Papacarie: A Chemomechanical Caries Removal Agent

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Chemomechanical caries removal (CMCR) is a noninvasive technique eliminating infected dentine via a chemical agent. The objective of CMCR is to eliminate the outer layer or infected dentin, leaving the affected layer or partly demineralized dentin, which can be remineralized and repaired. As this process based on minimally invasive dentistry, it not only removes infected tissues, also preserves healthy dental structure, avoiding pulp irritation and patient discomfort. This is a method of caries removal based on dissolution. Instead of drilling, this method uses a chemical agent assisted by an a traumatic mechanical force to remove soft carious structure. The chemomechanical method for caries removal is most outstanding among other alternative methods. This paper reviews one of the chemomechanical removal agent, Papacarie.

Keywords: Chemo-mechanical, Caries removal, Infected dentin, Papacarie

INTRODUCTION

Chemomechanical caries removal (CMCR), a method for minimally-invasive, gentle dentine caries removal based on biological principles.1 The objective of chemomechanical agents is to remove the infected layer, leaving the affected demineralized dentin that is capable of being remineralized and repaired. CMCR agents act by causing degradation of the partially degraded collagen in the infected dentine, without causing any damage to normal dentinal tissues. The technique involves applying of solution/gel to the carious dentin, allowing it to soften the tissue, and, finally, scraping it off with special hand instruments.

CMCR technique produces irregular and rough dentinal surface with no smear layer, which is well suited to modern adhesive restorative material.2

The concept of minimal invasive dentistry (MID) has gained popularity with the development of new dental restorative materials, a better understanding of the caries process and the tooth’s potential for remineralization. The management of dental caries has drastically evolved from G.V. Black’s “Extension for prevention” to “Construction with conservation.” In the present scenario, the focus is mainly on maximum conservation of demineralized, non cavitated enamel and dentin.3 CMCR is based on the concepts of MID. The CMCR technique applied with the intention to remove adequate quantities of carious dentin and at the same time preserve healthy tooth tissue and to offer more patient-friendly care to fearful patients.

DEVELOPMENT OF AGENTS

The idea of chemo-mechanical caries removal was developed in 1970s by Goldman, who was an endodontics, while using sodium hypochlorite (NaOCl) in removing organic materials in the root canals. This chemical has the ability to dissolve carious dentine and since then, the idea of removing caries chemically was borne.3 Sodium hypochlorite, however, was too corrosive in nature for use on healthy tissue and very unstable. Hence, they decided to incorporate it into Sorensen’s buffer (which contains glycine, sodium chloride [NaCl] and sodium hydroxide [NaOH]) in an attempt to minimize this problem.

Quite fortuitously, a reaction occurred which resulted in a product which was more effective in the removal of carious dentine than a saline placebo. This involved the chlorination of glycine to form N-monochloroglycine (NMG) and the reagent subsequently became known as GK-101 (composed of: NaOH, NaCl, glycine, and 0.05% of NaOCl) and marketed in 1972 as “first CMCR agent” developed by Goldman and Kronman. According to Kurosaki et al. GK-101 would soften...
only the first layer of carious dentine and would not affect the second layer, and it has a very slow action. It was the major disadvantage and limitation of the GK-101.4,6

In subsequent studies, they found that the system was more effective if glycine was replaced by amino butyric acid; the product then being N-mono chloroaminobutyric acid (NMAB). It was ethyl derivative of NMG and was designated as GK-101 E in 1975. Because of the addition of an ethyl group GK-101 was renamed as GK-101 E. GK-101 E was faster in its action compared to GK-101.7,8

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 food and drug administration approval for use in the USA in 1984 and was marketed in the US in 1985 as Caridex. Caridex developed by Schutzbank et al. actually a modification of GK-101.9 Its clinical failure was due to more time required for its action, its short shelf life, and its high cost. An additional attempt was made to improve the NMAB reagent by the addition of urea in its formula by Yip et al. in 1995. The action of this modification involves the two amino groups of urea being chlorinated by sodium hypochlorite to form mono or dichloro derivatives. Addition of urea enhanced its efficacy.

During this time, then team, Mediteam in Sweden continued to work on a system and CMCR agent known as Carisolv hit the headlines in January 1998. It contains two components. One component primarily contains three amino acids, and other contains sodium hypochlorite. The reaction of three amino acids with sodium hypochlorite neutralized the aggressive effect in sound tissues. The chemical action of Carisolv is similar to that of Caridex in softening the carious dentin but leaving the healthy dentin unaffected, new system is marketed in two syringes, one containing 0.5% sodium hypochlorite solution and the other containing pink gel of the three amino acids.

Considering the disadvantages of Carisolv due to its longer action time, a gel was developed known as Papacarie by Silva et al.7

**PAPACARIE**

In Brazil 2003, formula eacao by Sao Paulo, first time introduced papain gel commercially known as Papacarie (a word that means “eating caries”) for CMCR agent.7,10,11 Papacarie is a national product; patented, registered and approved by ANVISA in Brazil (Figure 1).

**COMPOSITION**

Its main components are papain, chloramine and toluidine blue.

![Figure 1: Papacarie agent](image)

**Papain**

Papain is a proteolytic enzyme. It has bactericide, bacteriostatic and anti-inflammatory characteristics. It is an endoprotein similar to human pepsin, papain acts as a debriding anti-inflammatory which does not damage the healthy tissue and accelerates the cicatrival process. Papain extracted from the latex of leaves and fruits of the adult green papaya, Carica papaya. It is cultivated in tropical regions such as Brazil, India, South Africa, and Hawaii, and is largely used in the food, beverage, and drug industries.10

Papain accelerates the cicatrival process. According to mandelbaum, pappain is indicated in all phases of the cicatral process; dry or exudative wounds, colonized or infected, with or without areas of necrosis. Papain promotes (i) chemical debridement, (ii) granulation and epithelialization, which hastens the phases of cicartrization and (iii) stimulation of the tensile strength of the scars.

The topical use of papain softens scabs of lesions and can cause borders to break loose. Papain acts only on infected tissues which lacks the plasmatic protease inhibitor alpha-1-antitrypsin. The alpha-1-antitrypsin is only present in sound tissues and it inhibits protein digestion. The absence of alpha-1-antitrypsin in infected tissues allows papain to break the partially degraded collagen molecules.

It acts by cleaving collagen molecules partially destroyed by the action of caries, and is able to digest dead cells and eliminating the fibrin coat formed by the caries process. Studies conducted by Emeruwa also showed significant antibacterial activity of C. papaya fruit against both Gram-positive and Gram-negative bacteria (Staphylococcus aureus, Escherichia coli, Bacillus cereus, Pseudomonas aeruginosa and Shigella flexneri).1

**Chloramine**

Formed during reaction between chlorine and ammonia. Chloramines are amines which contain at least one chlorine atom, which is directly bonded to nitrogen atoms. Chloramines have bactericidal and disinfectant properties. The disinfectant chloramines T, a well-known active chlorine compound, have been demonstrated to inactivate gram positive and gram negative bacteria.

Widely used as an irrigating solution of radicular canals in order to chemically soften the carious dentine. The partially
degraded collagen in carious dentine is chlorinated by the chloramines. It affects the secondary and/or quaternary structure of collagen, by disrupting hydrogen bonding and thus facilitating the carious tissue removal.

Toluidine blue\textsuperscript{1}
Initially, the malachite green was used as the coloring agent, however, after a few studies toluidine blue was found highly effective against \textit{Streptococcus mutans}. It is a photosensitive pigment that fixes into the bacterial membrane.

**MECHANISM OF ACTION\textsuperscript{10}**

Papain acts only in infected tissue because infected tissue lack a plasmatic anti protease called Anti-trypsin. Anti-trypsin is present only in sound tissue and it inhibits protein digestion. The absence of anti-trypsin in infected tissue allows papain to break the partially degraded collagen molecules, contributing to the degradation and elimination of the fibrin “mantle” formed by carious process (Figure 2).

**PROCEDURE FOR USE\textsuperscript{12,13}**

Carious lesion is covered with Papacarie gel and left undisturbed for 30 s in acute caries and 40-60 s in chronic caries.

1. After degradation of collagen, oxygen is freed, bubbles appear on surface, and a blearing of gel is noticed. These signs demonstrate that the removal process can be started. It is removed gently by scrapping with spoon excavator in pendulum like movement without applying pressure
2. Additional fresh gel is applied on excavation site and continued until the gel is no longer cloudy
3. Gel is removed and the cavity is wiped with moistened cotton pellet and rinsed. The main characteristic of the complete removal of infected dentinal tissue is the vitreous aspect of the cavity.

**EFFECT ON DENTIN\textsuperscript{11,14,15}**

1. Intact non mineralized Type I collagen fibrils are partially degraded by a papain-gel
2. It is hypothesized that the treatment of dentin with a papain-gel might affect the tissue’s mechanical properties
3. The application of chloramines resulted in opening dentinal tubules in the outer layer of carious dentin whereas occluded in sodium hypochlorite.

**ADVANTAGES OF PAPAIN GEL\textsuperscript{1,7}**

1. Papacarie is a biocompatible gel (Papacarie was evaluated in-vitro for cytotoxicity in fibroblasts culture at different concentrations (2, 4, 6, 8 and 10%). It was concluded that for its development, any of the papain concentrations was feasible and Papacarie was safe, not cytotoxic \textit{in-vitro} fibroblast culture, and it is biocompatible to the oral tissues (Slive \textit{et al.}, 2004)

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{mechanism.png}
\caption{Mechanism of action of Papacarie\textsuperscript{1}}
\end{figure}
2. This product has antimicrobial effectiveness, mainly regarding *S. mutans* and *Lactobacillus*.
3. The formation of a smear layer is not observed after using the gel.
4. The gel combines an atraumatic treatment with antibacterial properties without affecting healthy tissue and causing pain.
5. Cost is low, due to the use of low-cost Brazilian raw materials.
6. Easy to apply as it does not require special instruments or equipments.
7. Fast acting.

**INDICATION**

1. Papacárie gel can be successfully used in special health care needs patients and phobic adults in pediatric dentistry and public health sectors.
2. Papain gel has become an efficient alternative for deproteinization of the tooth enamel surface.
3. Before bonding orthodontic brackets with RMGIC.

**CONCLUSION**

Papacarie combines traumatic, conservative, and selective properties for removal of carious dentin, has antibacterial properties that reduce that reduce the number of cariogenic bacteria, and does not cause dentinal mud on the surface of prepared cavity, thus facilitating the bonding of the restorative material. The gel reduces the risk of pulpal exposure and does not damage the healthy tissue, making it an excellent option for caries removal. Papacarie has been found to be easy to manipulate, simple and cheap, as well as effective in removing infected tissues. Moreover its use can be afforded by unprivileged people which otherwise would have no other option.

**REFERENCES**


**How to cite this article:** Jain K, Bardia A, Geetha S, Goel A. Papacarie: A Chemomechanical Caries Removal Agent. IJSS Case Reports & Reviews 2015;1(9):57-60.

**Source of Support:** Nil, **Conflict of Interest:** None declared.