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Nutrition and oral health

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What do you tell patients when they want to talk about foods and dental caries ? Would you advise them to kick the sweet-snack habit? Are sweet foods the only reason why dentits should be interested in nutrition? (1) Although sugar consumption promotes dental caries, (2) the relationship between diet and oral health is complex. This relationship between nutrition and oral diseases has often been confussing and misleading. Concepts dealing with nutrition and oral health have been as simple as recommending the elimination of sweet from the diets of children, while others have dealt this with more sophistication such as, the incorporation of balancing body chemistry into their dental practices.

An important step towards understanding the potential relationhship between diet and caries susceptibility is determining the influence of nutrients in prenatal as well as postnatal oral development (3,4,5,6,7,8,9). Understanding the mechanism involved in these systems is the basis for the implementation of nutritional therapy in comprehensive patient care. Practitioners should expand their nutritional information base and develop techniques to identify nutritional problems and disseminate appropriate dietary guidance to patients. (1)

The relationship of nutrition to oral health clearly indicates that there is a developmental component to oral diseases. It seems reasonable, therefore, that nutritional stresses during fetal development can increase the susceptibility to oral disease later in life. Considering the complexity of nutrient interaction in the maintenance of oral health, it is obvious that the question, " Do you eat a balanced diet?" is an inadequate approach to the assessment of nutritional status. It is important for the clinician to develop sound, scientifically tested and approved oral health diagnostics, general and oral nutrition knowledge and skills in order to provide adecuate oral health service. If improperly implemented, this scenario may lead to non-traditional anecdotal methodologies because of the growing interest in diet therapy in dentistry. (1)

Clearly, dental caries is the most prevalent of oral diseases and currently no cure exists. Studies have helped clarify the complex etiology of this disease. (4,8,10,11) However, despite extensive investigation, no epidemiological or clinical evidence exists that clearly relates diet to dental caries. Therefore, detailed studies of the possible influence of various nutrient components of foods, on the cariogenic process depends primarily on studies in animal model systems, in vivo plaque pH measurements and in situ remineralization/demineralization studies.

The development of the oral cavity involves a dynamic series of events that begin during the second month of intrauterine life.

During the 5th and 6th weeks of gestation, the building blocks of the dentition are being prepared. From an embryological point of view, the teeth are a mixed organ system being from two germinal layers, the ectoderm (enamel crown) and the mesoderm (dentin, cementum and pulp).

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The deciduous teeth have begun to form by the end of the second month of gestation and the permanent teeth by the end of the 5th month. The calcification of deciduous teeth begins at 20 weeks after conception, while permanent teeth do not calcify until after birth. (5) As in the case of all mineralization processes, a variety of nutrients, such as vitamin D, calcium and phosphorus, must be present in adequate levels before and shortly after birth for optimun calcification and tooth development to occur. Prenatal and postnatal development of teeth and salivary glands can be affected during critical periods when a stress, such as nutrient deprivation, is imposed. Irreversible changes in these oral tissues have been demostrated which later influence the capability of teeth to resist microbial challenges. (3,4,8)

PROTEIN

The effect of inadequate protein intake during growth and development generally results in stunted growth and impaired development of the oral tissues that are undergoing rapid growth. The most significant oral changes include:

1) altered salivary gland capacity,
2) delayed eruption of teeth,
3) smaller teeth and
4) increased caries susceptibility

These changes are observed in studies in which rats were fed diets deficient in protein during prenatal and postnatal periods of development. (4,13) The offspring of female rats fed a low-protein diet (8%) grew more slowly, were smaller and had significantly increased susceptibility to caries compared to control animals.(4) Moreover, when normal levels of calories, vitamins and minerals were restored in the diet of rats from low protein dams, caries susceptibility was not reduced. However, addition of 10% protein to these diets reduced caries susceptibility to normal levels. These studies appear to be particularly relevant to conditions in developing countries and in small pockets of malnutrition in the United States where analogous problems of neonatal malnutrition exist. Protein malnutrition during gestation and neonatal periods may result in high incidence of enamel defect and dental caries in the primary dentition. Indeed, the high incidence of a relatively common defect in the primary dentition (commonly called the "cauque" lesion) of children from developing countries, such as seen in Guatemala populations, may be related to neonatal infections and protein calorie malnutrition.(14)

VITAMIN A

An important role of vitamin A is maintenance of integrity of epithelial tissue in glycoprotein systhesis. The primary effects of vitamin A deficiency on tooth development and maintenance are:

1) prenatal malformation of mandibular incisor,
2) delayed prenatal odontogenesis,
3) ameloblastic atrophy,
4) poor odontoblastic differentiation and
5) enamel hypoplasia.

The incidence of developmental abnormalities on the surface of deciduous teeth has been investigated. This linear defect occurs primarily during the neonatal period and is characterized by a groove on the labial surface of the upper primary incisors. After tooth eruption, groowes becomes discolored, due to bacterial melanin-like deposits and/or food pigments, and, subsequently, decay to the point of clinical crow destuction.(14) This type of lesion is limited predominantly to children of lower socio-economic status in which the prevalence parallels that of protein-calorie malnutrition. For example, studies performed in low socio-economic groups in the Pacific lowlands of Guatemala suggest a hihg prevalence of this condition in the primary dentition of children.(15)

MINERALS

Calcium and Phosphorus

Ninety-nine percent of the calcium and seventy-five percent of the phosphorus in the body are found as constituents of bone and teeth. The primary inorganic constituents of bone and teeth are the same and consist of small crystals of calcium phosphate in the form of hydroxyapatite. Metabolically, however, an important difference between the response of bone compared to that of teeth was suggested when a diet with an adequate calcium to phosphorus ratio was fed to weanling rats which were calcium and phosphorus deficient at birth. The ash content of the bone returned to normal but that of the teeth formed during the prenatal and postnatal deprivation period remained low. On the other hand, in normally developed animals, a diet low in calcium or phosphorus content may cause demineralization of bone, yet no parallel reaction occurs in teeth already formed.(16) These results provide additional evidence of the importance of early development on the subsequent potential lifespan of the tooth.

The mechanism by which calcium and phosphorus restriction exerts an increased caries susceptibility is not well understood, especially during tooth development. However, studies in rodents have show that calcium to phosphorus ratio of the diet during this period is an important factor in determining the composition of the inorganic fraction of enamel and dentin. Studies have demostrated that rodents fed a diet deficient in calcium during early tooth development, but with a calcium to phosphorus ratio greatly exceeding those norrmally found in human diets, had significantly higher caries scores than

control and pair-fed groups. (17,18) Abnormal calcium to phosphorus ratios may cause changes in the carbonate conten of the tooth resulting in weakened mineral crystals and more permeable enamel. Early studies showed that diets with a high calcium to phosphorus ratio when fed to weanling rats resulted in teeth with a high carbonate to phosphorus ratio and greater susceptibility to tooth decay. (19,20,21) Other workers, however, did not confirm this. (16) The important contribution of these studies is that the composition of the mineral portion of enamel and dentin varies as a function of blood levels of these elements which, in turn, is dependent on the amounts supplied in the diet.

Finally, it is well recognized that a developed tooth undergoes a continuos process of remineralization and demineralization through ionic exchanges between the tooth and saliva. Therefore, over a long period of time, it is possible that the mineral composition of the outer enamel layer could be altered, leading to greater caries susceptibility by changes in calcium to phosphorus or phosphorus to carbonate ratio of diets. (16)

IRON

Studies suggest that low dietary iron can increase caries susceptibility.(8) When rats were fed a caries-promoting diet (56% sucrose) which was also low in iron, they developed typical signs of iron deficiency, such as stunted growth, iron deficiency anemia and skin lesions. In addition, however, they also developed loss of normal tooth pigmentation and alterations in salivary protein profiles. When normal levels of iron were restored to this diet, the above defects were corrected and the animals achieved normal growth patterns. Interestingly, restoring iron in this caries-promoting diet also resulted in over a 50% reduction in caries. Moreover, the diet exerted its greatest developmental effects during the neonatal period. Subsequent investigations using purified low-sucrose diets, which were only marginally deficient iron, have confirmed this important role for iron as a determinant in caries susceptibility. These studies appear particularly relevant when one considers that almost 90% of U.S. infants at one year of age did not achieve the Recommended Dietary Allowance for iron in the latter part of the 1970's.(22)

In a study done with 5-year old children whose mothers had been iron deficient during pregnancy, dental caries susceptibility was investigated as a function of deficiency.(9) This group was divided into two subgroups based on their hemoglobin levels at one year of age. These children were given a clinical examination (visual) and data was collected for anthropometrics measurements, dental indices, salivary profiles and blood parameters. Results from this data showed that children who had been diagnosed iron-deficient at one year of age (<12g hemoglobin/dl), when compared to their "normal" counterparts (>12g hemoglobin/dl) had significantly lower levels of: salivary amylase and other salivary proteins; increased salivary calcium and phosphate; and increased dental plaque indices. Although this subgroup was marginally anemic, they had markedly improved hemoglobin and hematocrit levels compared to their anemic condition at one year of age. These results suggest that iron deficiency at an early age, even when largely corrected, may lead to prolonged alterations in salivary function and hence, a greater susceptibility to dental caries.

FLUORIDE

Fluoride is a nutrient beneficial to dental health and it was included for the first time in the 1980 Recommended Dietary Allowances, which emphasizes its importance in the field of nutrition. (23) But the question, "Does it meet the criteria for being an essential nutrient for health?" has not been satisfactorily answered. Messer and Singer have concluded from the several lines of evidence dealing with fluoride's effect on growth rate, reproduction, hematopoiesis and mineralization that evidence does not justify fluoride's inclusion in the list of essential trace elements.(24) The reason for this is that no one has been able to produce a diet totally devoid of fluoride to determine whether a fluoride supplement can support the life process. A physiological or biochemical role that can be attributed to fluoride alone has not yet been described.

The single most important nutritional factor that will reduce the incidence of caries is the presence of optimal amounts of fluoride in the diet during the postnatal period when teeth are calcifying.(25) During calcification of teeth, fluoride takes the place of some of the hydroxyl groups normally found in the enamel crystals. About 5% of the enamel form as fluoroapatite, thus making enamel less soluble to the decay acids. (26,27,28) On the other hand, most cariologists believe that there is insufficient evidence to indicate much caries-preventive effect in both primary and permanet teeth when fluoride supplemented during the prenatal period, either via drinking water or by the use of fluoride's supplements.(29) Although all foods contain at least traces of fluoride, waterborne fluorides are generally the most important source for humans. Modern diets are becoming increasingly importan as a source of fluoride because of the increased use of fluoridated water in the preparation of processed food and beverages. The positive attributes of fluoride on postnatal tooth development is well documented, the optimal benefit of fluoride should not be thought of as involving water fluoridation alone since significant amounts of fluoride are found in certain components of the normal diet, such as fish (sardine, salmon, shrimp), tea, salt, milk, cereals and breads.[30]

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