Dental Caries – A Strategic approach for prevention

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Abstract

Dental caries is a chronic, bio-behavioural disease that extends throughout the life span of human beings. Prevention of dental caries includes measures to prevent the occurrence of disease, such as risk factor reduction, but also to arrest the progress of disease and reduce consequences of the disease once it is established. Preventive measures like fluoride therapy and pit and fissure sealants have contributed a significant role in reducing the incidence of dental caries in the present scenario. The role of fluorides in caries prevention represents one of the most successful stories in general public health. The development of dental caries vaccine would create a revolution in preventive dentistry.

Keywords: Dental caries, Fluoride, Pit and fissure sealants, Caries vaccine

INTRODUCTION

Dental caries has evolved as a pilot for the significant progress in dentistry. Anthropological studies confirm the relative scarcity of dental caries before the turn of this millennium, when simple sugars were unavailable and dentistry essentially was nonexistent. Over the next 500 years, the incidence of caries increased with the introduction of dietary sugars. The presence of a carious tooth was considered to be a sign of gangrene, and extraction was the only available treatment. During the 1800s, debridement and restoration were introduced. Caries has historically been seen as a disease of the high income countries, with a low prevalence in poorer countries. The most obvious reason for this pattern is usually considered to be diet: high consumption of refined carbohydrates and other processed foods in the high income countries and hunting and subsistence farming in the low income countries. There is good evidence that this historical pattern was clearly changing by the later years of the twentieth century. First, there was evidence that caries experience in some low-income countries has risen in the years after World War II(1939-45),[1] although this change was by no means universal, with some populations, notably in Africa, remaining relatively unaffected.[2-6] The second change is the marked reduction in caries experience among children and young adults in high-income countries, a trend that first became evident in the late 1970s.[7]

Dental caries has evolved as a major public health problem in developing countries like India with the trend showing a constant increase. With the advent of fluoride, the caries prevalence was found to be decreasing to a significant level. The protective role of fluoride against dental caries was not recognized until the mid-1930s, when epidemiologic studies demonstrated that children drinking naturally fluoridated water had fewer cavities than those in matched populations with water supplies that were low in fluoride.[8] Today, even people who do not ingest fluoride-containing water, because of unavailability in their local area or perceived health risks, consume fluoride in

foods processed with water that contains fluoride. The low salivary concentrations of fluoride, provided by drinking water or processed foods, offer protection against caries for many people. As a result of fluoride use, dental caries rates have declined substantially.

FLUORIDE- AN ANTI-CARIOGENIC TOOL

Fluoride dentifrices

Clinical studies across the globe have shown that the use of fluoride containing toothpastes reduces the incidence of dental caries. Fluoridated toothpaste is recommended for all dentate persons, along with community water fluoridation, for the primary prevention of dental caries. Most toothpastes available in the market contain about 1,000 - 1,100 ppm fluoride. During a typical one minute brushing period, fluoride rapidly permeates the tooth and is taken up by the enamel as fluoroapatite, calcium fluoride or even free fluoride. Rinsing the mouth after brushing rapidly drops the salivary fluoride concentration to 1 ppm or less within 15 minutes.[9,10] However, the treated tooth enamel, and perhaps the oral mucosa, acts as a sink for fluoride and, subsequently, releases it to the oral cavity.[10] Analysis of saliva show that fluoride concentrations during the long periods between brushing range between 0.02 and 0.08 ppm.[9,10] During these intervals, this residual fluoride promotes the transfer of calcium and phosphate ions from saliva into the enamel. Because the concentration of calcium ions in saliva is low (up to 60 ppm in healthy people), the rate of remineralization is slow. Fluoridated toothpastes account for caries reduction in the range of 17% to 35%.[11]

Fluoride mouthrinses

Commercially available mouthrinses containing fluoride can be helpful in preventing dental caries. The FDA has approved neutral pH mouthrinses containing 0.02 percent sodium fluoride (90 ppm fluoride ion) or 0.05 percent sodium fluoride (226 ppm fluoride ion) and acidulated phosphate mouthrinses containing 0.22 percent sodium fluoride (100 ppm fluoride ion). Stannous fluoride also can be used in mouthrinse at a concentration of 0.1 percent (121 ppm fluoride ion).[11] Currently, however, the only fluoride mouthrinses marketed are those that contain 0.05 percent sodium fluoride at a neutral pH. Fluoride mouthrinses have been shown to raise the concentration of fluoride in saliva for several hours after use.[12-14] Even though the residual concentrations of fluoride in plaque and saliva are small, the modest elevation in fluoride concentration may be sufficient to boost the rate of remineralization and help inhibit caries development.[15-17, 12-14] Caries reduction has been shown to range from 30 to 50%.[18] Use of fluoride mouthrinses containing 0.05 percent sodium fluoride has been shown to raise salivary fluoride concentrations to a greater degree than brushing with conventional fluoride toothpastes.[13,14, 19] However, the combined use of fluoride rinse and conventional fluoride toothpaste does not result in further improvement in the level of fluoride retention.[13] It has been estimated on the basis of clinical studies that, when used, fluoride mouthrinses lead to an average reduction of 0.2 to 0.4 decayed, missing or filled surfaces per year in the average individual. This increases to more than 0.5 surfaces in adults older than 65 years of age and in children in nonfluoridated water areas. The use of a 0.5% daily rinse should routinely be advised for moderate or high caries risk patients over the age of 5 years. However, there is no clinical evidence as yet that fluoride mouthrinses actually provide additional benefits to people who regularly use a fluoride toothpaste.[20]

Multiple fluoride therapy

This program includes the application of fluoride in the dental office in the form of both a fluoride containing prophylactic paste and a topically applied fluoride solution and the home use of a fluoride dentifrice. In addition, some form of systemic fluoride ingestion, preferably community water fluoridation was included. The combination of topical fluoride applications and home use of fluoride dentifrice resulted in about 59% fewer carious lesions.

Pit and Fissure Sealants

Fluorides that protect the smooth surfaces of the teeth are less effective in protecting the occlusal surfaces.[21]The use of fluorides led to a large scale reduction of incidence in smooth surface caries but a smaller reduction in occlusal pit and fissure caries. The placement of pit and fissure sealants was found to be an effective method in preventing caries in the pits and fissures of teeth. The Cochrane review estimated that the caries preventive effect ranges from 87% at

12 months to 60% at 48-54 months.[22]Studies have demonstrated that bacteria in early caries beneath sealants decline in number when deprived of nutrients, but do not disappear entirely. Provided the sealants remain intact, caries does not progress, even if the disease is at a very advanced stage.[23] Pit and fissure sealants can thus be effectively used as a primary preventive agent and as a secondary preventive measure in early occlusal caries.

Protective Factors in Foods

Despite being one of the main sources of sugars in the diet of young children, cow's milk is non-cariogenic. The sugar in milk is lactose, which is the least cariogenic sugar, and milk is also known to contain protective factors. The non-cariogenic nature of milk can be attributed to the presence of calcium, phosphate and casein, and plaque pH and animal studies have confirmed its caries preventive nature. Recent epidemiological studies indicate a positive or neutral effect of cows milk consumption on caries.[24-25] Numerous animal studies and experimental studies have indicated that cheese is anticariogenic. Consumption of cheese increases oral pH by stimulating salivary flow and raises plaque calcium concentrations, both of which protect against demineralization. Cheese also contains caesin phosphopeptides, amorphous calcium phosphate nanocomplexes which play an important role in the remineralization process.[26]More recently, a study of 179 children aged 7 to 9 years, showed that consumption of 5 g of cheese following breakfast for a period of 2 years was effective in reducing caries.[27] In one extensive dietary survey it was shown that children who were caries-free consumed significantly more cheese than children who were more caries-prone.[28] Cheese is a good gustatory stimulant of salivary flow: consumption of a lump of cheese following a sugary snack almost abolishes the usual fall in plaque pH which follows sugar consumption.[29-31]

Futurist concepts of dental caries management

Currently scientific researches pertaining to the prevention of dental caries is progressing at a rapid pace throughout the world. Many of the clinical trials if proven successful would result in a drastic change in the field of preventive dentistry.

Chairside bacterial probes.

The use of chairside bacterial probes for assessing a patient's cariogenic bacterial challenge will be an essential component of caries management by risk assessment.

Dental Caries immunization.

In a program of dental caries management by risk assessment, it is logical that all available tools should be used. One such tool that has been investigated for many years is an immunization against dental caries. There are many obstacles to the success of immunization, as dental caries is not a systemic infection that can be dealt with simply by administering a specific antibiotic. The infection must be dealt with in the mouth, where the internal body fluids do not pass and, therefore, the normal immune response is not relevant. However, IgA that is produced by the saliva naturally can interfere with the colonization of the surface of the tooth by specific bacteria. Recent studies by Ma and colleague[32,33] have illustrated the effectiveness of specific IgA in the inhibition of recolonization of mutans streptococci. The next logical step is to use this technology as one of the tools for dental caries intervention. It is possible to use genetically engineered plants, such as tobacco to produce immunoglobulins.[33,34] A study is in progress at the University of California, San Francisco, to test IgA that has been produced using genetically engineered tobacco plants. At press time, the results were not known, but if the trial is successful, this IgA can be applied to the teeth after Chlorhexidine treatment has removed the cariogenic bacteria, with the aim of inhibiting future recolonization by mutans streptococci. Hillman and colleagues genetically engineered mutant of S.mutans that lacks lactate dehydrogenase, the enzyme that plays a crucial role in acid production. The mutant strain was established in rats and found to be non-cariogenic. The safety of the vaccine in humans is yet to be established.[35,36]

Laser treatment in prevention of dental caries.

In May 1997, the U.S. Food and Drug Administration approved the use of an erbium:yttriumaluminum- garnet, or Er:YAG, laser for use on teeth. This was the first approval for laser use on dental hard tissues. This laser was used

for the removal of dental caries and the cutting of sound tissue before the placement of restorations. Since then, other lasers have been approved for the same purpose, and additional hard-tissue uses are likely to be approved in the future, including the use of lasers for the inhibition of progression of dental caries by altering the composition of surface enamel or dentin mineral. Kantorowitz and colleagues [37] and Featherstone and colleagues[38] have studied the effects of lasers on hard tissues for almost 20 years. Their studies have demonstrated that specific pulsed carbon dioxide, or CO_2, laser treatment of dental enamel can inhibit subsequent caries like progression in a severe demineralization-remineralization model in the laboratory by up to 85 percent. They have demonstrated that carbonate is lost from the CAP mineral of the tooth during specific laser irradiation, making the mineral highly resistant to dissolution by acid. For practical purposes, it would be desirable to develop a laser that can remove carious tissue and subsequently be used to treat the walls of the area from which carious tissue is removed to make them resistant to subsequent caries challenge.

CONCLUSION

Current research into early caries detection techniques and a more comprehensive understanding of dental caries risk factors come at a time when new remineralizing and other topical treatments are becoming available. These developments will provide dentists with more effective preventive therapies and greatly improved nonsurgical treatment. The mechanism of dental caries is well-established to the point where new approaches are being made for caries prevention based on a scientific understanding of the processes involved. Several existing methodologies are available to enable successful management of dental caries by risk assessment. Understanding the balance between pathological factors and protective factors is the key. The development of newer caries preventive methods would contribute significantly to the reduction of the incidence of dental caries and to promote public oral health.

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