

## Caries Progression: How Can We Control this Disease?

Caroline Malavasi\*

Department of Dentistry, Federal University Fluminense, Rio de Janeiro, Brazil

\*Corresponding author: Caroline Malavasi, Department of Dentistry, Federal University Fluminense, Rio de Janeiro, Brazil, Tel: +0552199512; E-mail: carolinemalavasi@msn.com

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### Abstract

**Background study:** Dental caries is considered one of the most prevalent chronic oral diseases across the globe. In order to allow a comprehensive action and promoting health by the dentist, it is essential to know the process of development of this disease. It is necessary to understand the concept of caries and the mechanisms evolution involved in order to avoid its installation. Interfering adequately in its evolution and repairing consequent damages, it is possible follow the current philosophy of maximum dental preservation.

**Material and methods:** A literature review of articles published on PubMed was conducted. The selection criteria were: papers published and referring studies to dental caries progression and treatment over the last years.

**Conclusion:** Understand the complex biofilm that exists on tooth surfaces may hold the key to more effective control of dental caries by dentists. The dentist needs to know how to recognize the signs of caries disease and not only treat it with restorative procedures. Since caries can be reversible or irreversible it is necessary focus on prevention.

**Keywords:** Antimicrobials; Dental caries; Biofilm; Magnesium; Dental plaque; Dental materials

### Introduction

Dental caries is a disease of dental hard tissues and has been related to multi-factorial etiology, it is considered one of the most prevalent diseases (about 50%) in children across the globe [1]. Nowadays, in order to allow a comprehensive action and promoting health by the dentist, it is essential to understand the mechanisms involved in order to avoid caries development [2].

Caries is characterized as a dynamic process in which the presence of microorganisms, transmissible or not, present in the dental plaque, can lead to a disturbance of the balance between the mineral phase of the tooth and the surrounding environment through the production of acids by the microbiota [3].

In this way, it is the direct product of the continuous variation of oral cavity pH, being the result of successive cycles of demineralization and reprecipitation of minerals present in the saliva, such as calcium and phosphate, under the dental surface [4]. Consequently, the physiological balance of the reprocess can be restored and lead clinically to a "standstill" of the lesion.

These manifestations of carious lesions are characterized by their occurrence over time. Therefore, when planning the treatment of dental caries, the clinician should decide on the most appropriate procedure according to the clinical characteristics manifested and detected; and also regarding the characteristics referring to the health and customs of the host. The type of restorative material chosen and the ideal cavity preparation will be decided in each case according to a more conservative surgical therapy. The success of this therapy consists in the greater selectivity of carious tissue removal, a principle that is

based on the biological knowledge that the carious lesion is composed of two layers i.e., infected and affected.

The infected layer corresponds to the outer layer of carious dentin, is necrotic and irreversibly disorganized whereas the affected layer is located more internally to the infected dentin and is potentially remineralizable [5]. It is from this better understanding of the disease that minimally invasive methods can be successfully performed in the treatment of dental caries lesions, aiming at the removal of only infected dentin and minimal wear of the enamel, reducing the bacteria amount inside the cavity, without, causing the removal of remineralized carious tissue, that is, the affected dentin [6].

Patient characteristics such as: level of cariogenic activity found, presence of a balanced diet, frequency of meals, proper oral hygiene for plaque control, use of fluoride, among others, are the important factors that will consider the arresting of carious lesions in enamel and dentin [7]. It will be the degree of destruction caused by caries which determines whether the lesion can be remineralised or restored being an essential issue for the clinical routine of most dental surgeons [8].

Preventive measures will direct the progression of the lesion towards remineralization and continued preventive measures may lead to their control. Good cooperation between the dental surgeon and the patient will provide an excellent foundation for both prevention and control of early lesions [5]. If an injury is controlled, it is expected that there will be no progression over time, regardless of the stage at which control occurred. The point from which "there is no turning back" signifies the need for restoration, which is a crucial decision for any tooth.

Therefore, the ideal treatment is that directed to the control of caries disease and not only for the treatment of carious lesions. The purpose of this study is to review the important and determinant factors in caries disease progression in order to provide their arresting and to

describe the characteristics of mechanisms based on minimally invasive dentistry therapy.

## Caries Disease Development

The formation of a biofilm on the dental surface cannot be prevented in surface irregularities, such as occlusal fissures, or gingival or proximal niches [4]. In these areas, the occlusal function or the friction of the cheeks, lips and tongue does not occur [7].

All bacterial deposits, regardless of their maturation stage, are metabolically active. This metabolic activity will affect the underlying dental surface, and a plaque that has been formed for only a few days will produce a classic response of Stephan's curve in the presence of sugar. If, over time, irregular pH fluctuations are likely to result in mineral losses, the carious process will result in an obviously detectable lesion [9].

A dental surface covered by a biofilm that is metabolically active for long periods will be gradually chemically modified [2]. An example is biological apatite present in newly erupted dental enamel which contains various impurities such as carbonate and magnesium, leaving the crystal more soluble. If chemical conditions with constant pH variations prevail, a gradual loss of magnesium and carbonate on the surface of the enamel will occur [4,5]. This modification, therefore, can be considered as the earliest sign of the carious process.

Thus, by accepting that in any dental surface biofilm can be constantly formed and developed, these demineralization and remineralizations cannot be prevented, since they are an omnipresent and natural process [3,8]. However, its effects on dental surfaces may over time be influenced and metabolic processes modified [7]. Therefore, it is possible through the control of the disease to prevent the formation of cavities. Any injury at any stage of tissue destruction, not cavitated or cavitated, may be inactivated [5].

## The Control of Caries Disease Progression

Most disease control measures depend on the patient's degree of cooperation. Dental caries (progressing to the cavitation stage in the tooth) can be prevented in the majority of the population [10].

An assessment of each patient's disease risk and activity is a prerequisite to the appropriate treatment plan for each patient. Caries disease control comprises influencing the formation and development of biofilm and (or) modifying the dissolution kinetics of dental enamel apatites [11].

The following factors may reveal a significant role in this action:

- Mechanical and chemical removal of plaque (Oral hygiene)
- Chemical plaque changes (Antimicrobial use)
- Use of fluoride
- Diet composition
- Saliva composition

## Oral hygiene

Good dental plaque control should be the premise of non-invasive preventative treatment [10]. Teeth should be brushed at least once a day with fluoride dentifrices. Brushing acts on biofilm growth and fluoride slows the progression of the lesion. The quality of cleanliness, rather than frequency, seems to be more important [7].

The oral hygiene instruction should be directed to the entire oral cavity and also to a particular lesion. The patient should be instructed to start brushing first in the area where there is an injury, ensuring the necessary region cleansing. Enamel lesions are much better sanitized with yarn or dental tape, whereas, for root surfaces or proximal lesions, the interdental are better indicated [12].

For caries-active patients who do not have control over their plaque control and for patients with decreased salivary flow (<0.3 ml/min, a control through professional prophylaxis becomes necessary during a certain period [13]. Professional plaque removal significantly reduces the incidence of dental caries [7].

## Antimicrobial use

Nowadays, the odontology industry promotes different types of materials with antimicrobial properties like restorative products or solution products, that should be applied for limited periods, under specific conditions where rapid control of the cariogenic microbiota is necessary.

The antimicrobial agents are often used to control infection levels while other factors (eg dietary habits and plaque control) are gradually controlled. Some of these agents act on microbial cells by dissolving them while others can penetrate the cells and cause them to overflow or coagulate their vital constituents, destroying microorganisms [7,9,11].

One of the most commonly antimicrobial agents used for this control is chlorhexidine, because has the following properties: Substantivity to adsorbs mucosal surfaces and being teeth retained at inhibitory levels for long periods of time; predominant effect on mutans streptococci [14].

This antimicrobial agent may be presented in different forms. As solutions for mouthwash in concentrations of 0.12 to 0.2%; in gels in the concentration of 1%; in the form of varnish in concentration of 10% and recently, also inside restorative adhesive systems in concentration of 0,2%. Chlorhexidine can also be used in "shock therapies" when it is sought to rapidly reduce levels of infection in individuals with high caries activity. In these cases, the daily application of chlorhexidine gel (1%) is used in the office for 5 minutes for 2 weeks [15-17].

In addition to these development, others antibacterial components are added inside restorative dentistry materials formulations. Substances such quaternary ammonium methacrylates, dodecyl amine, bipyridine, tannic acid derivatives, polyhexanide, amphiphilic lipids, silver, sodium chloride gluconate, have been show improve the antibacterial effect and also shown ability to reduce restauration roughness, plaque retention and biofilm formation [18].

## Use of fluoride

Fluoride shows a decisive role in reducing the progression of caries lesions or dissolution of the enamel, acting as a cariostatic element, interfering in the dynamic balance of the interface between the mineral surface and the oral fluids, reducing the surface tension of the dental surface and, consequently, the adhesion of the microorganisms to the same. It also has an anti-enzymatic and antimicrobial effect and, at high concentrations, bactericidal effect [7].

When sugar is converted to acids by the dental plaque, it reaches a critical pH for the dissolution of the apatite-based minerals, but due to

the presence of fluorine, a certain amount of these minerals is simultaneously replaced in the form of fluorapatite. This action of fluoride depends on the salt used, concentration, duration and frequency of application. There is a consensus among researchers that the mechanism of action of fluoride is due to the supply in high frequency and low concentration, being important its presence in constant levels in the buccal cavity [3].

The concentration of fluoride in fluoride dentifrices varies from 0.025% (250 ppm F-) to 0.15% (1500 ppm F-), reaching even 0.50% (5000 ppm F-), for specific situations such as high caries risk patients [18,19]. Some studies have found that below 500 ppm F- there is no scientific evidence of a preventive effect. An example of this is the study carried out by Ammari et al. [20] that determine clinical efficacy of low fluoride concentration toothpaste (600 ppm or less) compared to 1000 ppm or more in dental caries prevention. They concluded that a dentifrice of 250 ppm of fluoride was not effective in preventing dental caries in the permanent dentition, contrary to the concentration of 1000 ppm of fluoride or higher.

Another form of fluoride application, is through mouthwash solutions. Recent studies have confirmed that topical fluoride treatment, like fluoride solutions for mouthwash, when used as a complement to oral hygiene with fluoridated dentifrice, result in a cavities inhibition in the order of 10 to 20%.

In addition to the daily use of fluoride dentifrices, fluoride gels are important for patients with high risk of caries and initial caries lesions, as well as for patients with ruptured caries, xerostomia, irradiated, orthodontic or hypersensitive [21]. In active-caries patients, it is essential to increase treatment with fluoride until the situation is under control.

Although a fluoride dose-response concentration makes regular effect on enamel and dentine demineralization reduction, a study by Fernández et al. [22] shows that the effect of fluoride is different on these dental substrates. While 450 ppm F produced a 60% demineralization reduction in enamel, in dentin this effect in the same percentage can only be obtained with 1350 ppm F.

This fact can be explained by the fact that dentin suffers twice as much demineralization as enamel, being considered more susceptible to caries [22-24].

Some clinical data [24-26] suggest that more fluoride would be needed to control root caries than that used for enamel caries. In addition, the difference in fluoride effect on dentin compared to enamel explains why the combination of professional application of fluoride with regular daily use of toothpaste with standard fluoride would be more effective to control caries in dentin [27], but not in enamel [28].

### Diet composition

Once a highly cariogenic microbiota is established, the chances of this microbiota suppression are more difficult [28]. Notwithstanding, it is known that reducing the frequency and sucrose amount in the diet is easier to reduce *S. mutans* proportion of relative to others commensal microorganisms [29].

Strict control of sucrose consumption may significantly influence the levels of mutans streptococci infection, but that control should be continuous [30]. This control was achieved not only by informing patients about the deleterious effects of sucrose consumption, but through detailed work on diet analysis and control, including:

Instruction not to eat foods with sucrose between meals, and reduction of sucrose concentrations ingested during main meals; Delivery of a detailed worksheet on sucrose concentrations in various food products; Request for the registration of all foods eaten during the day [7].

### Saliva composition

Patients who present xerostomia are a challenge for the dental surgeon, since the salivary stimulus can be considered preventive measure to caries disease. However, some patients with a moderate decrease in salivary secretion (saliva stimulated between 0.3 and 0.7 ml/min) may possibly control this situation by combining a better plaque control with fluoridated dentifrices and sugar intake.

Artificial saliva may help some patients, but relief of symptoms is usually temporary and patients may find these products unpleasant. Thus, it is important to check the pH of any saliva because very acidic products have been produced, and these would be an inadequate choice for dentate patients [30-32].

Other possibility, is the chewing gum use. It's may provide great relief for some patients who exhibit this dry mouth feature, particularly those caused by medications, since there is a need for glandular tissue sufficient to secrete saliva [32].

### Conclusion

Increased understanding of the complex biofilm that exists on tooth surfaces may hold the key to more effective control of dental caries by dentists.

The dentist needs to know how to recognize the signs of caries disease and not only treat it with restorative procedures. Since caries can be reversible or irreversible, it is necessary to focus on prevention. And for this, early detection and understanding of its progression mechanism are essential. As well as the domain and knowledge of possible effective alternatives to arresting dental caries disease.

It is important that there is more investment in clinical follow-ups and that the different alternatives proposed in this study are correctly indicated and monitored in vivo attempt effective results that can be better analyzed and compared over the years.

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