Review

DIET AND ORAL HEALTH

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Abstract:
Oral health is related to diet in many ways. The objective of this paper is to review the evidence for an association between nutrition, diet and dental diseases and to recommend proper diet for their prevention. Nutrition affects the teeth during development and malnutrition may exacerbate periodontal and oral infectious diseases. However, the most significant effect of nutrition on teeth is the local action of diet in the mouth on the development of dental caries and enamel erosion. Dental erosion is increasing and is associated with dietary acids, a major source of which is soft drinks. There is convincing evidence, for an association between the amount and frequency of free sugars intake and dental caries. Although other fermentable carbohydrates may not be totally blameless, epidemiological studies show that consumption of starchy staple foods and fresh fruit are associated with low levels of dental caries. In addition, the frequency of consumption of foods containing free sugars should be limited to a maximum of 4 times per day. It is the responsibility of national authorities to ensure implementation of feasible fluoride programs.

Introduction

In most animals, teeth are essential for survival. They are necessary tools for preparing food for ingestion and a weapon for defense or attack. In most human societies now, by far the most important role for teeth is to enhance appearance. The one more attribute of teeth is their role in speech. Teeth are also essential for making certain sounds. These teeth are prone to injury and disease. Diet has a great influence on the etiology and control of dental and oral diseases.¹

Diet and nutrition in relation to oral health and disease
The study of nutritional influence on oral health requires consideration of three groups of oral tissues with different structure, morphology, metabolism and pathologic response.¹
1. The hard tissues (with implication for dental health)
2. The supporting structures of teeth (with implications for periodontal health)
3. The oral mucosa (with implications for mucosal health)
Nutritional systemic Vs dietary local effects

In their relationships, there is a peculiarity to be considered regarding the dental hard tissues and nutrition. Once the enamel is formed, it is no longer subject to systemic nutritional influence; however it is subject to dynamic exchange of jaws as well as organic molecules and particles with its oral environment.

The main result of nutrition is the systemic effect of the absorbed nutrients on growth, development and maintenance of tissues and organs and their specific functions. Local dietary side effects are of great practical importance in the oral cavity. Dental enamel, after eruption is particularly subject to local side effect from whatever may enter the mouth. Dietary components not only provide essential nutrients for tissues of the host, but also for bacteria in the oral cavity which use them as substrates if readily available. Besides indirect side effects, there are ‘direct side effect’ of nutrients exerted by their ion content, acidity and physical properties.

Pre-eruptive Vs Post-eruptive influences

It is important to differentiate between formative nutritional and post eruptive local influences. The effect of nutrition on formation is generally constructive. Since the tissues lining the oral cavity are part of the surface of our body, they are colonized by numerous species of micro organisms interacting with the food passing, and / or with the underlying structures.

If integrity is maintained, it will be the result of a continuous interaction of protective and destructive influences. The difficulty is that nutritive as well as local dietary protective and destructive factors both act on the same tissues and their respective effects can not be differentiated readily and assessed separately.

The fact is that the formative influences are effective in an early distinct period of development, and destructive influences usually do not start before exposure and functioning.

Special position of Enamel among the oral structures

With respect to the tissues of bone, periodontium, dentin and pulp, development and lifelong integrity as well as functioning are associated with systemic molecular and cellular reactions to variables associated with nutrition and medication, some of them interacting with oral factors and bacterial antigens. Teeth enamel, in contrast, is subject to systemic influences on its development before eruption only; after eruption it interacts exclusively with local (topical) environmental factors.

Dental Health and Caries risk factors

Dental caries is a bacterial plaque - dependent disease that is characterized by an intermittent demineralization of
enamel, dentin and/or cementum. To be more specific, it is the microbial disease which causes the demineralization of the inorganic and destruction of the organic structures of the teeth. Oral microorganisms, when organized in voluminous masses as in dental plaque on tooth surfaces, hydrolyze and metabolize sugars to form weak acids (mainly lactic acid) which slowly and intermittently demineralize the hard tissues underneath.

This utilization of some food components such as sugars by bacteria is a local side effect in the mouth during food passage, in contrast to the systemic effect of carbohydrates as a source of energy for the host. Carious demineralization is the result of a side effect.

The sugar and other carbohydrates exert no direct damaging effect on the teeth. During sleep and when no food is available, the acidogenic plaque bacteria can slowly metabolize and survive on a minimum supply of substrate derived form carbohydrate side chains of salivary mucins. At these low substrate concentrations, no cariogenic amounts of acid are formed. However oral acidogenic bacteria can handle substrate concentrations of a very large range from very low to very high, and to very high concentrations of sugars they react with acid formation immediately.

The demineralization is a diffusion controlled process resulting in an increase in pore volume only, without disintegration of the mineralized tissues, supply and access of saliva are important for remineralization between acid attacks because saliva contains buffering systems, and transports minerals and fluoride ions to the tooth - environment interface.

The attacks resulting in demineralization and remineralization resulting in repair are modified by a number of variables. The most important factor is the plaque, its thickness and bacterial composition. If there is no mature plaque present, there are no more than thin layers bacteria and no appreciable amount of acid formation.

This had been showed by Stephan and Millar as early as in 1943 who measured the acid formation on the teeth after rinsing with sugar solutions. They found immediate pH drop when thick plaque was present, no dangerous acidity could be detected on the cleaned surface.

**Dietary sugars and caries experience and the role of eating habits in the development of dental caries**

An association between intake of sugars and dental caries was first studied experimentally in the early 1950s in inmates of the Vipeholm asylum in Sweden. Studies conducted in 1960 and 1970 confirmed this relationship. The experiments showed that restriction of sugar intake to four main meals daily did not significantly increase the
baseline caries activity even if large amounts of sugar were given, whereas when between-meal sugar containing snacks were given daily, caries incidence rose dramatically.\(^3,4,5\)

**Cariogenicity of diets rich in carbohydrates other than sucrose**\(^6\)

Because of the special situations in developing countries, it seems appropriate also to consider constellations in which the cariogenic potential of certain foodstuffs can be isolated because they are the once preponderantly, or even solely used.

**Milk**

Lactose has repeatedly been reported to stand out among the major dietary sugars as being of markedly lower cariogenicity. One must keep in mind that this is based on the laboratory studies. Several papers on observations and in babies breast-fed over periods of a year or longer have shown that lactose in milk can be highly cariogenic when drunk frequently.\(^7\)

**Sugars in fresh fruits**

The saying ‘an apple a day keeps the doctor away’ may also apply to ‘keeping the dentist away’. However, these findings do not provide direct evidence of low cariogenicity of fruit-borne sugars since individuals who consume relatively high amounts of fresh fruit may differ in a number of other dietary and other hygiene variable which affect caries activity. The studies suggest that sugars contained in fruits may be even more cariogenic than extrinsic sugars.\(^5\)

Some fruits tend to cause only moderate falls in plaque pH. Apples, however, besides containing sometimes high concentrations of free acids, by virtue of their sugar content, can also give rise to formation of acids in the plaque. An apple contains 9 - 11% sugar, mostly fructose. It is interesting to note that the pH turned and remained low not only in plaque, but also in oral fluid in which the pH was monitored concomitantly. The studies suggest that there is no difference in acidogenicity of fruit-borne and dissolved or soluble sugars, although same properties of fruits appear favorable in theory. Some studies of caries in rats fed various fruits indicate that, apples, bananas and grapes can give rise to appreciable levels of caries, sometimes as much as or more than sucrose itself. Moreover, it has been demonstrated that fruit, especially citrus fruit, carry a risk of acid erosion of tooth enamel.

**Complex carbohydrates (starches)**\(^8,9\)

The idea behind recommendations to eat more food with complex carbohydrates is to reduce fat intake, because of the caries risk associated with consumption of sugars, sugars
are not recommended as energy providing substitutes for fat.

Acid formation can start surprisingly quickly after starchy food has got in contact with the dental plaque. Pollard et al, in 1993 tested the acidogencity of white bread, cooked spaghetti, cooked long - grain rice and many other starch products with and without added sugar. This showed that none of the test products was significantly different from 10 per cent sucrose solution. So there is no doubt that starches are acidogenic in the mouth. Imfeld in 1983 referred to a large number of animals experiments showing that cooked starch cannot be considered a non - cariogenic dietary component.

**The role and functions of non - fermentable sweeteners in relation to dental caries**

Sugar alcohols or polyols, with the pentitol xylitol and the hexitols sorbitol and mannitol are sweet, but not cariogenic or much less cariogenic than sugars. The stimulating effect of xylitol on salivary glands is established and it is well known that it can be taken up by oral bacteria, but because in the cells it has the form of a toxic xylitol phosphate it can not be further metabolized. Under certain growth conditions xylitol resistant mutants of mutans streptococci can emerge, but not all strains of these species show this phenomenon. If such a mutation occurs, the cell is unable to synthesise a cell wall transferase system necessary to transport the xylitol molecules inside. At the same time these resistant mutants of mutans streptococci seem to be less virulent which may result in a less cariogenic plaque flora. Modern 'non - caloric' artificial sweeteners such as asp-artame or cyclamate are not carbohydrates and therefore do not give rise to cariogenic acid formation in plaque.

**Dietary components increasing the risk of erosive loss of hard tissues**

Erosion is due to strong acid such as citric acid in fruit and acid beverages. Contact of the strong acid with teeth causes an immediate strong dissolution of the surface and mechanical fiction afterwards (teeth brushing after eating grape fruit or apple).

Regular removal of plaque even though is essential for prevention of caries and periodontal diseases; it increases the susceptibility of teeth surface to erosion. So it is important for the dental surgeon to instruct the patients regarding the correct time for daily oral hygiene practice. Not only the acid in the fruit and drinks is erosive, but all individuals addicted to eating raw vegetables and other unprocessed food run a very high risk of erosion.

Considering the positive health effect of fruit and vegetables it would not be feasible to advice against consuming them. The best compromise seems to advice people to avoid eating the same fruits every day. This is not only
in order to avoid erosion of teeth but also to make sure one gets all essential nutrients, vitamins and minerals.

**Nutrition and Periodontal disease**

Periodontal disease is likely to be the main cause of tooth loss in the world. In Periodontal disease there is downward migration of the epithelial attachment of gingiva to tooth, loss of fibres of the periodontal ligament, and resorption of the crest of the alveolar bone. This progresses down the root surface, so that more and more of the support for the tooth are lost.

The essential role of plaque in the etiology of gingivitis was clearly demonstrated by Loe et al in 1965 and Theilade in 1966. The transition of gingivitis to periodontal disease, which involves the breakdown of the periodontal tissues, has been demonstrated experimentally in humans.

The first step in the development of gingivitis is changes in the epithelium, which allows toxins produced by plaque organisms to permeate through the junctional epithelium and initiate an inflammatory response in the gingival connective tissue. As a result of this there will be:

1. Loss of connective tissue fibres between tooth, gingiva and bone.
2. Migration of crevicular epithelium down the root surface.
3. Resorption of the crest of the alveolar bone.
4. Pocket formation which allows plaque and calculus to spread further down the tooth root and become inaccessible to mechanical methods of removal.

**Relevance of nutrition**

A number of ways in which diet and nutrition may affect the disease can be identified.

Factors concerned with the pathogenesis of periodontal disease which may be influenced by diet and nutrition:
- Dental plaque
- Epithelial integrity
- Immune response
- Collagen formation and repair
- Bone formation and repair
- Food consistency (fibrous or soft)

**Physical character of the Diet**

Numerous experiments in animals have shown that the physical character of the diet may play some role in the accumulation of plaque and the development of gingivitis. Soft diets, although nutritionally adequate, may lead to plaque and calculus formation. Hard and fibrous foods provide surface cleansing action and stimulation, which result in less plaque and gingivitis even if the diet in nutritionally inadequate.

There are nutritional deficiencies that produce changes in the oral cavity including periodontal tissues, but there are no nutritional deficiencies that by themselves can cause gingivitis or
periodontitis, or pockets. There are however nutritional deficiencies that can affect the condition of the periodontium and thereby aggravate the injurious effects of local irritants and excessive occlusal forces. Theoretically, it can be assumed that there may be a “border zone” in which local irritants of insufficient severity could cause gingival and periodontal disorders if their effects upon the periodontium were aggravated by nutritional deficiencies. However, regarding the relationship between nutrition and periodontal health, it can be concluded as, periodontal diseases are caused by local inflammatory irritation due to overgrowth and differentiation of dental plaque, and not by systemic nutritional deficiencies. Therefore the rational method of prevention is regular cleaning of teeth and not dietary measure.\(^8\)

**Mucosal Health**

Diet and nutrition can affect the soft tissue by influencing plaque bacteria, and to some extent the immunological response as well as healing and repair. However in contrast to the retentive morphology of the teeth and periodontal structures, the mucosa self - cleans by desquamation of peripheral epithelial cells. This continuously minimizes the antigenic load of bacteria and food residues. Nevertheless, inflammatory reactions to bacterial colonization and / or infections occur, and soluble food components can cause irritations.\(^{13}\)

Precancerous lesions and oral cancer develop upon inherited predisposition and a variety of environmental agents, notably alcohol in high concentrations and tobacco, but also nutritional / dietary components.

**CONCLUSION**

In case of risk to mucosal health, medical rather than dental advice is appropriate. In addition to this question of competence, there is a practical aspect; the risk to develop pathology originating from the oral mucosa is high in elderly people and due to the high percentage of edentulates among them it is most likely that they see a medical doctor more often than a dentist.

**REFERENCES**


