Review Article

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Dentistry Section

Malnutrition and its Oral Outcome – A Review

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ABSTRACT

Malnutrition affects the oral health and a poor oral health in turn, may lead to malnutrition. This interdependent relationship sees good nutritional health, thus promoting good oral health and vice versa. 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. It may even affect the development of the oral cavity. Protein-energy malnutrition occurs when there is a deficiency of protein, energy foods or both, which are relative to a body's need. Studies have suggested that enamel hypoplasia, salivary gland hypofunction and saliva compositional changes may be the mechanisms through which the malnutrition is associated with caries, while an altered eruption timing may create a challenge in the analysis of the age specific caries rates. This paper gives an insight on the relationship of the malnutrition and the protein-energy malnutrition with the oral health status.

Key Words: Malnutrition, Protein Energy Malnutrition (PEM), Dental Caries

INTRODUCTION

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"[1,2] 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" [3]. 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 [1,2]. 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 [1] [Table/Fig-1 and 2].

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 [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.

[Table/Fig-1]: Effect of Malnutrition on oral structures and its development

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 [1]. 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 [4, 5]. The structural damage can testify the period in which the lack of nutrition has occurred.

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

[Table/Fig-2]: Effect of Vitamin B Complex and Iron On Oral Structures

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 [3,6].

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 [7].

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 [4]. 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 [5].

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 [1]. 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 [8].

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 [4].

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 [9]. 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 [3]. 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 [5].

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 caviy [3,6,10-12].

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 [1,13].

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 [14]. 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 [15]. Many studies have observed an association between the Early Childhood Malnutrition and enamel hypoplasia in the primary teeth by using various study designs [1].

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 [16]. 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 [7].

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 [17-19]. 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 [8]. A similar longitudinal study suggested a cause-effect relationship between early malnutrition and increased dental caries [20]. Various studies in India also reported a significant association between a poor nutritional status and a delayed tooth eruption [21]. 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 caries 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 [3,22,23].

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 [2].

CONCLUSION

Various 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.

REFERENCES

[1] Psoter WJ, Reid BC, Katz RV. Malnutrition and Dental Caries: A Review of the Literature. *Caries Res.* 2005 ; 39(6): 441–47.

[2] Russell SL, Psoter WJ, Charles GJ, Prophte S, Gebrian B. Protein-energy malnutrition during early childhood and periodontal disease in the permanent dentition of Haitian adolescents aged 12–19 years: a retrospective cohort study. *Int J Paediatr Dent.* 2010 ;20(3): 222–29.

[3] Ehizele AO, Ojehanon PI, Akhionbare O. Nutrition and Oral health. *Journal of Postgraduate Medicine.* 2009; 11 (1) :76-82.

[4] Scardina GA, Messina P. Good Oral Health and Diet. *J Biomed Biotechnol.* 2012.

[5] Moynihan P, Petersen PE. Diet, nutrition and the prevention of dental diseases. *Public Health Nutrition.* 7(1A): 201–26.

[6] Field EA, Speechley JA, Rugman FR, Varga E, Tyldesley WR. Oral signs and symptoms in patients with undiagnosed vitamin B12 deficiency. *Journal of Oral Pathology and Medicine.* 24 (10):468-70.

[7] Psoter WJ, Spielman AL, Gebrian B, Rudolph SJ, Katz RV. Effect of childhood malnutrition on salivary flow and pH. *Arch Oral Biol.* 2008; 53(3): 231–37.

[8] Psoter W, Gebrian B, Prophete S, Reid B, Katz R. Effect of early childhood malnutrition on tooth eruption in Haitian adolescents. *Community Dent Oral Epidemiol*. 2008;36(2):179-89.

[9] Erika BAF Thomaz , Maria Cristina T Cangussu , Antônio Augusto M da Silva, Ana Marlúcia O Assis. Is Malnutrition Associated with Crowding in Permanent Dentition?. *Int. J. Environ. Res. Public Health.* 2010 ;8:3531-44.

[10] Pontes HAR, Neto NC, Ferreira KB, Fonseca FP, Vallinoto GM, Pontes F S C, et al. Oral Manifestations of Vitamin B12 Deficiency: A Case Report. *JCDA.* 2009;75(7):533-37.

[11] Kozlak ST, Walsh SJ, Lalla RV. Reduced dietary intake of vitamin B12 and folate in patients with recurrent aphthous stomatitis. *J Oral Pathol Med*. 2010; 39(5): 420–23.

[12] Nutrition, Diet and Oral Health. By Andrew J.Rugg- Gunn, June H.Nunn. *Oxford Medical Publications*.

[13] Louis P Di Orio, Sanford A Miller. The separate effects of protein and calorie malnutrition on the development and growth of rat bones and teeth. *J Nutr.* 1973;103: 856-65.

[14] Sweeney EA, Cabrera J, Urrutia J, Mata L. Factors associated with linear hypoplasia of human deciduous incisors. *J Dent Res.* 1969;48: 1275-79.

[15] Infante PF, Gillespie GM. Dental caries experience in the deciduous dentition of rural Guatemalan children ages 6 months to 7 years. *J Dent Res.* 1976;55:951-57.

[16] Johansson I, Lenanderer-Lumikari M, Saellstrom AK. Saliva composition in Indian children with chronic protein-energy malnutrition. *J Dent Res.* 1994;73:11–19.

[17] Alvarez J0, Lewis CA, Saman C, Caceda J. Chronic malnutrition, dental caries, and tooth exfoliation in Peruvian children aged 3-9 years. *Am J Clin Nuir.* 1988;48:368-72.

[18] Alvarez JO, Eguren JC, Caceda J, Navia JM. The effect of nutritional status on the age distribution of dental caries in the primary teeth. *J Dent Res.* 1990;69(9):1564-66.

[19] Jose o Alvarez. Nutrition, tooth development, and dental caries. *Am J Clin Nutr* 1995;61(suppl):410S-6S.

[20] Alvarez JO, Caceda J, Woolley TW, Carley KW, Baiocchi N, Caravedo L, Navia JM. A longitudinal study of dental caries in the primary teeth of children who suffered from infant malnutrition. *J Dent Res.* 1993;72(12):1573-76.

[21] Alvarez JO, Navia JM. Nutritional status, tooth eruption, and dental caries: a review. *Am J Clin Nutr.* 1989;49:417-26.

[22] Dr Hildebolt CF. Effect of Vitamin D and Calcium on Periodontitis. *Journal of Periodontology.* 2005;76(9):1576-87.

[23] Vitamin C, Oral scurvy and Periodontal disease. *S Afr Med J.* 1984. May 26;65(21):838-42.

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