among risk factors, nutrition represents an aspect that is often neglected. Indeed, nutritional factors including vitamins have a vital importance for the equilibrium between those predisposing factors and the host response, from which depends the onset and progression of oral and dental diseases.

After tooth extraction, for instance, there is resorption often observed in the alveolar bone which may later interfere with the ideal rehabilitation of the edentulous site with dental implants and dental prosthesis. Bone adequacy around dental implants has been well documented as a prerequisite for implant osseointegration and its survival in long run. Different bone grafting techniques and bone substitutes have been suggested for bone augmentation. In this regard, various growth factors, drugs, and nutrients including vitamins have been evaluated to promote bone formation(5,6,7).The role of vitamins in dental caries, which is one of the most public oral disease, has been debated and mechanisms by which vitamins might influence caries have been suggested and should be considered. Inadequate intakes of nutrients e.g., riboflavin, vitamin D, and vitamin B12 can be associated with increased caries experience(8,9).

The efficacy of various vitamins on their prevention or treatment is sparse in literature. A review is warranted to highlight such findings available as evidence.

CLINICAL RELEVANCE:

In order to improve postoperative management, the level of vitamins over all patient groups have to be considered in guidelines of treatment.

Vitamin A

Vitamin A is a group of nutritional unsaturated organic compounds. However, it is known that many carotenoids act as vitamin precursors, being β -carotene the most important(10). The active form of vitamin A, retinoic acid, is essential for maintaining the integrity of mucosal tissues and for proper differentiation of cells, including those of the immune system (11).According to this, it is expected that an adequate intake of this nutrient prevent oral and dental diseases onset or progression since it contributed to connective tissue maintenance. Moreover, its role in immune system could be also important for maintaining some bacteria in adequate level and for prevention of massive inflammation(12, 13).Investigators have reported antioxidant activities for

retinol and dehydroretinol as well as for many pro-vitamin A compounds, including b- and a-carotenes (14,15). Antioxidant activities can play an important role in the periodontal disease and application of antioxidant vitamin therapy (vitamins A, E and K) normalizes and improves the status of the parodontium (16,17). Vitamin A deficiency has definite effects on developing teeth in animals and preferably in human beings, although only a few reports on dental disturbances in Vitamin A deficiency in humans are available in literatures.(18)

Vitamin B-Complex

Vitamin B-complex refers to all of the known essential water-soluble vitamins (except for vitamin C). These include thiamine (vitamin B1), riboflavin (vitamin B2), niacin (vitamin B3), pantothenic acid (vitamin B5), pyridoxine (vitamin B6), biotin (vitamin B7 or B8), folic acid (vitamin B9) and cobalamin (vitamin B12)(19) vitamin B-complex is necessary for cell growth and metabolism but each member of the B-complex has a unique structure and performs unique functions. Vitamins B1, B2, B3, and biotin participate in different aspects of energy production, vitamin B6 is essential for amino acid metabolism, and vitamin B12 and folic acid facilitate steps required for cellular division(20) . The relationship between vitamin B12 deficiency and oral health still remains unclear. The available medical literature does not show any study performed with such a correlation.

Vitamin B12 is one of the important micronutrients for brain development and function. Vitamin B₁₂ deficiency is common, and the incidence increases with age. Studies on the development of cleft lip, alveolus, palate, and velum and neural tube defects have revealed several shared multifactorial causes. Vitamin deficiency disorders are one of several factors contributing to the etiology of these anomalies. A lack of or deficiency in these vitamins thus has severe consequences for the organism(21, 22).

In a study conducted by Ishimiya M et al it was found that intakes of vitamin B1 correlated significantly with the number of remaining teeth(23). Vitamin B12 deficiency may cause an increase in prevalence of dental caries and gingival diseases in children. Studies were found that inadequate intakes vs low adequate or high adequate intakes of nutrients (e.g., riboflavin, vitamin D, and vitamin B12) were associated with increased caries experience and low adequate intakes vs inadequate or high adequate intakes of nutrients (e.g., vitamin B12 and vitamin C) were associated with decreased caries experience.(9, 24,25)

Pontes et al also found presence of oral signs and symptoms, including glossitis, angular cheilitis, recurrent oral ulcer, oral candidiasis, diffuse erythematous mucositis, and pale oral mucosa in subjects with cobalamin deficiency offering the dentist an opportunity to participate in the diagnosis of this condition. Supplementation with vitamin B12 will improve the gingival health and oral hygiene of children with deficiency(26)

Folic acid is a water-soluble B-complex vitamin. It is required for essential biochemical reactions for the synthesis of amino acids, purines, and DNA. Folate deficiency is relatively common, even though the deficiency is easily corrected by administration of folic acid. Insufficient intake of folic acid during the pregnancy has been suggested to increase the risk for cleft palate. Studies have shown the essential role of folate during tissue development and is required for the integrity of gingival tissues. Orofacial clefts of the lip and palate are common birth defects of complex genetic and environmental etiology. There is some suggestive evidence for a possible role of folic acid in prevention of this defect. (27, 28)

The role of nutrition in periodontology has been studied extensively, and recent studies on the interactions between nutrition, host defense, and infection have found a correlation between nutrition and the pathogenesis of periodontal disease. Vitamin B-complex supplementation has also demonstrated positive effects on wound healing after periodontal surgery. It has been reported that one of the B vitamins, thiamine (vitamin B₁), may increase wound repair. Furthermore, niacin (vitamin B₃) supplementation reportedly has a positive effect on the healing of repositioned flaps, suggesting that the vitamin creates a more balanced collagen structure during the wound-healing processes(29). Reports have demonstrated that nutrient supplements, in particular vitamin-B complex, can positively influence wound healing processes including oral and dental wounds(30).

Vitamin C

For humans vitamin C is an essential vitamin. Its deficiency have largely been a product of inadequate dietary intake. Vitamin C is naturally found in fresh fruits and vegetables. Lack of exposure to foods that contain vitamin C has been the most frequent cause of the deficiency. Additionally, vitamin C is heat sensitive so, boiling or cooking has removed the nutritional value. There is very little storage of vitamin C in the body, and therefore, plasma concentration is largely related to recent intake. Total body storage of vitamin C is 1500 mg, and clinical features of deficiency occur after that level is reduced to less than 350 mg (31). Studies showed that consumption of diets that are rich in vegetables and vitamin C appears to associate positively with periodontal health and using vitamin C supplementation improves

postoperative healing following dental implant surgery in patients with chronic periodontitis and patients treated with Bio-Oss Collagen grafts(32,33,34).

Dental caries is a complex multifunctional disease. Vitamin C plays an important role in maintaining the integrity of the teeth and also as a non-enzymatic antioxidant defense system. It is evident that serum and salivary vitamin C level decreases with increase in caries activity suggesting the powerful antioxidant property of vitamin C which is able to scavenge free radical of both reactive oxygen group and reactive nitrogen group(35) Deficiency of Vitamin C is well recognized as producing severe changes in the periodontal tissue and pulps of the teeth. Also it is essential for the formation and maturation of collagen, and for the integrity of connective and osteoid tissues, and dentine(4). Also Using vitamin C supplementation could improves postoperative healing following dental implant surgery in patients with chronic periodontitis(36)

Vitamin D

Vitamin D deficiency is a frequent health problem worldwide, it regulates calcium levels and plays a key role in craniofacial development and the maintenance of good oral health. It has a critical role in enamel, dentin, and oral bone formation as ameloblasts and odontoblasts are target cells for 1, 25-dihydroxyvitamin D, the active form of vitamin D. Deficiency in vitamin D during periods of tooth development may also result in developmental defects including enamel hypoplasia. In general, higher serum levels of 25-hydroxyvitamin D (25(OH)D) are associated with improved oral health outcomes(4,37,38). Vitamin D is associated with the two main oral diseases, caries and periodontal disease and also linked to several infectious and inflammatory conditions in oral cavity. Its deficiency may be a potential risk factor for aggressive periodontitis (39,40). Also is an important modifiable risk factor for dental caries specially in children. So, vitamin D supplementation can be used in children for preventing caries in the primary dentition (41,42). A diet rich in vitamins D, significantly reduced periodontal inflammation in humans(43). Periodontitis is characterized by alveolar bone loss induced by the host immune response to bacterial insult. Because vitamin D plays a crucial role in bone maintenance and immunity, there is biologic rationale to suspect that a vitamin D deficiency could negatively affect the periodontium. and vitamin D intake was associated with lower severity of periodontal disease(44,45).

Vitamin E

Vitamin-E is the collective term for a family of chemical substances that are structurally related to alpha-tocopherol. Vitamin E occurs naturally in eight different forms: four tocopherols, alpha (α)-, beta (β)-, gamma (γ) - and delta (δ) tocopherol and four tocotrienols, alpha-, beta-, gamma- and delta-

tocotrienol. Vitamin-E exhibit antioxidant properties by acting as a lipid-soluble free radical scavenger in cell membranes. Anticarcinogenic effects of Vitamin E are its ability to inhibit formation of the carcinogenic chemical nitrosamine from nitrites in some foods, and its ability to promote immune system function. Oral cancer is generally preceded by precancerous lesions which include leukoplakia, lichen planus, oral submucous fibrosis, oral epithelial dysplasia, erythroplakia. Vitamin-E is an essential nutrient that is receiving growth attention in the prevention of precancerous lesions because of its anti oxidant properties(46).also it was found that topical application of Vitamin E had performed better on oral mucositis induced by Cancer Chemo/Radiotherapy than Vitamin E systemic administration and the efficacy of Vitamin A topical treatment also showed reduction in severity of oral mucositis similar to vitamin E.(47)

Research in animals has allowed to evaluate the use of vitamin E supplements on periodontal diseases and its possible role on recurrent aphthous stomatitis and inflammatory processes associated with this conditions. vitamin E supplements would prevent oxidative stress associated to periodontitis but its potential for periodontal disease treatment is not clear (48)

Vitamin K

Vitamin K is a fat-soluble substance found primarily in leafy green vegetables. The dietary requirement is low because the vitamin is naturally produced by the bacteria in the intestines. Two natural forms exist: vitamins K1 and K2. Vitamin K1 is found in food(49).

Vitamin K have a role in a wide range of biological activities including cell growth and proliferation, regulation of calcium metabolism in tissues, inflammatory reactions, oxidative stress, and plays an essential role in normal blood clotting, promoting bone strength, and helping to produce proteins for blood, kidneys, and bones metabolism. So it's a multifunctional vitamin has been recently deemed appreciable in researches. In bone, vitamin K exerts its anabolic effect in different ways such as promoting osteoblast differentiation, upregulating transcription of specific genes in osteoblasts, and activating the bone-associated vitamin k dependent proteins which play critical roles in extracellular bone matrix mineralization. A recent study has evaluated the behavior of dental pulp stem cells after being exposed to Vitamins K2 in an osteogenic medium. According to the findings, based on ALP activity and extracellular Ca deposition assay, Vitamins K2 can ameliorate differentiation of dental pulp stem cells into osteoblast and may enhance bone regenerative capacity of cell-based bone tissue engineering therapies (50, 51)

Vitamin K has been tested as possible anticaries agent by virtue of its enzyme inhibiting activity in the carbohydrate degradation cycle. Vitamin K was found to prevent acid formation in incubated mixtures of glucose and saliva in

In vitro studies. The traditional theory of dental caries considers only the oral environment and does not recognize any significant role for the brain. A healthy tooth is nourished by a centrifugal fluid flow through the dentin. This is moderated by the hypothalamus/parotid axis which signals the endocrine portion of the parotid glands. High sugar intake creates an increase in reactive oxygen species and oxidative stress in the hypothalamus. When this signaling mechanism halts or reverses the dentinal fluid flow, it renders the tooth vulnerable to oral bacteria, which attach to the tooth surface. Acid produced by oral bacteria such as Strep Mutans and lactobacillus de-mineralize the enamel and irritate the dentin. The acid attack stimulates an inflammatory response which results in dentin breakdown from the body's own matrix metalloproteinases. Vitamin K2 has been shown to have an antioxidant potential in the brain and may prove to be a potent way to preserve the endocrine controlled centrifugal dentinal fluid flow. Vitamin K2, such as that found in fermented cheese, improves salivary buffering through its influence on calcium and inorganic phosphates secreted. Data collected from several selected primitive cultures on the cusp of civilization demonstrated the difference in dental health due to diet. The primitive diet group had few carious lesions compared to the group which consumed a civilized diet high in sugar and refined carbohydrates. The primitives were able to include the fat soluble vitamins, specifically K2, in their diet (4 ,52).

CONCLUSION

Vitamins are essential to boost physical well-being, and doubtlessly vitamin deficiency can have serious health consequences. This review analyzed some of the published data on the relationship between vitamins and oral health to understand the potential benefits and risks of supplementation with vitamins on some oral conditions. the use of supplements with several or certain vitamins for people under physiological or pathological conditions that increase the risk of oral and dental diseases could contribute to protect teeth and periodontal tissues. More studies are needed to confirm this and clarify what vitamins use for each case, as well as dosages and taking frequency. Problems in obtaining positive results from experimental studies could be due to used dosages or its combination with treatment more effective that may occult the effect of this nutrient. There have been many advances in understanding of dental diseases and oral health that should be changing the way of dental practice on a daily basis. It is the responsibility of Dentists, Researchers, and Educators to use the best available evidence in the detection, assessment, management, and monitoring of oral health and dental diseases in relation to nutritional factors including vitamins.

Abbreviations

Bio-Oss Collagen grafts: Geistlich Bio-Oss Collagen® consists of 90% [Geistlich Bio-Oss®](#) granules with the addition of 10% porcine collagen.

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All authors reviewed the manuscript.

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The author(s) declare no competing interests.

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