DENTAL CARIES

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1. INTRODUCTION

Dental caries is an ecological disease in which the diet, the host and the microbial flora interact over a period of time in such a way as to encourage demineralisation of the tooth enamel with resultant caries formation. Dental caries is still one of the most common diseases in the world today. Until recently almost everyone had experienced tooth decay in their lifetime. However, today many people are caries free and there has been a 40-60 % reduction in the incidence of tooth decay around the Western world. Most developed countries and many non-industrialised countries are now well below the World Health Organisation goal of less than 3 decayed, missing or filled teeth per 12 year old child.

2. THE HOST

Teeth are composed of a thin layer (1-2mm) of dental enamel which forms the hard protective coating over the tooth. This consists mainly of calcium, phosphate and other ions in a structure known as "hydroxyapatite". Dental enamel is porous and is susceptible to acid dissolution during the process of demineralisation. This demineralisation process is offset by the repair process known as remineralisation. Tooth susceptibility varies among individuals. The reasons are not fully known, but influences include:

* Shape, size and order of the teeth which affect the "washing" effects of saliva. This is largely determined by hereditary factors.
* Salivary components which can be critical in controlling dental caries since they affect bacteria, immune status, plaque formation, and enamel structure and can neutralise acids. Saliva has a vital role in the balance between demineralisation and remineralisation. These salivary factors will be outlined in greater detail below.
* Enamel structure can be altered by a selection of mineral ions and fluoride, as well as by acid. The balance between demineralisation and remineralisation of the enamel determines whether caries occurs. Availability of fluoride favours remineralisation.

3. SALIVA

Saliva is the body's natural protective mechanism against decay. It contains salivary proteins which adsorb strongly onto the teeth, protecting enamel against acid dissolution. This adsorbed protective layer is referred to as the pellicle. Salivary proteins also act as antibacterial agents.

Saliva is the primary resource of calcium, phosphate and fluoride, the materials used to remineralise the enamel.

Saliva also acts quickly to clear away food debris from the mouth and to buffer the organic acids that are produced by the bacteria.
Saliva is therefore a very vital and complex material in the prevention of dental caries. Thus, salivary dysfunction can lead to rapid deterioration of dental enamel. Salivary dysfunction can occur whenever certain medications are taken or medical treatments such as radiotherapy are undergone.

4. THE BACTERIA

Dental caries will not occur if the oral cavity is free of bacteria. These bacteria are organised into a material known as dental plaque which is yellowish coloured film on the surface of the teeth. Of the many types of bacteria in the mouth, the most caries active appear to be *Streptococcus mutans, Lactobacillus spp., Veillonella spp. and Actinomyces spp.* These bacteria can be transferred from mother to child and are present at varying levels in all human mouths. A variety of carbohydrates provide substrates for these organisms to grow on and the waste products of their metabolism - acids - initiate the tooth decay process by dissolving tooth enamel.

Most research on the bacteriology of dental caries has focused on the ubiquitous *S. mutans* and its ability to ferment sucrose. This organism preferentially ferments sucrose to produce significant amounts of acid and extracellular polysaccharide (plaque). However, most researchers now agree that other organisms present in the mouth are capable of plaque formation and acid production from a variety of fermentable carbohydrate substrates besides sucrose which are present in the normal mixed diet.

5. THE ROLE OF THE DIET

The dietary components that contribute most to the caries process are fermentable carbohydrates. These need to be retained in the mouth long enough to be metabolised by oral bacteria (principally *Streptococcus mutans*, but others can be involved) to produce acid. The acid attacks the tooth enamel and gradually dissolves it (demineralisation). This demineralisation process is offset by the repair process known as remineralisation. The balance between remineralisation and demineralisation determines whether caries occurs.

Extensive data now exists to show that any foodstuff or drink containing fermentable

carbohydrate (sugars or cooked starches) has the potential to cause significant acid production, followed by demineralisation of the enamel.

Biochemical Studies: Studies of plaque pH both *in vivo* and *in vitro* have shown that all fermentable carbohydrates whether cooked starches, added or naturally occurring sugars - have the potential to cause acid production in the mouth.

The amount of carbohydrate is not important.

Animal Tests: The cariogenic potential of foods has been assessed using laboratory rats. Again, these tests demonstrate that all fermentable carbohydrate foods - whether cooked starches or sugars - have the potential to cause decay. Again the amount of carbohydrate is not important.

Food retention: The ability of a food to be retained in the mouth will alter its potential cariogenicity. Tests to determine food retention indicate that high sugar foods, often perceived to be sticky, are not necessarily retained in the mouth for a longer time. In practice starchy foods are retained longer in the oral cavity than some of the fast clearance sugary foods.

6. Frequency of Carbohydrate Intake

It is now widely recognised that it is not what one eats but how often carbohydrate is ingested that is the most significant dietary factor in the aetiology of dental caries. In subjects with normal salivary function an acid challenge occurs within 10 - 15 minutes after ingesting fermentable carbohydrate foods or drinks, and it lasts for between 30-60 minutes. Greater time between such acid attacks allows greater time for the repair process - remineralisation - to occur.

Although there is now a consensus that frequent eating of carbohydrate foods and drinks is the main dietary factor in the development of dental caries, no one has yet determined precisely how many occasions per day are safe for all individuals. It is, however, generally agreed that three meals plus three to four snacks per day is acceptable. Research is needed to further establish the dynamic interactions between frequency of eating/drinking and oral hygiene and the use of fluoride. There is however an increasingly recognised view that, provided that oral hygiene is adequate and the use of fluoride optimal, the frequency of eating diminishes in importance. This has been demonstrated in human studies in New Zealand, UK, USA, Spain, Sweden, Norway and Netherlands.

7. Sensible Snacking

It had been common practice among many in the dental profession to recommend that 'three meals a day' is safe for teeth, and 'snacking' is unacceptable. This advice is no longer given as such. Some reasons why the dental profession has modified their message are as follows:

1. It has been well documented that eating and drinking frequency has been increasing in most industrialised countries over the last few years, and that the 'three meals a day' pattern of eating has long been abandoned by most sectors of the population.

   This change in frequency has occurred over a period when the incidence of dental decay has declined. Sugar consumption has also remained static or increased.
   This would suggest that another factor - which most believe to be fluoride (especially in dentifrices) has counterbalanced and overridden the effect of increased frequency. This is well documented in Sweden, Norway, UK and Switzerland.

2. An experimental caries model has been developed in the US and the Netherlands which stimulates what happens in the human mouth, by alternating periods of demineralisation and remineralisation. The model has been used to mimic human eating experiences over a 24 hour period, and it demonstrated the power of fluoride to 'neutralise' the effect of frequent snacking. Where fluoride was used twice daily, there was less mineral loss following 10 challenges, than there was following 3 in the absence of fluoride.

8. HOW IMPORTANT IS DIET ?

In most industrialised countries, the percentage of the population that is caries free has been steadily increasing. It is generally accepted that the major factor has been the use of fluoride in water, toothpastes, mouth rinses, and tablets. This decline in caries has not been associated with any significant reduction in sugars ingestion or in snacking. In fact as noted above, while frequency of eating has generally increased, sugars consumption is either stable or increasing.

Additionally, recent epidemiological studies (UK, USA, Spain, New Zealand) have shown that in both children and adults, the total of all dietary factors examined (carbohydrate amount, type and frequency) accounted for only a very small increase in caries incidence. Dietary factors, although statistically significant were clinically insignificant as they were overridden by the effects of fluoride and oral hygiene programmes.

This contrasts markedly with the older studies of the pre-fluoride era where diet and particularly sugars intake was directly related to caries experience in most countries and in most population groups. Availability of fluoride, especially used topically in toothpastes, has brought about a dramatic change in the aetiology of the disease.

9. CARING FOR TEETH

Dental caries is primarily a disease of children and teenagers. Its causes are complex, but there are some quite simple methods for preventing it. This advice aslo applies to the adults who are increasingly suffering from decay because of the greater number of natural teeth that they maintain into adult and older life.

1. *Sensible eating:*
   Eat a well balanced diet which includes a variety of foods. 'Nibbling' or drinking constantly throughout the day should be avoided because it provides more opportunities for demineralisation and less time for remineralisation.

   Sensible snacking, that is six to seven eating occasions a day, is acceptable, but 'grazing' is not.

2. *Cleaning teeth:*
   Teeth should be cleaned thoroughly at least twice a day using a fluoride toothpaste. Brushing helps to remove the plaque and food particles from the tooth surface and flossing helps to remove the plaque and food particles from the areas between the teeth. Regular brushing, also keeps gums healthy. Fluoride in the toothpaste retards demineralisation and favours the remineralisation process and thus prevents caries.

3. *Visiting the dentist:*
   Visit the dentist for regular checkups and professional plaque removal.

10. IOCCC POSITION

The IOCCC welcomes the decline in dental caries around the world. The IOCCC supports all reasonable and scientifically valid efforts to reduce tooth decay. The optimal use of fluoride in toothpaste and mouthrinses is the most effective way of eliminating the disease, as has been noted in many epidemiological studies. The very substantial decline in caries incidence and prevalence in many parts of the world has generally been attributed to the use of fluoride toothpaste.

Dietary measures can play a part, but will depend on the reduction in frequency of intake of **all** fermentable carbohydrate foods and drinks whether cooked starches or sugars. There is no scientific evidence for asserting that confectionery is the main cause of tooth decay.

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