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Review Article

Nutrition in Periodontal Health

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Abstract

Good nutrition is crucial for maintaining periodontal health and preventing chronic diseases. Inadequate nutrient intake can increase the risk of periodontal infections and complicate wound healing. A diet high in sugar, saturated fat, and low in fibre can increase the risk of periodontal diseases. Conversely, a diet low in sugar, high in fibre, and with a high omega-6-to-omega-3 fatty acid ratio can reduce the risk. Micronutrients like vitamins A, B, C, calcium, zinc, and polyphenols can help prevent periodontal diseases. Probiotics and prebiotics can also promote periodontal health. Any changes in periodontal health should be considered a warning signal to control the dietary quality of patients.

Keywords: Periodontal Health; Nutrition; Saturated Fats; Anti-Inflammatory; Antioxidant; Balanced Diet

Introduction

The state of our teeth and gums is greatly influenced by the foods we eat. Foods have a nutritional or systemic influence on tooth development before to eruption, and they have a topical or dietary function in preserving tooth structure following tooth eruption. Millions of individuals worldwide suffer from the common inflammatory condition known as periodontaldisease. Maintaining the synergy between periodontal health and mouth bacteria requires balanced eating. Wound healing and periodontal inflammation are influenced by nutrition.

Nutrition has a critical role in periodontal health, even though there are no easy changes tomicro- or macronutrient consumption that may completely prevent or stop periodontal disease [1-3].

Nutrition

The science of food, nutrients, and other compounds they contain, as well as how they interact with the body during ingestion, digestion, absorption, metabolism, and excretion, isknown as nutrition.

The components of food that the body needs to get in appropriate levels are known as nutrients. These consist of water, fiber, minerals, vitamins, proteins, lipids, and carbs. Based on the amount that each of us needs to eat on a daily basis, nutrients may be dividedinto two categories: macronutrients and micronutrients.

Balanced diet

A balanced diet consists of a range of meals in the right amounts and ratios to fulfill the dailyneeds of all vital nutrients, including water, fiber, proteins, carbs, fats, vitamins, and minerals. A well-balanced diet always provides slightly more of each nutrient than is necessary to sustain the brief state of leanness and maintain optimal bodily functions.

Dietary reference intakes (DRI)

A collection of reference values used to plan and evaluate the nutritional intakes of healthyindividuals is known by the generic term DRI. These values are age- and sex-specific and consist of

The term "Recommended Dietary Allowance" (RDA) refers to the average daily consumption that is appropriate to fulfill the dietary requirements of around 97-98% of healthy persons. It is frequently used to help individuals plan meals that are sufficiently highin nutrients.

- **Adequate Intake (AI):** When there is insufficient data to determine an RDA, intake at thisamount is presumed to provide nutritional adequacy.
- **Estimated Average Requirement (EAR):** Average daily intake level estimated to fulfill 50%of healthy persons' requirements; often used to evaluate nutrient intakes of groups and develop diets that are appropriate for them nutritionally; can also be utilized
- **Tolerable Upper Intake Level:** Maximum daily intake unlikely to cause adverse health effects.

Recommended dietary allowances

The recommended dietary/ daily allowances RDA represents the quantities of the nutrients to beprovided in the diet daily for maintaining good health and physical efficiency of the body.

Malnutrition

Malnutrition can be caused by deficiencies or excesses in nutrient intake. Undernutrition and overweight/obesity together form double burden of malnutrition. Nutrients, both micronutrients and macronutrients, play a crucial role in periodontal health. Sugary diet can lead to dental decay whileobesity has a strong link with periodontal diseases. Omega-3s have a positive effect on periodontalhealth. Protein deprivation can lead to the breakdown of periodontal ligaments, degeneration of gingival tissues, and resorption of the alveolar bone [4,5].

Nutrition deficiency

Nutritional Influence on Inflammation

- Diets rich in antioxidants are beneficial, while those high in refined carbohydrates canworsen inflammation.
- Subtle shifts in nutritional status are linked to the prevalence of periodontal disease.
- Fat-Soluble Vitamin Deficiency:

Vitamin A

- Maintains epithelial cell health.
- Deficiency can lead to epithelial degeneration, potentially compromising the protective barrier against microbial invasion.
- Animal studies suggest exacerbation of gingival pathology and hinderedwound healing.

Vitamin D

- Essential for calcium absorption and bone health.
- Animal studies show it can cause osteoporosis and affect periodontal tissues.

Vitamin E

- Acts as an antioxidant, protecting cells from damage.
- Impact on oral health remains unclear, though it may accelerate gingival woundhealing in rats.

Water-Soluble Vitamin Deficiency

B-Complex Deficiency

- Can manifest as various oral conditions like gingivitis, glossitis, and angular cheilitis.
- Thiamine deficiency (beriberi) leads to mucosal hypersensitivity and erosion.
- Riboflavin deficiency causes glossitis, angular cheilitis, and gingival lesions.
- Niacin deficiency results in pellagra, often presenting as necrotizing ulcerative gingivitis.
- Folic acid deficiency is associated with macrocytic anemia and oral changeslike ulcerative stomatitis.
- Folic Acid Supplementation:
- Studies suggest it can reduce gingival inflammation, particularly in pregnant women and patients taking phenytoin.
- Conflicting evidence exists regarding its impact on gingival overgrowth induced by phenytoin [6,7].

Vitamin c deficiency

Vitamin C deficiency in humans causes scurvy, which is characterized by hemorrhagic diathesis and delayed wound healing. It may occur in infants if infant formulas are not fortified with vitamins and inolder persons with restricted diets. Malnutrition associated with alcoholism may also predispose an individual to scurvy. Clinical manifestations of scurvy include bleeding, swollen gums, and impaired wound healing.

Clinical features of scurvy

- Spongy and sore gums, loose teeth.
- Hemorrhagic lesions in muscles, joints, and nail beds.
- Petechial hemorrhages around hair follicles.
- Impaired wound healing.
- Sluggish adrenal cortex and gonadal function.

Effect of Vitamin C Deficiency on Periodontium

- Gingival changes: Redness, swelling, bleeding upon stimulation, spongy consistency.
- Defective collagen synthesis affects alveolar bone, leading to resorption.
- Weakened periodontal fibers due to collagen synthesis defects.
- Increased risk of periodontal disease in smokers and diabetic patients.
- Possible Etiological Relationship between Ascorbic Acid and Periodontal Disease:
- Low ascorbic acid levels affect collagen metabolism, tissue regeneration, and repair.
- Interference with bone formation leads to periodontal bone loss.
- Enhances leukocyte function, affecting inflammation and phagocytic activity.
- Required for maintaining microvasculature integrity.

Toxicity

- Generally non-toxic; excess excreted by kidneys.
- High concentrations stored in eyes, adrenal glands, and brain for about 3 months.
- Symptoms of excessive intake include gastrointestinal upset, diarrhea, orange-colored urine, interference with anticoagulants, and iron toxicity.

Treatment

- Infantile scurvy: 50-100 mg of ascorbic acid four times daily, reducing after a week.
- Adult scurvy: 250 mg four times daily for a week, then decreased to 50-100 mg four times daily until normal plasma levels attained.
- Improvement seen within 24 hours, complete recovery expected in about 3 months.

Risk factors

Alcoholism, low socioeconomic status, severe psychiatric illness, fat diets, anorexianervosa, Crohn's disease, celiac disease, and hemodialysis patients [8,9].

Possible etiological relationships between ascorbic acid and periodontal disease

- Low levels of ascorbic acid influence the metabolism of collagen with in periodontium, thereby affecting the ability of the tissues to regenerate and repair itself.
- Ascorbic acid deficiency interferes with bone formation, leading to loss of periodontal bone failure of osteoblast to form osteoid.
- Ascorbic acid deficiency increases the permeability of the oral mucosa to tritiated endotoxin and tritiated inulin and of normal human crevicular epithelium to tritiated dextran.
- Increase in levels of ascorbic acid enhances both the chemotactic and migratory action of leukocytes without influencing their phagocytotic activity. An optimal level of ascorbic acid is apparently required to maintain the integrity of the periodontal vasculature, as well as the vascular response to bacterial irritation and around healing
- Depletion of Vit-C may interfere with the ecological equilibrium of bacteria in plaque and thus increase its pathogenicity.

Necrotizing ulcerative periodontitis

Malnutrition is directly linked to necrotizing periodontal disease. It impairs the immune system's function, increasing the risk of infections and intensifying existing oral infections. Malnourished individuals have dysregulated cytokine production leading to an impaired ability to fight infections [10].

Nutrition and epithelial barrier

- Rapid rate of turnover of epithelial cells of gingival sulcus indicates the need of continuous synthesis of DNA, RNA and tissue protein.
- This indicates that sulcular epithelium has high requirement of such nutrients as folic acid and protein which are involved in cell formation
- At the base of the sulcular epithelium is a narrow basement membrane made up of collagen
- Since collagen is the major component of basement membrane and ascorbic acid and zinc are important for collagen synthesis
- This membrane act as a barrier for the entrance of toxic material.[11]

Role of nutrition in periodontal disease

Nutrition plays a crucial role in periodontal disease development and treatment. While bacterial infections are the primary cause, dietary factors impact disease progression. Nutritional deficiencies weaken the body's defenses, making it more susceptible to bacterial invasion. Vitamin C and D, as wellas calcium, have been linked to periodontal health. Some dietary interventions, like increased tomato consumption, help reduce the risk of adverse outcomes. Nutritional supplementation may offer benefitsin periodontal management, but further research is required to understand its effectiveness [12].

Herbal and nutritional supplements

Periodontal disease affects gums and bones surrounding teeth. Coenzyme Q10 is suggested as a modulator for periodontal disease, but studies are limited. Chewing sticks, such as miswak, are a traditional approach to oral hygiene in some cultures and have been shown to have antimicrobial effects.Some natural products show promise in improving oral health [13].

Antioxidants and periodontal health

The oral cavity can undergo inflammation and injury due to disease and trauma, which can produce ROS and free radicals molecules. Antioxidants help reduce the severity of disease by scavenging ROS.Certain dietary components have shown potential for improving periodontal health, such as vitamins A,C, and E, foods high in these vitamins, lycopene found in tomatoes and watermelons, and melatonin. Melatonin gel application promotes bone-implant contact and can be used on post-extraction sockets. Future research should focus on the effect of dietary melatonin supplementation on periodontal therapy [14].

Effect of nutrition on periodontal disease

Numerous studies have demonstrated a possible link between nutrition and periodontal disease. It has been suggested that in response to periodontal pathogens, polymorphonuclear leukocytes (PMN) produce destructive oxidants, proteinases and other factors. The balance between these factors, the antioxidants, and endogenously synthesized anti proteinases determine the extent of periodontal damage. Malnutrition is characterized by a significant reduction in key antioxidant nutrients such as gamma-glutamyl-cysteinyl-glycine (GSH) and impaired acute-phase protein response to infections.

The acute-phase protein response is critical to promoting healing, and its deficiency in malnutrition is due to impairment in the production and cellular action of cytokines. Malnutrition also causes an inverted helper-suppressor T cell ratio, histaminemia, hormonal imbalance with increased blood and saliva levels of free cortisol, and defective mucosal integrity. Malnutrition may adversely affect the prognosis of periodontal infections. It also results in adverse changes in the oral microbial ecology, volume, and the antibacterial and physicochemical properties of saliva [15].

Impact of probiotics and prebiotics on periodontal disease

Probiotics are beneficial microorganisms that balance the intestinal microbiome and have a positive effect on human health. Some probiotics can help maintain periodontal health and treat periodontal disease (PD). Studies have shown that certain strains of Lactobacillus, including L. reuteri, L. salivarius, L. brevis, and L. plantarum, can reduce clinical signs of PD and levels of periodontal pathogens. However, continuous probiotic administration is necessary to sustain the benefits. Several mechanismscould explain the action of probiotics:

- Production of lactic acid that inhibits the proliferation of periodontal bacteria by penetrating themembrane of bacteria and acidifying the cytoplasm
- Production of hydrogen peroxide that inhibits the growth of pathogenic bacteria
- Modification of proteins at the level of the site of attachment
- Production of inhibitory substances such as bacteriocins
- Production of vitamins or other substances.189 101

Chandra., *et al*. 2016, reported the efficacy of a probiotic, Saccharomyces boulardii 1.6 × 109 CFU, mixed in a ratio 4:1 with a prebiotic, fructooligosaccharide, in the treatment of PD when used as an adjunct to non-surgical periodontal therapy [16].

Mechanisms linking nutrition and periodontal disease

Pathogenesis of periodontal disease and oxidative stress

- Oxidative stress defined as an imbalance favoring oxidants over antioxidants, leading to redox signaling disruption and molecular damage.
- Implicated in chronic inflammatory conditions like Type 2 diabetes, rheumatoid arthritis, and cardiovascular disease.
- Growing evidence suggests strong associations between periodontitis and systemicconditions.

Dietary factors promoting oxidative stress

- Increase in refined carbohydrates can overload the Krebs cycle, leading to excessive superoxide radicals production.
- Formation of advanced glycation end products (AGEs) from chronic hyperglycemia activates pro-inflammatory pathways.

- Metabolism of excess saturated fats leads to increased production of oxidized LDL, activatingpro-inflammatory cascades.

Impact of dietary choices on inflammation

- Diets high in refined carbohydrates and saturated fats induce "meal-induced inflammation" or "post-prandial oxidative stress."
- Incorporating fiber into the diet can reduce post-prandial glucose spikes and associatedinflammatory responses.

Role of antioxidants and micronutrients

- Oxidative stress defined as an imbalance favoring oxidants over antioxidants, leading to redox signaling disruption and molecular damage.
- Implicated in chronic inflammatory conditions like Type 2 diabetes, rheumatoid arthritis, and cardiovascular disease.
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Impact of dietary choices on inflammation

- Diets high in refined carbohydrates and saturated fats induce "meal-induced inflammation" or "post-prandial oxidative stress."
- Diets rich in antioxidant micronutrients, particularly glutathione, may reduce oxidative stress.
- Periodontal therapy has the potential to improve compromised redox balance by restoringglutathione levels.

Anti-inflammatory effects of polyunsaturated fatty acids (PUFAs)

- Omega-3 PUFAs downregulate pro-inflammatory gene expression and produce pro-resolving lipid mediators.
- Resolution of inflammation is an active response, not just a reduction in pro-inflammatorysignals.

Impact of western diets on health

- High calorie, protein, fatty acid, and sugar content.
- Associated with increased risk of chronic conditions like cardiovascular disease (CVD), diabetes, and cancers.
- Salt content and additives in Western diets contribute to health risks.

Association with Chronic Conditions:

- Observational studies link Western diets to increased risk of CVD, stroke, coronary heart disease, and type 2 diabetes.
- Consumption of meat, processed foods, and cooking methods in Western diets may contributeto cancer risk.

Complex impact on cancer risk

- The overall risk of cancer increases with the proportion of ultra-processed foods in the diet.
- Red and processed meat consumption associated with increased risk of certain cancers like prostate cancer.

Nutrition as a common modifiable risk factor for periodontal diseases and other chronic diseases.

This article discusses the relationship between nutrition and periodontal diseases (PDs), emphasizing the impact of dietary patterns on oral health. It highlights how diets low in sugar, high in fiber, and with a balanced ratio of omega-6 to omega-3 fatty acids, such as the Mediterranean, DASH, vegetarian, andOkinawa diets, are associated with reduced PD risk and improved overall health. The text also suggests a bidirectional association between nutrition/PDs and nutrition/CDs (chronic diseases), emphasizing the importance of dietary habits in preventing not only PDs but also other CDs. Dental professionals play a crucial role in educating patients about the significance of adopting a healthy diet and practicinggood oral hygiene to prevent the progression of PDs [17].

Effects of reactive oxygen species on periodontal tissues and components

- Inflammation, especially chronic inflammation, is a significant factor in various diseases, including periodontitis.
- Oxidative stress, characterized by an imbalance between oxidants and antioxidants, is a key driver of chronic inflammation.
- Periodontitis involves a hyperinflammatory response that fails to eliminate pathogens, leadingto prolonged release of proteolytic enzymes, pro-inflammatory mediators, and reactive oxygenspecies (ROS).
- ROS, including molecules like hydrogen peroxide and hypochlorous acid, cause tissue damage by initiating free radical chain reactions.
- The body employs protective antioxidant mechanisms to remove harmful ROS or repair the damage caused by them.

- When ROS production overwhelms antioxidant defenses, it leads to periodontal tissue damage through processes like ground substance degradation, collagenolysis, and excessive cytokine release.
- Dietary factors may influence inflammation and oxidative stress levels, potentially impacting periodontal health.
- Understanding the interplay between inflammation, oxidative stress, and diet is crucial for managing and preventing periodontal disease.

Nutrigenomics

Nutrigenomics studies how diet and genes affect each other, and aims to improve public health throughdietary means. It focuses on the relationship between nutrition and the genome and can help determinethe risk of common complex diseases, such as periodontal diseases.

Benefits from nutrigenomics

Nutrigenomics research aims to develop strategies for improving health and preventing diseases by understanding the interactions between phenotype, genotype, and diet. Identifying biomarkers that describe changes from healthy to pre-disease and disease states is crucial. Nutritional genomics uses genomics, transcriptomics, proteomics, and metabolomics studies to generate biomarkers indicating homeostasis or health, predecease, and disease states [18].

Conclusion

Nutritional factors play a significant role in the integrity of periodontal tissues, although the precise relationship between nutritional deficiencies and periodontal disease in humans remains uncertain. While experimental studies in animals may offer insights into metabolic abnormalities induced by nutritional deficiencies and their impact on periodontal health, further investigation is necessary to drawdefinitive conclusions. Processed carbohydrates and unhealthy fats have been associated with increased gingival and periodontal inflammation, whereas complex carbohydrates and omega-3 fatty acids appearto have protective effects. Although some studies suggest potential benefits of dietary supplements likevitamin C for periodontal health, robust long-term studies are needed to confirm their efficacy. Emphasizing a diet rich in fruits, vegetables, and micronutrients can offer anti-inflammatory and protective effects for periodontal health. While current dietary recommendations may not require revision specifically for periodontal health, ongoing research is essential to better understand the intricate interplay between diet and periodontal disease. Dentists have a crucial role in identifying and addressing dietary malnutrition early on to prevent broader health complications, underscoring the importance of integrating nutritional considerations into periodontal therapy.

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