

Chemicomechanical Caries Removal; A Promising Revolution: Say No to Dental Drills

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ABSTRACT

The foundation for all that exists in dentistry today was laid with the principle of GV Black's "Extension for Prevention". However, now are the days of maximum conservation of tooth structure, giving rise to the principle of "prevention of extension". Dentistry has evolved significantly in the last decennium and the demand for painless, high precision and extremely conservative dentistry has taken the front seat. Conventional method involves quick and efficient removal of the caries but it may also cause unnecessary irreversible damage to the healthy tooth structure. Various methods were introduced to overcome these problems but chemicomechanical caries removal methods have proven to be an effective alternative. This article throws light on chemicomechanical caries removal methods that holds a lot of promise as an effective substitute to the customary methods of caries removal in the field of paediatric dentistry.

KEYWORDS: Chemicomechanical Caries Removal, Caries, Paediatric Dentistry

INTRODUCTION

Caries continues to affect a significant portion of the world population and treatment of the decay is associated with pain by many patients. Dental caries is a major cause of pain and infection, which can have critical consequences on the quality of life of the affected children and their parents.¹

Conventional caries removal and cavity preparation necessitates the use of tungsten carbide burs. Modern high speed drills are the latest development of this more than a century old technique.² It's being considered as a blessing to the dentistry, with certain assets such as precision cutting, tactile sensation of the extent of cutting whereas pitfall of this system included unpleasant experience, need of local anesthesia, thermal insult to the pulp, excessive loss of sound tooth structure.

As a result, there is a growing desire for procedures or materials that facilitate caries management. The chemo-mechanical method for caries removal was developed to overcome these drawbacks and it holds a lot of promise as an effective alternative to the traditional methods of caries removal.³ It is not only more comfortable for the patient but also able to better preserve the healthy tissue. These are, in brief, some of the methods that abolish the use of the beloved turbines and are extremely conservative.

CHEMICO-MECHANICAL CARIES REMOVAL METHODS

The principal on which chemo-mechanical method for

caries removal work are based on studies by Goldman and Kronman working in New Jersey, U.S in the early 1970's. Goldman (1970) an endodontist first developed the chemicomechanical caries removal method by using sodium hypochloride (NaOCl).⁴

Since then, many studies have being attempted to improve this century old technique. The sole use of 5% sodium hypochlorite was known to be toxic and aggressive to healthy and sound tissues. Therefore, a new solution was developed by adding sodium hydroxide, sodium chloride and glycine to the 5% sodium hypochlorite solution. This modified formula was known as GK-1019 and it was comprised of N-monochloroglycine.⁵ However, further discoveries revealed that aminobutyric acid was more competent than glycine and the brand new product then formed was known as N- monochloroaminobutyric acid also nominated as GK- 101 E.

Originally it was thought that the procedure involved chlorination of the partially degraded collagen in the carious lesion and the conversion of hydroxyproline to pyrrole-2-carboxylic acid.⁶ More recent work suggests that cleavage by oxidation of glycine residues could also be involved which causes disruption of the collagen fibrils making them more friable and easy to remove.⁷

After certain trials the first product launched into the market known as, "Caridex".⁸

CARIDEX

It was patented in the US in 1975 and a further patent

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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.⁸ Caridex was developed from a formula made of N-monochloroglycine and amino butyric acid.⁹

The system was granted in the form of two bottles, solution I having sodium hypochlorite and solution II having glycine, aminobutyric acid, sodium chloride and sodium hydroxide.

Contents of the two bottles were assimilated promptly before use to give the working reagent (pH 11) which was stable for approximately one hour.

Caridex claimed to involve the chlorination and disruption of the partially degraded collagen fibres in carious dentine. The carious dentine then becomes easier to remove by excavation using the modified needle tip.¹⁰

Despite its effectiveness, Caridex had certain clinical pitfalls such as¹⁰

- It was expensive
- It required a large reservoir with pump
- It demanded ample amounts of solution
- It had a displeasing aftertaste and
- It had a short shelf life.

CARISOLV

Medi Team in Sweden continued to work on the Caridex system and resulted in the launch of chemico-mechanical caries removal reagent known as Carisolv in January 1998. Carisolv reached the market promising to be more effective and easy to manipulate. The fundamental dissimilarity between Carisolv and other products already in the market was the use of three amino acids – lysine, leucine and glutamic acid– instead of the amino butyric acid. These amino acids counteracted the sodium hypochlorite aggressive behavior at the oral healthy tissues.¹¹

The entity is retailed in the form of two syringes:

- Syringe I- containing 0.5% sodium hypochlorite solution .
- Syringe II- gel consisting of three amino acids.

Carboxymethyl cellulose and erythrocin were also added to make the gel viscous and readily visible in use. The ingredients should be blended shortly before use as it will decrease its effectiveness after 20 minutes.

The mixed gel is applied to the carious lesion for 30 seconds and then the carious portion can be gently removed using specially designed, non-traumatic hand instruments. The same procedure is consecutively repeated until removing clear gel is accomplished. 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. Undeterred by its effectiveness, Carisolv was not a blockbuster chiefly because it enforced:

- Comprehensive guidance and trained authorities are needed and
- Customized instruments which increased the cost of the solution.

PAPACARIE

In 2003, a research project in Brazil led to the development of a new formula to globalize the use of chemo-mechanical method for caries removal and promote its use in public health. The contemporary blueprint was marketed as Papacarie. Papacarie is intrinsically formed of papain gel, chloramines, toluidine blue, salts, thickening agent which altogether idiosyncratically to its antibacterial and anti-inflammatory features. Commercially available as a gel syringes that have 3 ml of solution.

PAPAIN

Papain comes from the latex of the leaves and fruits of the green adult papaya.^{12,13} Papain is a proteolytic enzyme and an endoprotein similar to human pepsin. Papain acts as a debriding, anti-inflammatory agent which does not damage the sound tissue and hastens the cicatricial process.

Clinical studies had been reported where papain has shown excellent results in skin lesions caused by burns, areas with necrotic and purulent processes, aided cleansing of necrotic tissue and secretions and shortening the period of tissue repair.^{14,15} Flindt established that papain executes only in infected tissues because infected tissues lack a plasmatic anti protease called a1-antitrypsin. The a1-antitrypsin is only present in sound tissues and it restrains protein digestion. Because of unavailability of the a1-anti-trypsin in infected tissues papain is able to rupture the partially degraded collagen molecules.^{16,17}

Dawkins concluded that Carica papaya contain antibacterial activity that inhibits growth of gram-positive and gram-negative organisms. (*S. aureus*, *E. coli*, *B. cereus*, *P. aeruginosa* and *S. flexneri*).¹⁸

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CHLORAMINES

Chloramines are formed due to the reaction between chlorine and ammonia. They have bactericidal and disinfectant properties. Fuursted *et al* compared five antiseptics (chloramines T, chlorhexidine, povidone-iodine, phenoxyethanol and mandelic-lactic acid) on the basis of lag of regrowth and the antibacterial action contrary to nine bacterial pathogens.

Results showed that the chloramines T and mandelic-lactic acid induced a somewhat longer lag as compared with the other agents.¹⁹ Chloramines are customarily used to chemically soften the carious dentin. According to Maragakis *et al* chemo-mechanical caries removal solutions acts by chlorinating the partially degraded collagen in carious dentin.²⁰

Tonami's study disclosed that chloramines resulted in the opening of dentinal tubules in the outer layer of carious dentin as compared to sodium hypochlorite application which resulted in occluded dentinal tubules.

TOLUIDINE BLUE

Originally, the malachite green was used as colouring agent, nonetheless, 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.²¹

MECHANISM OF ACTION

The mixed gel is applied to the carious lesion for 30- 40 seconds and then the carious portion can be gently removed using specially designed, non-traumatic hand instruments.

Degrades and eliminates the fibrin "mantle" formed by carious

process



Breaks the partially degraded collagen molecules



By digesting the dead cell, causes breakdown of the collagen molecules



Degraded collagen is chlorinated by chloramines



Disturb the hydrogen bond and affects the secondary and quaternary structure



Chemically soften the carious dentin and facilitating removal of caries tissue.

APACARIES GEL

Apacaries gel is a novel dental material and composed of

a mixture of polyphenol from mangosteen extracts and papain in a gel preparation.

Mangosteen pericarp extract, which contains alpha mangostin, was active against *S. mutans* strain ATCC25175. *In vitro* study depicted that 1mg/ml of mangosteen extract can reduce *S. mutans* by 50% within approximately 5 seconds, after this the bacterial count drops to 0 after 60 seconds. Combination of mangosteen extract and papain gel created a larger zone of inhibition as compared to using mangosteen and papain gel separately.²² Papain activity can hydrolyse the proteins in the outer portion of gram-negative bacteria and, as a result, perturbs the membrane permeability.²³

Apacarie gel is a biocompatible material and also has antibacterial characters. The mixed gel is applied to the carious lesion for 40 seconds and then the carious portion can be gently removed using hand instruments. It removes only the compromised tissue, and preserves the healthy tissue and also there is no need of local anesthesia. It is less painful, noise and vibration free and also provides serenity to the patients.

CONCLUSION

In panorama of major population "Dental venture is one of the most arduous procedure they have ever experienced." The injection site, noise and vibration caused by dental drilling machines is the most well known cause of fear and anxiety.

These stumbling blocks can be easily eliminated using novel techniques such as air abrasion with aluminium oxide, chemomechanical caries removal, atraumatic restorative therapy (ART)²⁴ and most recently, lasers.²⁵ Out of these techniques air abrasion, sono abrasion, ultrasonic instrumentation and lasers are cost sensitive and tooth effective methods hence are not frequently used.

Chemomechanical caries removal methods does not use a slow-speed handpiece and round bur, so one might wonder if it might be a more patient-friendly technique and thus a preferable alternative to traditional method. This outcome could be especially important when treating paediatric patients.

Chemomechanical caries removal methods works on the art of using a selective reagent which will degrade and partially solubilises degraded dentine collagen present in the tooth. The chemo-mechanical caries removal methods has been an explication for the treatment of patients pursuing substitutes to conventional methods.

The key supremacy offered by the chemo-mechanical method are (i) its affirmed capability, (ii) the method's assurance, (iii) omission of local anesthesia and bur, (iv) the reduced level of dental anxiety and (v) the preserval of the sound tissue.

The chemicomechanical caries removal methods offers considerable attractions in certain cases, but if such a

system is to be used frequently it may need to be more expeditious in its form of functioning.

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