

EVALUATING THE IMPACT OF VITAMIN C ON ORAL HEALTH- A RANDOMISED CONTROL TRIAL

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Abstract--- *Background: Oral health is an integral part of overall health. Nutrition plays an important role in maintaining oral and hence general health. Vitamin C also known as Ascorbic acid is a water soluble Vitamin which plays an important role in maintaining periodontal and oral health. However excessive intake of Vitamin C leads to detrimental oral conditions such as enamel erosion. Hence a balanced intake according to RDA is important.*

Objectives: The present clinical study was conducted to evaluate the positive as well as the negative aspects of Vitamin C on oral health.

Methodology: 170 patients were randomly categorized into 2 groups; Group 1 (n=85): group with normal serum Vitamin C levels and with history of adequate intake according to the Average Requirement value and Group 2 (n=85): with deficient Vitamin C levels and inadequate intake. Evaluation of oral manifestations and their prevalence was recorded in both the groups by a well experienced oral medicine expert and findings were recorded in terms of gingivitis, periodontitis, petechial, paleness of oral mucosa and dental erosion. Data collected was statistically evaluated.

Results: One way ANOVA showed statistically significant difference between two groups where group 2 had significantly more patients with gingivitis and periodontitis as compared to group 1 with mean value of 1.3529 ± 0.5049 & 1.5882 ± 1.208 in group 1 and 1.6118 ± 0.6743 & 2.4353 ± 2.1737 in group 2 for gingivitis and periodontitis respectively. In Group I, 27 subjects reported with enamel erosion, 29 presented with bleeding gums, 4 with established periodontitis. A petechial on buccal mucosa was seen in 1 patient while 2 presented with pale mucosa. In Group II enamel erosion was present in 4 subjects bleeding gums/ gingivitis 50.5% individuals, periodontitis in 17 cases, 02 presented petechial on hard palate and 04 on buccal mucosa.

Conclusion: Vitamin C (Ascorbic acid) is an important Vitamin playing key role in maintenance of oral health and works as anti-oxidant (free radical scavenger). Deficiency leads to oral health detriment and oral manifestations characterized by delayed wound healing, bleeding, swollen gingiva Pale mucosa was observed 12. However inter group difference between two groups was statistically insignificant ($p > 0.1$). There was increased incidence and development of periodontal disease eventually leading to tooth loss was noted. Adequate and balanced intake of Vitamin C is advocated for healthy oral cavity.

Keywords--- *Enamel Erosion, Gingivitis, Periodontitis, Scurvy, Vitamin C.*

INTRODUCTION

Maintaining natural dentition is a realistic goal given today's increased attention to good oral hygiene. Expanding knowledge in the area of periodontal diseases provides further insight into health promotion practices which can be effective in preventing tooth loss. Oral health is an integral part of overall health. Deprived oral health may be associated with an increased risk of ailments including cardiovascular disease; diabetes mellitus, etc.¹ Oral health and nutrition are also allied to each other in a critical compartment. Vitamins, minerals, and other nutrients is Vitamin to the growth, development, maintenance, and repair of healthy dentition and oral tissues. Poor oral health can hamper one's aptitude to consume certain nutritious foods while poor nutrition may increase the risk of poor oral health including periodontal disease and tooth loss.²

The term Vitamin has been derived from the term *Vitamin* and describes essential nutrients that are required for various biochemical and physiological processes in the body.³ A certain group of Vitamins cannot be synthesized by the body and therefore their supplementation in diet is critical. Based on the solubility, Vitamins can broadly be classified as water soluble (C and B complexes) and fat soluble Vitamins (A, D, E, K).⁴

Vitamin C also known as Ascorbic acid is a water soluble Vitamin, was first isolated by a Hungarian biochemist Szent-Gyorgyi in 1923 synthesized by Howarth and Hirst.⁵ It is synthesized by many plants and animals for their own requirement through the uranic acid pathway, however, humans lack the ability to synthesize ascorbic acid due to lack of an enzyme gluco-lactone oxidase.⁶ Vitamin C's role in maintaining the health of teeth and gingivae remains unchallenged. Now clinical evidence indicates that Vitamin C functions in improving host defense mechanisms and is thereby implicated in preserving periodontal health.¹ Vitamin C has diverse functions in the body at a chemical and structural level. For example, a major function of ascorbic acid is its involvement in the synthesis of collagen fibres from proline via hydroxyproline. Other metabolic reactions for which Vitamin C is required are the hydroxylation of lysine into hydroxylysine in collagen, the conversion of folic acid to the active form of folic acid in-vivo, the formation of steroids by the adrenal gland, the oxidation of lysine in muscle proteins, the microsomal metabolism of drugs and the protective action on enzymes such as p-Hydroxy-phenyl-pyruvic acid oxidase.⁷

It is an important nutrient that wields an anti-oxidant (owing to its high electron-donating power and reducing effect), acts as a free radical scavenger and as an enzyme cofactor in cells.⁸ It is chiefly required for the synthesis of intercellular substances and the collagen fibers of various forms of the connective tissues like organ capsular/trabecular, tendinous and facial tissue, the matrix of calcified tissues such as bone and teeth and the endothelial cells of the entire vascular system, including capillaries.⁸

The RDA of Vitamin C is 90 milligrams for males and 75 milligrams for females. An additional of 35 milligrams is required by smokers because of the free radical damage they are exposed due to cigarette smoke.⁹ The recommended daily allowance for pregnant and breastfeeding women are 85 and 120 milligrams, respectively. For infants upto 6 months of age the daily allowance is 40 milligrams and 50 milligrams for infants up to 12 months. For teenagers the RDA is 75 and 65 milligrams for 13–17 years of age.⁹

Vitamin C is found in abundance in fruit and vegetables mainly citrus fruits like oranges, lemons, grapefruit, watermelon, papaya, cantaloupe, pineapple, raspberries, cherries, kiwi, mango, strawberries, Indian gooseberry and vegetables such as broccoli, tomatoes, cauliflower and cabbage, green and red peppers, sprouts, and other leafy vegetables.¹⁰

Periodontal disease has been recognized as the most widespread chronic disease afflicting around 90% of the global population. It is an inflammatory disease initiated by bacterial infection, subsequently progresses via an aberrant host response, and primarily contributes to periodontal tissue destruction leading to loss of alveolar bone eventually leading to tooth loss.¹¹ Periodontitis is believed to be associated with excessive production of reactive oxygen species or reduced levels of antioxidants. Antioxidants are required for scavenging of ROS, Vitamin C being one of important dietary antioxidants associated with periodontal health. Adequate intake of dietary Vitamin C could be considerably significant for periodontal health.¹¹

Prolonged deficiency of Vitamin C leads to scurvy. This condition was seen with extended sea voyagers or sailors in 16th, 17th, and 18th centuries due to nutrition diminution. Features of Scurvy include the formation of brown spots on the skin, anemia, myalgia, arthralgia easy bruising, petechial, perifollicular hemorrhages (especially in the lower extremities), corkscrew hair, poor wound healing, mood swings, depression, spongy & swollen gums and bleeding from all mucous membranes. The deficiency is associated with inability to produce intercellular ground substance such as collagen (affecting hydroxylation of proline), resulting in widespread pathology of supporting tissues of blood vessels, bone and teeth, with increased permeability of the capillaries.¹²

Vitamin C deficiency is not responsible for gingivitis or periodontitis by itself, but it increases the severity of gingivitis by aggravating gingival response to plaque and results in gingival bleeding. This embellished response is in part by host bacterial interaction and rest by the deficiency. Severe deficiency leads to scorbutic gingivitis; characterized by ulcerative gingivitis, rapid periodontal pocket formation, and tooth exfoliation.¹¹

Dental erosion is the irreversible chemical dissolution of the superficial layers of teeth without the presence of bacteria due to a chemical process of acid dissolution but not involving bacterial plaque acid, and not directly associated with mechanical or traumatic factors, or with dental caries. It may occur as a result of a variety of factors such as vomiting, lifestyle disorders like bulimia nervosa, acid reflux, consumption of certain types of food, drink or medication.³ Vitamin C is reported to have a pH of 2.3 and the critical point at which enamel dissolves is around pH 5.5. The buffering action of saliva neutralize the acid effects, however, if the protective potential is inadequate and there is continuous exposure of acid, erosion will ensue.¹³

Dental erosion can be described as the irreversible loss of Tooth structure due to the chemical process of acid dissolution which does not involve plaque bacteria. Sources of Erosion can be intrinsic such as acid reflux and vomiting or Extrinsic, from the ingestion of food, drink, or medication. Dental erosion can be described as the irreversible loss of Tooth structure due to the chemical process of acid dissolution which does not involve plaque bacteria. Sources of erosion can be intrinsic such as acid reflux and vomiting or extrinsic, from the ingestion of food, drink, or medication.

The present study was carried out to evaluate and establish the positive as well as negative aspects of Vitamin C for oral health and its role in improving the quality of life and well-being of patients.

METHODOLOGY

195 patients reporting to out Patient Department, Department of Periodontics, Ar Rass College of Dentistry, University of Qassim, Kingdom of Saudi Arabia; were screened for the study after taking ethical clearance from Ethical Committee of the institute.

This randomized clinical study population included 22-45 years old males and females, which were selected randomly.

Exclusion criteria for study included patients with enamel/ dentin mineralization disease, dental Fluorosis, underlying systemic diseases, gastro-esophageal reflux disease, anorexia nervosa, bulimia and motor diseases and handicapped patients.

Subsequently, 25 patients were excluded from the study based on exclusion criteria. Remaining 170 patients underwent Vitamin C assay and were broadly categorized randomly into following 2 groups;

Group 1 (n=85): with normal serum Vitamin C levels (0.6- 2 mg/dl) and with history of adequate intake of Vitamin C according to RDA value (Table 1)

Group 2 (n=85): group with deficient Vitamin C < 0.6mg/dl levels and inadequate intake of Vitamin C.

The evaluation of oral manifestations and their prevalence was done by a well experienced oral medicine expert deputed in the dental department of the hospital. A single examiner performed all oral evaluations. The oral manifestations were recorded according to clinical presentation in terms of gingivitis (using gingival index by Loe & Silness¹⁴), periodontitis (Periodontal Index by Russell A¹⁵), dental erosion and other clinical symptoms. All the data was collected and subjected to statistical analysis.

Age	Male	Female	Pregnancy	Lactation
0- 6 months	40 mg	40 mg	-	-

7- 12 months	50 mg	50 mg	-	-
4- 8 years	15 mg	15 mg	-	-
9- 13 8 years	25 mg	25 mg	-	-
14- 18 years	45 mg	45 mg	80 mg	115 mg
19+ years	75 mg	65 mg	85 mg	120 mg
Smokers	Individuals who smoke require 35 mg/day more Vitamin C than non-smokers			

Table 1: Recommended Dietary Allowances (RDA) for Vitamin C¹⁶

RESULTS

Total 195 patients were screened for this clinical study and were subjected to serum Vitamin C estimation. 25 patients were excluded based on exclusion criteria and remaining 170 patients were randomly categorized into 2 groups with 85 patients in each group; Group 1 (n=85): group with normal serum Vitamin C levels and with history of adequate intake of Vitamin C according to the Average Requirement value (Table 1) and Group 2 (n=85): group with deficient Vitamin C levels and inadequate intake of Vitamin C. 50 out of 85 subjects in Group I 50 subjects were males whereas 35 were females, 43 out of 85 in Group II were males whereas 42 were females. The findings were recorded in terms of enamel erosion, gingivitis, periodontitis, petechial and paleness of oral mucosa. The gingivitis scoring was done based on Gingival Index by Loe and Silness and recorded inter group data was subjected to statistical evaluation using one way ANOVA. The results depicted a value of mean and standard deviation as 1.3529±0.5049 for group 1 and 1.6118±0.6743 for group 2 respectively (Table 2), which shows statistically significant difference between two groups where group 2 had significantly more patients with gingivitis as compared to group 1.

Data Summary					
Groups	N	Mean	Std Dev	Std Error	p value
Group 1	85	1.3529	0.5049	0.0548	0.0052 (p<0.1)
Group 2	85	1.6118	0.6743	0.0731	

Table 2: Inter- group variation in gingivitis

The assessment for periodontitis was done based using Periodontal Index by Russell AL 1967 and data was statistically analyzed using ANOVA. The results described a mean and standard deviation value of 1.5882±1.208 for group 1 which was significantly better (p<0.1) than 2.4353±2.1737 for group 2 (Table 3) depicting significantly lesser established periodontitis prevalence in groups with adequate intake of Vitamin C.

Data Summary					
Groups	N	Mean	Std Dev	Std Error	p value
Group 1	85	1.5882	1.208	0.131	0.001 (p<0.1)
Group 2	85	2.4353	2.1737	0.2358	

Table 3: Inter- group variation in Periodontitis

The evaluation of oral manifestations and their prevalence was done by a well experienced oral medicine expert and data was tabulated. In Group I, 31.76% subjects (n= 27) reported with enamel erosion, 29 subjects (34.11%) presented with a chief complaint of bleeding gums, clinically exhibiting bleeding on probing and 4.70% (n= 4) subjects presented with established periodontitis (Russell Periodontal index). A petechia on buccal mucosa was seen in 1 patient (%1.17) while 2.35% (n= 2) presented with pale mucosa (Table 4). In Group II (Table 5) enamel erosion was present in 04 subjects (4.7%) owing to less intake of ascorbic acid found in abundance in Vitamin C; bleeding gums/ gingivitis in 50.5% individuals (n=43), periodontitis in 17 subjects (20%) and 02 subjects (2.35%) presented with petechial on hard palate whereas 04 (4.7%) on buccal mucosa. Pale mucosa suggestive of Vitamin C deficiency was observed in 14.11% individuals (n= 12).

Intra Oral Findings	Group 1 (n=85)	Percentage
Enamel erosion	n=27	31.76%
Gingivitis	n=29	34.11%
Periodontitis	n=4	4.70%
Petechia	n=1	1.17%
Pale mucosa	n=2	2.35%

Table 4: Intra oral findings in Group 1

Intra Oral Findings	Group 1 (n=85)		Percentage
Enamel erosion	n=04		4.70%
Gingivitis	n=43		50.5%
Periodontitis	n=17		20%
Petechia	n=2 (Hard palate)	n=04 (Buccal Mucosa)	7.05%
Pale mucosa	n=12		14.11%

Table 5: Intra oral findings in Group 2

However on inter group statistical comparison between the oral findings; the difference between two groups was statistically not significant ($p > 0.1$) (Table 6).

Data Summary				
Groups	Mea n	Std Dev	Std Error	p value
Group 1	12.6	14.117 4	6.3135	0.434 ($p > 0.1$)
Group 2	16.4	15.725 8	7.0328	

Table 6: Inter group comparison of oral findings

DISCUSSION

Oral health is indispensable to general health and well-being at every juncture of life. A healthy mouth facilitates not only provides adequate nutrition to the body, but also augments social interaction and promotes self-esteem. The mouth serves as a “window” to the rest of the body, providing signals of general health disorders.¹⁷

The energy from the dietary nutrients like fats, carbohydrates and proteins cannot be utilized without consumption of enough Vitamins. Vitamins do not endow with energy and cannot be used without an adequate supply of fats, carbohydrates, proteins and even minerals.¹⁸

Vitamin C plays an imperative role as an antioxidant in numerous bodily reactions and also serves numerous metabolic roles as a coenzyme. It plays a Vital role in a variety of body functions including healing of wounds; synthesis of collagen; strengthening tissue; endorsing capillary integrity; facilitating growth of RBCs by enhancing iron absorption; utilization of folate and Vitamin B12. Deficiency of Vitamin C may lead to scurvy, which is characterized by spontaneous gingival bleeding, petechiae, follicular hyperkeratosis, fatigue, depression, diarrhea, and termination of bone growth (attributed to maligned osteoid formation). Atrophy of ameloblasts and odontoblasts also occurs in Vitamin C deficient environment during the tooth development stage.¹⁹

In our study, 170 patients were included who were broadly categorized into 2 groups; enamel erosion, bleeding gums/ gingivitis, periodontitis, petechiae and pale mucosa were observed, where in Group II number of these findings was significantly higher than in Group 1 with adequate Vitamin C intake. However, in present study Group 1 had more number of subjects with enamel erosion in comparison to Group II. The findings in our study were in concordance with the review conducted by *Moynihhan et al* who found that there is a positive association between dental erosion and consumption of acidic foods and drinks including fruit juices, soft drinks, citrus foods and

berries.²⁰ Another case study conducted by *Giunta et al* concluded that the use of chewable Vitamin C tablets is shown to drop the salivary pH to a level at which tooth enamel tends to lose calcium by formation of calcium citrate complexes.³ Chewable Vitamin C tablets have a pH of 2.3 and dissolution of enamel occurs around pH 5.5.

According to an overview conducted by *Naidu KA*, Vitamin C is believed to have antioxidant, anti-atherogenic, anti-carcinogenic and immunomodulatory actions.²¹ According to a systematic review conducted by *Tada et al* it was seen that the subjects with periodontitis presented a lower Vitamin C intake and lower blood-Vitamin C levels than the subjects without periodontal disease. The patients with an inadequate consumption of Vitamin C showed a greater progression of periodontal disease and administration of Vitamin C in these patients reduced gingival bleeding in gingivitis, but had no effect in periodontitis.⁸ Vitamin C obtained from diet reduces the inflammatory reaction in periodontal disease. Vitamin C has a powerful anti-oxidative effect in living organisms, particularly at the intracellular level and this is thought to decrease the oxidative stress generated in gingivitis.²²

A study was conducted by *Raghavendra et al* to assess the efficacy of Vitamin C supplementation, on periodontal health in patients with chronic periodontitis. The study comprised of 50 patients diagnosed with Chronic Periodontitis and 50 healthy controls. Patients with periodontitis were further divided into 2 groups: 25 patients received nonsurgical therapy alone and 25 patients received Vitamin C supplementation (1500 mg/day). There was a highly significant reduction in all the clinical parameters in both the subgroups at 1-month and 2-month post therapy. The group with Vitamin C supplementation showed significant reduction in gingival bleeding.²³

Cagetti MG et al undertook a review is critically appraised the currently available data on diet and maintenance of periodontal health and periodontal healing and concluded that Vitamins are important in the prevention and treatment of oral diseases including Vitamin C.²⁴ Also another review concluded that Vitamins are important in the prevention and treatment of oral diseases, with Vitamin C having important role in maintaining oral health.²⁵

CONCLUSION

Oral health is the mirror of general health and is directly related to nutrition one consumes. In order to maintain the recommended level of various macro and micro nutrients, human body need to take them exogenously. Vitamin C (Ascorbic acid) being a salient Vitamin playing key role in maintenance of oral health, deficiency of which leads to oral health detriment, bleeding, swollen gingiva, increasing periodontal disease eventually leading to tooth loss. Adequate and balanced intake of Vitamin C pertaining to recommended dietary allowance is necessary for maintaining oral health.

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