



Malnutrition and Oral Health

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Abstract

Mouth being a reflecting mirror of general health often helps in early diagnosis of many diseases and disturbances. Like any other system of our body, oral cavity relies on adequate nutritional supply but with certain special cautions to protect the dental structures which in turn help for consumption of nutrients. In this way nutrition and oral health are mutually dependent and hence an extensive understanding of this inter relationship is essential for healthy life. Nowadays people are conscious in knowing about the healthy diet through various media and try to practice it to their kitchen style. Diet, the customary allowance of food and drink taken by any person per day varies from nutrition, which involves the metabolic processes and utilization of nutrients in the food. The nutritional status of a person is implicated on oral mucosa due to rapid turnover of their epithelial cells, which is five times faster than it is in the skin. These self renewing cells live for approximately 5 to 6 days This turnover keeps the mucosa healthy and acts as a barrier to many toxins, drugs, chemicals and bacteria. Inadequate nutrition may leads to tissue breakdown, infection, and inflammation Worldwide there are more than 2 billion people, particularly pregnant women and young children are at mal nourished status with compromised health circumstance

Malnutrition affects the oral health and a poor oral health in turn, may lead to malnutrition. Malnutrition may alter the homeostasis, which can lead to disease progression of the oral cavity, reduce the resistance to the microbial biofilm and reduce the capacity of tissue healing. Malnutrition, besides producing gener effects on other organs/systems of the body, leads to the development of well defined development and pathologic changes in the or mucosa, tongue, teeth, gums and jaw bones. Proper understanding of the relationship between deficiency of good constituents and various ailments of the or cavity is, therefore, of immense importance for prevention and treatment of a variety of orodent disorders. This review deals with complex relationship among diet, nutrition and their implications on oral health and so the need for effective contribution of dietitians in dental team to enhance the general health status of population This review also reveals the essence of knowledge required to maintain high-quality oral and general health by precise diet.

Keywords: malnutrition, oral health, nutrition

Introduction

Nutrition affects oral health and oral health affects nutrition. This interdependent relationship sees good nutritional health, promoting good oral health and vice versa. On the other hand, poor nutritional health is associated with poor health, oral health and vice versa Nutrition concerns the assimilation of food and its effect on the metabolic processes of the body.

According to the W.H.O: "Nutrition is the science of food and its relationship to health and "Malnutrition is the cellular imbalance between the supply of the nutrients and the energy and the body's demand for them to ensure growth, maintenance, and specific functions" It is concerned primarily with the part which is played by the nutrients in the body's growth, development and maintenance. Malnutrition is the condition that develops when the body does not get the right amount of the vitamins, minerals, and other nutrients which it needs to maintain healthy tissues and organ functions. Protein- Energy Malnutrition (PEM) occurs when there are

deficiencies in the protein, energy foods or both, which are relative to a body's needs the dietary energy and protein deficiencies usually occur together. Mild PEM has an acute course and it has a main deficiency in energy; moderate PEM is chronic in nature and it has a main deficiency in protein, while severe PEM is both chronic and acute, and it is composed of deficiencies in both protein and energy. Such a malnutrition status of the body during its development, can affect the oral structures

Mutual relationship between nutrition and oral tissue

- Vitamins and minerals produce characteristic manifestation on teeth, periodontal tissues, salivary glands and perioral skin in their deficiency state
- Systematic diseases associated with malnutrition also accompanying oral manifestations
- Altered anatomic and functional effects of oral cavity like advanced dental caries, periodontal diseases and the

resulting edentulousness may cause chewing difficulty and thus put in malnutrition
 So there exists a dynamic interaction as follows: Complete

nutrition Healthy oral cavity (Promote healthy regeneration of oral tissues) <----> By effective chewing, mastication and swallowing enhances nutritional benefits)

Effect of Malnutrition on oral structures and its development

Table 1

Protein/calorie malnutrition	Delayed tooth eruption, Reduced tooth size Decreased enamel solubility, Salivary gland dysfunction.
Vitamin A	Decreased epithelial tissue development, Impaired tooth formation, Enamel hypoplasia.
Vitamin D/Calcium phosphorus	Lowered plasma calcium, Hypomineralization Compromised tooth integrity, Delayed eruption pattern Absence of lamina dura, Abnormal alveolar bone patterns.
Vitamin C	Irregular dentin formation, Dental pulpal alterations Bleeding gums, Delayed wound healing, Defective collagen formation.

Effect of Vitamin B Complex and Iron on oral structures

Table 2

Deficient Nutrient	Effect on oral structures
Vitamin B1(Thiamine)	Cracked lips, Angular cheilosis
Vitamin B2 (Riboflavin) Vitamin B3 (Niacin)	Inflammation of the tongue, Angular cheilosis Ulcerative gingivitis
Vitamin B6	Periodontal disease, Anemia Sore tongue Burning sensation in the oral cavity.
Vitamin B12	Angular cheilosis, Halitosis Bone loss, Hemorrhagic gingivitis Detachment of periodontal fibers Painful ulcers in the mouth
Iron	Salivary gland dysfunction Very red, painful tongue with a burning sensation, Dysphagia, Angular cheilosis

According to the UNICEF 2006- Progress for Children World Report, 5.6 million children who are under the age of 5 years in the developing countries, contribute to the country’s death rate, because of a high prevalence of malnutrition. This accounts to 10 children per minute
 The teeth which are in a pre-eruptive phase are influenced by the nutritional status of the body. The deficiencies of vitamin D, vitamin C, vitamin B and vitamin A and Protein Energy Malnutrition (PEM) have been associated with the disturbances in the oral structures. Enamel hypoplasia is a lesion which is characterized by hypoplastic grooves and/or pits in the enamel, which are often horizontal or linear in appearance Some hypoplasia and pits on the surface of the enamel correlate to a lack of vitamin A. More diffused hypoplastic forms of the enamel have been reported with a vitamin D deficiency as well The structural damage can testify the period in which the lack of nutrition has occurred.
 The conditions like recurrent aphthous stomatitis, atrophic glossitis or a painful, burning tongue which is characterized by inflammation and defoliation of the tongue, are possibly caused by nutritional deficiencies such as vitamin B and iron deficiencies
 The normal functioning of the salivary gland is necessary for the maintenance of a healthy oral cavity. Hypofunctioning of the salivary glands has been reported with PEM, which results in a decreased salivary flow rate, a decreased buffering capacity, and decreased salivary constituents, particularly proteins [1, 7]. PEM and vitamin A deficiency are associated with salivary gland atrophy, which subsequently reduces the defence capacity of the oral cavity against infection and its ability to buffer the plaque acids. Navia states ‘moderate malnutrition, particularly a lack of protein and deficiencies of certain micronutrients such as vitamins, zinc and iron, can influence the amount and the composition of the saliva, thus limiting the protective effects that it has in the oral cavity
 Caries is demineralization of the inorganic part of the tooth

structure, with the dissolution of the organic substance due to a multifactorial aetiology. The demineralization of the enamel and the dentine is caused by organic acids that form in the dental plaque because of the bacterial activity which occurs due to the anaerobic metabolism of the sugars which are found in the diet. Demineralization occurs when the organic acids which are produced, increase the solubility of the calcium hydroxyapatite that is present in the hard tissue of the teeth The development of caries requires sugars and bacteria, but is influenced by the susceptibility of the tooth, the bacterial profile, the quantity and quality of the saliva, and the time for which the fermentable dietary carbohydrates are available for the bacterial fermentation
 PEM can be correlated with the host factors which are associated with the development of caries, especially tooth defects and the salivary system. The tooth defects of interest are the external structural defects (hypoplasia) that can provide a more cariogenic environmental niche and less protective enamel and defects that include hypomineralization, which might increase the susceptibility to demineralization. The salivary flow rates are related to caries directly through oral clearance and in terms of the buffering capacity and the antimicrobial components A retrospective cohort study which was conducted to determine the effects of Early Childhood Protein-Energy Malnutrition (EC-PEM) and the eruption patterns of teeth among adolescents, concluded that a delayed exfoliation of the primary teeth and a delayed eruption of the permanent teeth were associated with EC-PEM
 Periodontal disease evolves more quickly in undernourished populations; the pathology starts in the gum and it could invade the periodontal ligament up to the alveolar bone. The most important risk factor in the development of periodontal disease is represented by inadequate oral hygiene. Malnutrition and bad oral hygiene represent the two important factors that predispose to necrotizing gingivitis

Discussion

Malnutrition is a multifactorial disease that can have an early onset during the intrauterine life or childhood, or it can occur during an individual's lifetime as a result of poor nutrition. Malnutrition appears to have multiple effects on the oral tissues and the subsequent oral disease development. It affects the development of the oral cavity and the progression of the oral diseases through an altered tissue homeostasis, a reduced resistance to the microbial biofilms and a reduced tissue repair capacity. Deficiencies of vitamin D and vitamin A and Protein Energy Malnutrition (PEM) have been associated with the enamel hypoplasia. PEM and vitamin A deficiency are also associated with salivary gland atrophy, which subsequently reduces the defence of the oral cavity against infection and its ability to buffer the plaque acids. In a study, it was suggested that moderate malnutrition, principally, a lack of protein and other micronutrients such as vitamins, zinc and iron, limits the protective effect of saliva on the oral cavity, by manipulating its composition and amount.

The vitamin B deficiencies affect the oral structures. A common oral effect of the vitamin B (complex) deficiency is a burning sensation in the mouth, especially on the tongue. The other oral symptoms include cracked and red lips, inflammation of the lining of the oral cavity and the tongue, oral ulcers, cracks at the corners of the mouth (angular cheilitis), and a sore throat. The effects of iron deficiency are

similar to those of the vitamin B deficiency. The body requires iron, vitamin B-12 and folic acid to produce healthy red blood cells within the bone marrow. A deficiency of vitamin B-12 or folic acid results in immature red blood cells and a condition called pernicious anaemia. Vitamin B-2 (riboflavin) is primarily needed for the breakdown of fat, ketone bodies, carbohydrate and proteins. However, a riboflavin deficiency causes ariboflavinosis, which manifests as cracked lips, inflammation of the tongue and dryness or burning of the oral cavity.

Dental caries occur due to the demineralization of the enamel and the dentine by organic acids which are formed by the bacteria in the dental plaque, through the anaerobic metabolism of the sugars which are derived from the diet. The biological factors of caries are: (1) cariogenic bacteria in a complex ecological system (plaque); (2) fermentable carbohydrates, and (3) host factors. The cariogenic bacteria produce an acid by using the fermentable carbohydrates, that demineralizes the tooth. The base-producing bacteria and the remineralizing activity may modify or counter the produced acid effects. However, more pertinent in terms of PEM, are the host factors which are associated with caries, specifically the tooth defects and the salivary system. The tooth defects which are of importance here are enamel hypoplasia / hypomineralization which provide a more cariogenic environment.

Manifestations of nutritional deficiency in oro-facial region

Table 3

Site	Manifestation	Nutrient deficiency
Face	Edematous appearance	Protein Niacin,
	Paleness	Iron
	Malar pigmentation	niacin, riboflavin
Lips	Nasolabial seborrhea	B6, niacin, riboflavin
	Fissuring at corners	Niacin, riboflavin
	Swelling and redness	B6, Iron
Gingiva	Red, swollen, spongy and bleeding gums	Vitamin C
Tongue	Red and fissured tongue	Folate, niacin, B12, B6, riboflavin Fe + +,
	Pale, smooth and glossy tongue	B12, Fe + +

In a study, Sweeney et al., found the linear hypoplasia of the primary maxillary incisors to be associated with infectious episodes which occurred early in life and with low serum vitamin A. Likewise, Infante and Gillespie observed a strong correlation between the degree of linear enamel hypoplasia and the caries experience in the primary teeth of undernourished Guatemalan children. Many studies have observed an association between the Early Childhood Malnutrition and enamel hypoplasia in the primary teeth by using various study designs.

A study which was conducted on Indian children, found that the moderate to severe PEM had a reduced salivary secretion rate, a reduced buffering capacity, lower calcium levels, a lower protein secretion in stimulated saliva, and reduced agglutinating defense factors in unstimulated saliva. In a retrospective cohort study which was designed by Psoter W J et al., the effect of both the past early childhood protein-energy malnutrition and the current adolescent nutritional status on the salivary flow and the pH were studied. This study was the first to report a continuing effect on the diminished salivary gland function into adolescence, which

was a result of Early Childhood Malnutrition (EC-PEM) and it suggested that the exocrine glandular systems may be compromised for extended periods following EC-PEM, which may have important implications for the body's systemic antimicrobial defenses. In 3 cross-sectional studies, it was inferred that the malnutrition in children may not only cause a delay in tooth eruption and exfoliation, but that it also appeared to render the deciduous teeth more susceptible to a caries attack later in life. Another retrospective cohort study suggested the evidence of an association between the tooth exfoliation/eruption patterns and a nutritional insufficiency (stunting) throughout childhood. This study observed a delay in the exfoliation of the primary dentition and in the eruption of the permanent dentition. A similar longitudinal study suggested a cause-effect relationship between early malnutrition and increased dental caries. Various studies in India also reported a significant association between a poor nutritional status and a delayed tooth eruption. It can be concluded on the basis of these studies, that malnutrition caused delayed tooth development, it affected the age distribution of dental caries, and it resulted in an increased

carries experience.

The health of the periodontal tissues is strongly related to the diet. There is a relationship between the calcium intake and periodontal diseases. Calcium plays an important role in building the density in the alveolar bone that supports the teeth. A similar relationship exists between vitamin C and periodontal diseases. Vitamin C plays the main role in maintaining and repairing the healthy connective tissue, along with its antioxidant properties. A deficiency of vitamin C is known to cause scurvy, which is characterized by defective collagen formation due to disturbances in the collagen synthesis. The oral manifestations of scurvy include bleeding gums and gingivitis

A retrospective cohort study was conducted to examine whether an exposure to Early Childhood Protein-Energy

Malnutrition (ECPEM) was related to a worsened periodontal status in the permanent dentition during adolescence. This study revealed that ECPEM was related to a poorer periodontal status. Because ECPEM is likely to affect the developing immune system, a person's ability to respond to the colonization with the periodontal pathogens may be adversely affected permanently

Critical determinant of immune response is nutrition and there exists an interdependent relation of these two factors and oral health Malnutrition severely affects the host immune resistant against microbial growth. This reduced immune response encourages the oral microbial colonization and leads to bacterial stomatitis and gingivitis which in turn affects the regular diet consumption due to pain and discomfort.

Immune functions of Vitamins and their influence on oral health

Table 4

Vitamin	Function	Oral manifestations in deficient state
Vitamin A	Immune cell differentiation and lymphocyte proliferation	Bacterial Colonization
Vitamin E	Reduce cell membrane damage by anti-oxidant potential	Oral tissues will be more vulnerable for bacterial and chemical toxins
Vitamin C	Neutralizes toxins that are produced during phagocytes	Overwhelming acute and chronic bacterial infection.
	Antioxidant	(Especially Gingiva)

Oral manifestations of specific nutrient deficiency

Calcium

Teeth are the densest structure of the body with highest calcium content. Deficiency during developmental period (in-vitro) causes enamel hypoplasia and later increased incidents of dental caries. Systemic osteoporosis (reduction in bone mass due to inequity of bone metabolism favoring bone resorption to compromise the calcium insufficiency) due to estrogen deficiency in post menopausal women and calcium deficiency during lactation also affecting the alveolar bone, and causes mobility and tooth loss [20]. Food supply of calcium depends on the intake of yogurt, cheese, milk, turnips, spinach, soybeans and enriched breads and grains.

Protein

Protein deficiency manifests as edema of tongue, pigmentation around lips, restarted jaw growth and crowded dentition there is significant impairment of cell mediated immunity, phagocytic function, altered immune response and reduced IgA and lysozyme secretion in severely affected protein malnutrition patients and causes increased bacterial adhesion to oral epithelial cells, invasion and infection. Dietary intake of milk, fish, egg, soybean and cheese will provide adequate protein supply to the body

Fluoride

Being an essential micronutrient for healthy bone and teeth, its supplementation should be encouraged for growing children consuming non fluoridated water Water containing fluoride level of less than 1 parts per million will prone for dental caries. The use of packaged water and utilization of water filtration devices, distillation system and reverse osmosis techniques result in 90% reduction of fluoride content. Rich sources of fluoride include tea leaves and fish.

Iron

The texture of oral mucosa is altered due to its deficiency due

to epithelial atrophy, which attracts the microbial colonization. The bactericidal activity of iron, which enhances the movement of O₂ to the cells of system, also gets affected. Together iron deficiency encourages the opportunistic oral infection Dietary source of iron include red meat, egg yolks, dark leafy greens, dried fruits, liver, beans and lentils.

Vitamin B12

The oral signs and symptoms include glossitis, angular chellitis,, recurrent oral ulcer, oral candidiasis, and diffuse mucositis. Oral manifestations often precede the major complications of megaloblastic anemia, in which morphological abnormalities of red cell precursors in bone marrow occur. The clinical symptoms include weakness, fatigue, shortness of breath and neurologic abnormalities. Early oral findings in dietary deficiency of cobalamine may help to prevent the neurological signs which are often irreversible. Oysters, liver, caviar, octopus, crab and lobsters, cheese and yogurt are rich in Vitamin B12.

Vitamin C

Collagen represents about 30% of total body protein and is involved in the matrix formation of dentin, cementum, alveolar bone and periodontal ligament. Deficiency of Vitamin C manifests first in oral cavity as swollen, bleeding gingiva and finally losing of teeth. This is the result of under hydroxylation of collagen leading to increased vascular permeability of gingiva. Gingival bleeding decrease when Vitamin C is supplemented and bleeding score is increased in its deficiency state. Vitamin C deficiency on the other hand increases only the severity of gingival inflammation, but not the single cause. Humans are unable to synthesis this vitamin and rely upon dietary intake to supply for the physiological needs. Being water soluble, body is incapable of storing it and necessitate continuous intake of fruits and vegetables like citrus fruits, mango, papaya, pineapple, strawberries, broccoli,

cauliflower which are rich in Vitamin C.

Conclusion

An individual's general health is determined by genetic and environmental factors which are also potentially influenced by nutrition. Oral tissues are susceptible to nutritional stresses that may affect a person's general health and wellness. Diet and nutrition of the host may establish the oral diseases by their influences on ecology of oral flora. Regular diet and nutritional counseling should include nutritional strategies for oral health as a part. To achieve the moderate level of oral health, we should aim for the following objects.

1. Individualized nutritional advice for dental patients by regular diet counseling.
2. Nutritional counseling for immunocompromised individuals.
3. Regular diet screening programs for school children.

The co-ordination between the dentist and dietitian should go a long way in preventing and treating many of the unsolved dental problems associated with nutrition studies which have been conducted, dictate that malnutrition and protein energy malnutrition affect the dentition. The resultant defects include the effects on the tooth eruption patterns, enamel hypoplasia, dental caries prevalence and periodontal ligament. They also have other effects on the oral cavity, like inflammation of the lining of the oral cavity and the tongue and oral ulcers. A detailed case analysis of malnutrition, particularly PEM, is required to substantiate the above discussed factors. Such an in depth analysis of PEM might reveal other milestones that might be affecting the healthy oral cavity.

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