

CHEMICO-MECHANICAL CARIES REMOVAL: A REVOLUTIONARY ALTERNATIVE FOR CONVENTIONAL METHOD

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Abstract

Dental caries is one of the most prevalent diseases present worldwide. The removal of caries with use of conventional method is an unpleasant experience. The pain caused because of thermal changes & vibrations during cavity cutting may cause discomfort to the patient. Various methods were introduced to overcome these problems but chemico-mechanical caries removal (CMCR) method holds a lot of promises as an effective alternative. This innovative method seems to be efficient in removing infected dentine without altering the healthy dental tissue or harming the adjacent oral mucosa, decreasing patient discomfort and providing a pleasant dental experience. Various CMCR agents with their method have been used in the past for the removal of the caries, but very few of them got into a stable clinical practice. Amongst them Carisolv is considered as the most successful and effective measure in removal of caries. Another revolutionary change was seen with emergence of the Papacarie. This brief review provides simple ideas about the benefits and the drawbacks about the CMCR and how to use these agents on clinical practice.

Key Words: - Papaine, Chemicomechanical caries removal, Caridex

Introduction

Mentioned history of the dental caries is as old as 5000 BC when Sumerian text describes a “tooth worm” as a cause of caries. At the earliest dental caries was treated with the bow drills operated perhaps, by skilled bead craftsmen.^{1,2}

Currently, conventional methods of caries removal are used which are carried out usually with high speed handpieces. This conventional method involves quick and efficient removal of the caries but it may also need use of local anesthesia to minimize the pain caused by the thermal changes and mechanical injuries to the dental pulp. The noise and vibration caused is the another shortcoming of the drilling. The main drawback of the conventional method is it will cause unnecessary irreversible damage to the healthy tooth structure.²

Now days the management of dental caries has drastically evolved from G.V. Black’s “Extension for prevention” to “Construction with conservation”. The concept of minimally invasive dentistry is evolving rapidly these days. It includes following techniques

- Air abrasion
- Atraumatic restorative technique
- Sono abrasion
- Lasers
- Chemicomechanical caries removal

Among all the above mentioned technique chemico-mechanical caries removal holds a lot of promises as an effective alternative to the traditional method of caries removal.³

THE CHEMO-MECHANICAL CARIES REMOVAL METHODS (CMCR)

Goldman (1970) an endodontist first developed the chemico-mechanical caries removal method by using sodium hypochloride (NaOCl). He first noticed that while using sodium hypochloride in root canal treatment it dissolves carious dentin and since that time the idea of chemico-mechanical caries removal born. However sodium hypochloride is too much of corrosive and it also has ability to decompose non necrotic tissue the idea of using it as chemico-mechanical caries removing agent was discarded.⁴

Subsequently sodium hypochloride was incorporated with Sorensen’s buffer (which contains glycine, sodium chloride and sodium hydroxide) this resulted in chlorination of glycine to form N-monochloroglycine (NMG) and the reagent which became known as GK-1019.

Proceeding further glycine was replaced by amino butyric acid, the product then being N-monochloroaminobutyric acid (NMAB) also called as GK-101E. After certain trials the first product launched into the market known as, “Caridex”^{5,6}

Caridex:

The NMAB system was patented in the US in 1975 and a further patent taken out by the National Patent Dental Corporation, New York in 1987. It received FDA approval for use in the USA in 1984 and was marketed in the 1980’s as Caridex.⁵

It was presented as a two-bottle system

- ⇒ Solution I: contains sodium hypochlorite
- ⇒ Solution II: contains glycine, amino-butyric acid, sodium chloride and sodium hydroxide.

The two solutions were mixed immediately before use to give the working reagent (pH approx. 11) which was stable for one hour.

The delivery system of Caridex consisted of a reservoir for the solution, heater and pump which passed the liquid warmed to the body temperature through a tube to a hand piece and applicator tip (20 gauge hypodermic needle, the tip of which had been modified into spoon shape). Caridex system was claimed to involve the chlorination and disruption of the partially degraded collagen fibres in carious dentine with NMAB. The carious dentine then becomes easier to remove by excavation using the modified needle tip.⁶

The advantage of this system includes reduced need for local anaesthesia, reduced risk of pulp exposure and also the conservation of healthy tooth structure. It is also helpful in treatment of medically compromised patients as well as pediatric patients. Although few patients complain of the unpleasant taste but the studies have shown that there is no toxic or any other adverse effects of it on healthy tissues and pulp. But this method also need rotary and hand instrument for removal of some amount of tooth structure.

The main drawback of the system is large volumes of solution were needed (200–500 ml) and the procedure was slow. Time taken for removal of the caries is also more because of these reasons caridex system was not popularized.⁵

Carisolv:

Another revolutionary change was seen with development of Carisolv. It is developed in close collaboration between universities, scientists and industry in Sweden. Carisolv is a patented product system, comprising two parts: a gel and specially-designed hand or power-operated instruments.

Carisolv® gel

The first marketed version of Carisolv® gel was red. In recent years, the gel has been further developed at the University of Göteborg, Sweden. To improve its efficacy, an increase of the amount of free chloramines was needed, which in turn required a higher concentration of NaOCl. One effect of the higher

concentration of NaOCl is that the colour agent has been removed, i.e. the gel is uncoloured.

Mode of Action:

The three amino acids present in cariosolve gel are differently charged, which allows for an electrostatic attraction to different areas of the proteins in the carious dentine. The peptide chains of all proteins, including collagen, are made up of hydrophilic (positively or negatively charged) and hydrophobic (non-charged) patches. So each of the three chloro-amino acids in Carisolv® electrostatically attracts one of these patches, effectively bringing reactive power to the full length of the target, the collagen fibre, while minimising unwanted side-reactions from hypochlorite.⁷

The system is marketed in two syringes, one containing 0.5% sodium hypochlorite solution and the other containing gel of the three amino acids. Carboxymethyl cellulose and erythrocin are also added to make the gel viscous and readily visible in use. The contents of the two syringes should be mixed immediately before use as its effectiveness begins to deteriorate after 20 minutes. The mixed gel is applied to the carious lesion for 30 seconds and then the carious dentine can be gently removed using *Carisolv* specially designed, non-traumatic hand instruments. The same procedure is continuously repeated until removing clear gel is achieved. The average time required for complete caries removal is about 9-12 minutes and the volume of gel utilized for this purpose is only 0.2-1.0 ml.⁴

The *Carisolv* system also seemed very successful in selective removal of carious dentine with no pain demonstrated and no need for local anaesthesia; however its slowness was the only apparent drawbacks.⁴

Papacarie®:

A research project in Brazil in 2003 led to the development of a new formula to universalize the use of chemomechanical method for caries removal commercially known as Papacarie®.

Papacarie® is basically comprised of papain, chloramines, toluidine blue, salts, thickening vehicle, which together are responsible for the Papacarie's bactericide, bacteriostatic and antiinflammatory characteristics.⁸

Comparison of Caridex and Carisolv⁵:

	Caridex	Carisolv
Solution I	1% NaOCL	0.5%NaOCL
Solution II	0.1 M Aminobutyric Acidglycine 0.1M NaCl 0.1 M NaOH	0.1M Glutamic Acid / Leucine/Lysine NaCl * NaOH *
Dye	-----	Erythrocin (Pink)
pH	11	11
Physical Properties	Liquid	Gel
Volume Needed	100-500 ml	0.2-1.0 ml
Time Required	5-15 mins	5-15 mins
Equipment Required	Applicator Unit	None
Instruments	Applicator Tips	Specially Designed
Time preparation Remains active after mixing	1 Hours	20 ins.
* Concentration not Stated		

PAPAIN

Papain is a proteolytic enzyme. It has bactericide, bacteriostatic and anti-inflammatory characteristics. Similarly to the human pepsin, papain acts as a debrillant anti-inflammatory agent which does not

damage the healthy tissue and accelerates the cicatricial process. Papain comes from the latex of the leaves and fruits of the green adult papaya. *Carica papaya*, for instance, is cultivated in tropical regions such as Brazil, India, South Africa, and Hawaii, and is largely used in the food, beverage, and drug industries.⁸

Certain clinical studies on patients with skin lesions caused by burns, observing that the enzymatic action of papain was considered excellent in areas with necrotic and purulent processes & also verified that papain aided cleansing necrotic tissue and secretions, shortening the period of tissue repair.^{9,10}

Papain facilitates the cleaning of both necrotic tissues and secretions. As a result, it decreases the time required for tissue recovery and does not damage the sound tissues around the lesion.¹¹

Chloramine

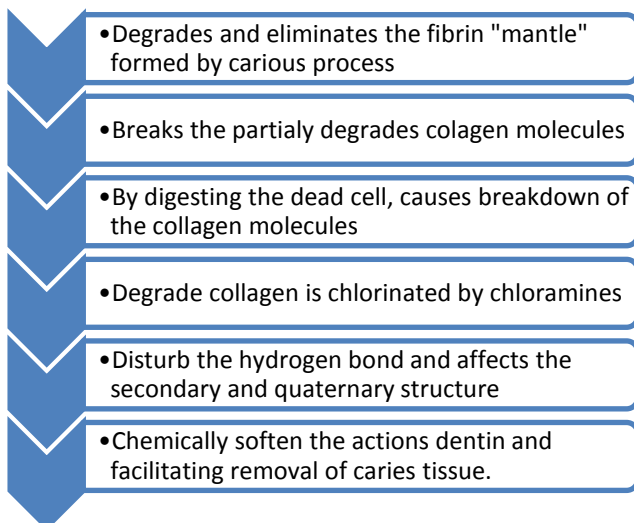
Chloramines are formed during a reaction between chlorine and ammonia. They have bactericide and disinfectant properties. Chloramines are widely used as an irrigating solution of radicular canals in order to chemically soften the carious dentine.^{8,12}

The application of chloramines resulted in the opening of dentinal tubules in the outer layer of carious dentin and occluded dentinal tubules were seen after sodium hypochlorite application.

Toluidine blue

Initially, the malachite green was used as colouring agent, however, after a few studies toluidine blue was found highly effective against *Streptococcus mutans*. Toluidine blue is a photosensitive pigment that fixes into the bacterial membrane.¹²

Mechanism of action of Papacarie®



Material Presentation

Papacarie® is a gel syringes that have 3 ml of solution.

Instructions for Use⁸

The use of Papacarie® for carious tissue removal must be done in accordance with the following methodology:

- ⇒ Radiograph of the target tooth;
- ⇒ Prophylaxis of the region using rubber cup and slurry of pumice;
- ⇒ Isolation of target tooth
- ⇒ Application of Papacarie® for 30 to 40 seconds
- ⇒ Removal of the softened carious dentin using the opposite side of the excavator and promoting a pendulum movement. The softened tissue must be scraped, but not cut
- ⇒ Application of gel, if necessary
- ⇒ vitreous appearance when the cavity feels free from caries
- ⇒ Rinsing 0.12%, 1% or 2% chlorhexidine or water spray
- ⇒ Drying with moisture-free and oil-free air
- ⇒ Restoration with a suitable filling material

Papacarie is a biocompatible material and also have antibacterial properties. It removes only the compromised tissue, and preserves the healthy tissue and also there is no need of local anaesthesia. It is less painful, noise and vibration free and also provides comfort to the patients.

Conclusion:

In opinion of many of the peoples, "Dental procedure is the most painful procedure they have ever faced." Fear and anxiety is mainly because of the injection site and the noise caused by the cavity cutting. These drawbacks can be easily eliminated using Chemo-mechanical caries removal methods. In the past Caisolv is used effectively in treating dental caries and currently Papacarie is gaining popularity with the same. It also helps in instillation of positive attitude towards the dental treatments in patients mind and in creating a healthy smile.

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