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Mini Review

Prevention of Oral Pathologies

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Abstract

Prevention includes bacterial reduction partially or totally, eliminating infectious disease, and implying the control or the eradication of specific colonizers. Prevention aims to prevent the re-emergence of oral bacteria. Glucosyltransferases (GTFs) are produced on tooth surfaces by specific species, namely the cariogenic mutans streptococci. The acid-producing bacteria rapidly metabolize these sugar-producing acids at the tooth surface. A pH value lower than 4.0 is observed at the tooth surface within a few minutes following exposure to sugar. Lactic, acetic, and formic are the most commonly detected acids. Initial attachment of *S. mutans* is followed by its accumulation and proliferation. Its leads to the formation of a sessile, exopolymer community known as a biofilm. Dietary factors are linked to the risk of caries. Sugars, both naturally occurring or added, and fermentable carbohydrates stimulate bacteria to produce acid and decrease the pH. Research has shown that when the intake of free sugars is <15 kg/person/year, the level of dental caries is low. The treatment of endodontic infection is mostly related to the control of the smear layer. The smear layer contains bacteria and their by-products. It prevents the penetration of intracanal medicaments into dentinal tubules and influences the adaptation of filling materials to the canal walls. Current methods of smear layer removal include chemical [chlorhexidine, sodium hypochlorite, chelating agents, organic acid (such as citric acid, polyacrylic acid, lactic and phosphoric acid), and tannic acid], and physical techniques. As antimicrobial irrigants, medicament vehicles are important. The vehicles include water-soluble substances, viscous and oil-based vehicles. Root canal irrigants, acting as topical agents during antimicrobial root canal therapy are aiming to reduce or eliminate microbial infection. All these methods may be associated and constitute the bulk of prevention.

Keywords: Prevention; Bacteria; Glucosyltransferases; Sugar-produced acids; Biofilm; Dietary factors smar layer; Antimicrobial irrigants; Reduction or elimination of bacteria

Introduction

Prevention includes eradication and/or firm reduction of the bacterial flora implicated in caries and/or periodontpathies. The actual question is: can we eliminate an infection? Can we reduce [chlorhexidine, sodium hypochlorite, chelating agents, organic acids (such as citric acid, polyacrylic acid, lactic and phosphoric acid), and tannic acid] the bacterial colonies implicated in dental cariesor periodontal lesions? A decisive answer can't be provided, but at the moment will be only an expectation.

Prevention in dentistry has two diverging targets: 1) the crown and root canal caries, and 2) periodontal diseases, despite the two pathologies display their own specific colonizers.

The eradication or the elimination of an infectious disease implies 1) either the complete removal or 2) the control and possible destruction of the agents involved in the pathologies [1]. At present, prevention in dentistry includes a series of measures taken to decrease or eliminate the microbial colonizers of the two major oral decays [2,3].

Some Definitions: Control and Eradication

Control means a public policy intervention that restricts the circulation of an infectious agent beyond the level that would result from spontaneous, individual behaviors and protect the patient against the pathogen. Eradication differs from control in that it is global. The term denotes the absence of human cases, includes a reservoir for the human organism, and absolute containment of any infectious source. Eradication permits control interventions. The control levels may vary, but a disease is either certified as eradicated or not.

The ultimate achievement of control is eradication. But not every disease can be controlled or can be eradicated. Control and eradication are the essential concepts, but two other terms bear to be mentioned. The first is elimination. Eradication programs have explicitly defined this term to denote the cessation of transmission of an organism. In contrast, eradication is defined as a global achievement. Like control, elimination is location-specific and would require ongoing interventions to be sustained in order to prevent reemergence of the disease from infected microbe importations. Two problems exist with the term elimination. First, it has been used to describe different phenomena. For example, some public health officials have promoted programs aiming at "eliminating a disease as a public health threat," which is interpreted as reducing incidence to an "acceptable" level but not necessarily to zero.

Second, the definition of the word elimination in common use, as applied to disease control, is indistinguishable from eradication [4].

Prevention of the Carious Disease

The total eradication of bacteria is irrealistic. Along this line, the prevention of the carious decay and other oral pathologies (e.g. periodontal disease) are hypothetical. On the other hand, control of endodontic bacteria can be performed when using root canal irrigants during root canal treatment. Such controls are efficient and combine with prevention [5].

Three major factors are involved in the carious process: the tooth structure (Pitts and fissures), plaque flora, and fermentable carbohydrates. To prevent dental caries, fluoride administration is efficient, together with fissure sealing, dietary selection avoiding

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fermentable carbohydrates, and plaque control [6].

Dental plaque bacteria are typical for bio films, creating its own hydrated exopolysaccharide matrix. They include glucans, which acts as a "glue". Sugar, especially sucrose, promotes this matrix formation. A group of enzymes, known as the Glucosyltransferases (GTFs), are produced on the tooth surface by specific species of oral bacteria, especially the cariogenic mutans streptococci. The acid-producing bacteria rapidly metabolize this sugar-producing acid at the tooth surface. The pH value slower than 4.0 are observed at the tooth surface within a few minutes following exposure to sugar. Lactic, acetic, and formic are the most commonly detected acids [7].

Streptococci Mutans (SM) are the most cariogenic highly acidogenic pathogens, producing short-chain carboxylic acids resulting from many cycles of de- and re-mineralization. The group of streptococci comprises several species. *S. mutans* (SM) and *S. sobrinus* (SS) are most important in terms of human caries.

Initial attachment of *S. mutans* is followed by its accumulation and proliferation, leading to the formation of a sessile, exopolymer community known as a biofilm. Dental biofilm formation occurs through a series of stages.

- The first stage involves deposition of an acquire dental-enamel pellicle. This cellular coating includes salivary components and bacterial constituents.
- The second stage involves the adherence and co-adherence of bacteria from the oral cavity with the aid of polysaccharides.
- Proliferation occurs in the third stage, whereas the biofilm reaches a steady state in relation to the surrounding environment.

Dietary factors reduce the risk of caries [8]. Sugars, both naturally occurring or added, and fermentable carbohydrates stimulate bacteria to produce acid and decrease the pH. Research has consistently shown that when the intake of free sugars is <15 kg/person/year, the level of dental caries is low.

The sugars consumed more commonly in the USA are the monosaccharides glucose and fructose. Fructose is less cariogenic than sucrose. In patients with excellent oral hygiene there is virtually no 'plaque' on the tooth surfaces and therefore SM may be below the detection level.

Free sugars, at even very low intake, are cariogenic [9]. They include the mono and disaccharides added to food plus those naturally present in honey, syrups fruit juices and concentrates. Sometime the term of fermentable carbohydrates is also used. The group of patients receiving xylitol developed very little caries compared with the sucrose group.

A sugar substitute is a food additive that duplicates the effect of sugar in taste, but usually has less food energy. Sugar substitute's are natural, as well as artificial and very much popular because of their beneficial effect on overall dental, as well as general health (Table 1) [10].

Table 1: Sugars substitutes.

	Caloric/nutritive sweetner	Non-caloric non-nutritive sweetner
1	Poly alcohols	Cyclamate
	Xylitol	
	Sorbitol	
2	Hydrogenated starch hydrolysates	Saccharin
	Lycasin	
	Palatinit	
3	Coupling sugars	Aspartame
	Sorbose	
	Palatinose	
		Sucralose
		Neotame

Antimicrobial and Root Canal Irrigants

The treatment of endodontic infection is mostly related to the control of the smear layer. The smear layer contains bacteria and their by-products. It prevents the penetration of intracanal medicaments into dentinal tubules and influences the adaptation of filling materials to the canal walls. Current methods of smear layer removal include chemical and physical techniques [11].

The smear layer is made of particles ranging in size from les0s than 0.5 μm to 15 μm. It contains also remnants of odontoblastic processes, pulp tissue and bacteria. The thickness of the smear layer is about 1 μm. Within the tubules, smear layer was found up to a depth of 40 μm (Table 2).

Table 2: Calcium hydroxide.

1	**The lethal effects of calcium hydroxide are due to several mechanisms, namely:**
	a) A chemical action through:
	Damage to the microbial cytoplasmic membrane by the direct action of hydroxyl ions,
	Suppression of enzyme activity and disruption of cellular metabolism,
	Inhibition of DNA replication by splitting DNA,
	b) Physically by:
	Acting as a physical barrier that fills the space within the canal and prevents the ingress of bacteria into the root canal system, and
	Killing the remaining micro-organisms by withholding substrates for growth and limiting space for multiplication.
2	**The biological properties of calcium hydroxide include:**
	Biocompatibility (due to its low solubility in water and limited diffusion),
	The ability to encourage periapical hard tissue healing around teeth with infected canals, and
	Inhibition of root resorption and stimulation of periapical healing after trauma.

Methods to remove the smear layer include chemical agents [chlorhexidine, sodium hypochlorite, chelating agents, organic acid (such as citric acid, polyacrylic acid, lactic and phosphoric acid), and tannic acid] [12].

The most widely used endodontic irrigant is 0.5% to 6.0% sodium hypochlorite (NaOCl), because of its bactericidal activity and ability to dissolve vital and necrotic organic tissues.

Other substances, such as Camphorated Paramonochlorophenol (CMCP) and metacresyl acetate, are known to possess also these properties. A number of phenolic derivatives, such as CMCP, camphorated phenol, thymol and eugenol have been extensively used in dentistry for many years [13].

Sodium hypochlorite

Sodium hypochlorite (NaOCl) is both an oxidizing and hydrolyzing agent. It is bactericidal and proteolytic. Sodium hypochlorite solutions have been used as endodontic irrigants. They are relatively cheap, bactericidal, and virucidal, dissolving proteins. They have a low viscosity, and a reasonable shelf life [14].

Chlorhexidine (CHX)

A 2% chlorhexidine solution is a potent antimicrobial agent. CHX has been used in endodontics as an irrigating substance or intracanal

medicament, as it possesses a wide range of antimicrobial activity, lower cytotoxicity than NaOCl whilst demonstrating efficient clinical performance, lubricating properties, rheological action. It inhibits metalloproteinases (Table 4) [15].

Other antimicrobial irrigants

Ethylenediaminetetraacetic Acid (EDTA) extracts bacterial surface proteins by combining with metal ions from the cell envelope. It leads to bacterial death. In addition to EDTA, citric acid can also be used for irrigation of the root canal to remove the smear layer. MTAD is a mixture of 3% doxycycline, 4.25% citric acid, and Tween-80, as detergent [16]. Tetracleanisa mixture of doxycycline hyclate. It is able to eliminate microorganisms and the smear layer in dentinal tubules of infected root canals. Clindamycinis effective against many of the endodontic pathogens. It is also an antimicrobial detergent. Triclosan and Gantrez® is a broad-spectrum antimicrobial agent. Evaluation of the Minimum Inhibitory Concentrations (MIC) and Minimum Bactericidal Concentrations (MBC) of triclosan and triclosan with Gantrez® seems efficient. Metronidazole, ozonated water, iodine compounds may also be used in this context (Table 3) [17].

As antimicrobial irrigants, medicament vehicles are important. The vehicles include water-soluble substances, viscous and oil-based vehicles. Root canal irrigants, acting as topical agents during antimicrobial root canal therapy are aiming to reduce or eliminate microbial infection. This also takes part to the oral prevention and prevents periapical acute or chronic infection [18].

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Table 3: Antimicrobial solutions as root canal irrigants**.**

1	**The requirements for root canal irrigants need to:**
	have a broad antimicrobial spectrum and high efficacy against anaerobic and facultative microorganisms organized in biofilms,
	dissolve necrotic pulp tissue remnants,
	inactivate endotoxins,
	prevent the formation of a smear layer during instrumentation or dissolve the latter once it has formed,
	Be systemically nontoxic,
	Be non caustic to periodontal tissues,
	Be little potential to cause an anaphylactic reaction.

Table 4: CHX as a canal irrigant.

CHX as a canal irrigant:
CHX is effective in the control of dental plaque and gingivitis, in the prevention and treatment of carie. It is used in endodontics as an irrigating substance, and a intracanal medicament.
CHX can be used in a liquid or gel presentation. The concentration most frequently used is 2%.
A shelf-life of at least 1 year can be expected, provided that the packaging is adequate and the liquid kept in a dark bottle.
The bactericidal effect of the drug is due to the cationic molecule binding to extra microbial complexes and negatively charged microbial cell walls.
CHX is bactericidal and effective against Gram-positive, Gram-negative, facultative and strict anaerobes, yeasts and fungi, particularly Candida albicans.
CHX shows substantively up to 12 weeks.
Although CHX is effective against bacterial biofilms, NaOCl is the only irrigation solution with the capacity of disrupting biofilms.
2% CHX have no detoxifying effect on endotoxins, but it improves CH properties of reducing the endotoxin content in root canals *in vitro*.
Canals medicated with CHX alone or in combination with CH delay the entrance of microorganisms through the coronal portion of the tooth into the root canal system.
Canals irrigated or medicated with CHX do not affect adversely the ability of root fillings to prevent penetration into the root canal system through the apical foramen.
CHX does not dissolve organic tissues.
CHX in contact with NaOCl, EDTA, saline and ethanol forms precipitate. However, no precipitate was observed when CHX was combined with citric acid, phosphoric acid or distilled water.
The *in vitro* and *in vivo* application of 2% CHX in cavities after acid etching and before hybridization with adhesive monomers prevents the loss of bond strength with time and preserves the integrity of the hybrid layer.
CHX does not interfere with the collagen present in the organic matrix of root dentin and inhibits MMPs.
2% CHX containing medicaments is able to diffuse into the dentin and reach the outer surface, exerting antimicrobial action.
CHX can be used during all phases of the root canal preparation, i) including the disinfection of the operative field, during the enlargement of the canals orifices and removal of necrotic tissues before root canal length determination; ii) in the chemo-mechanical preparation: alternating its use with an irrigation with an insert solution prior to the foraminal enlargement.
If it extrudes through the apex, during instrumentation and foramen enlargement, it does not induce pain, for being less irritating to the periapical tissues than NaOCl. CHX has been recommended as an alternative to NaOCl, especially in cases of open apex, root resorption, foramen enlargement and root perforation or in cases of allergy related to bleaching solutions.
No adverse effects have been published regarding CHX use as an irrigant or intracanal medicaments. CHX adverse effects are usually related to its topical or oral application, including transient taste disturbances and a burning sensation of the tongue. The incidence of skin irritation and hypersensitivity is low and the biocompatibility is acceptable [17].

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