Chemo Mechanical Caries Removal - A New Horizon
Pratap Kumar M¹, Nandakumar K², Sambashivarao P³, Sandhya P S⁴

Introduction:
The concept of conserving healthy tooth structures during cavity preparation has gained popularity with the advent of adhesive restorative materials. Conventional methods of cavity preparation based on the philosophy of “extension for prevention” are performed by using drills and sharp edged hand instruments. This method often removes healthy tooth structure in addition to the decayed areas. This induces pain and discomfort. Awareness regarding the preservation of tooth tissue led to the usage of alternative techniques like abrasion, ultrasonics, lasers, ozone application and CMCR (chemo mechanical caries removal). Therefore, chemo mechanical caries removal has been introduced as an alternative to the conventional methods of removing caries. This new method CMCR which is patient and user friendly acts by causing further degradation of the partially degraded collagen in the infected dentine, without affecting the normal dentinal tissues.¹

Development of CMCR agents:
The first used chemo mechanical caries removal agent was Sodium hypo chlorite, which is a non specific proteolytic agent, which effectively removes organic components at room temperature. Effects of sodium hypo chlorite as a chemo mechanical caries removal agent were studied by Habib C M, J Goldman and M Kronman, by placing a carious tooth in 5% sodium hypochlorite with the result that all carious tissue was removed. However it proved to be too unstable and aggressive on healthy tissue. It was therefore incorporated into the solution of Sorensen’s buffer, which contains a mixture of sodium hydroxide, sodium chloride and Glycine in an attempt to minimize the problem. This first formula, called GK101 consisted of N-MONOCHLORO GLYCINE (NMG), which proved to be more effective than sodium hypo chlorite alone.²

GK 101 turned out to act slowly and additional efforts to speed up the procedure resulted in development of GK101E. In this system glycine was replaced by amino butyric acid, the product was...
named as N-monochloroaminobutyric acid (NMAB), designated as GK101E.3

**CARIDEX:**

Based on GK101E, a caries removal system called caridex gained FDA acceptance in 1984. It was introduced in the US market in 1985 by National patent medical products Inc., a pharmaceutical company in New Jersey.

**Mechanism of action of caridex:**

Involves the chlorination of partially degraded collagen in the carious lesion and conversion of hydroxyproline to pyrrole-2 carboxylic acid. It may also involve cleavage by oxidation of glycine residues, which disrupts the collagen fibrils and makes them more friable for removal.2, 4

Caridex application selectively removes decayed dentin leaving a surface with many overhangs and undercuts. Dentinal tubules were found to be patent and occluded. Such surface is well suited for restoration with modern adhesive restorative material like GIC.5

NMAB (caridex) system consists of two solutions containing.

1. Solution I - Sodium hypo chlorite.
2. Solution II — Glycine, Amino butyric acid, Sodium chloride and Sodium hydroxide.

The two solutions are mixed just before use to give a working reagent (pH Approx. 11) which is stable for an hour. Studies carried out on the dentine surface remaining after caries removal by caridex, have shown that the dentine is sound and properly mineralized though the surface formed was highly irregular.6

Although caridex system initially proved to be quite popular, there were many shortcomings like,

1. Procedure was slow (10-15 min).
2. Large volumes of solutions were needed.
3. The solutions had to heat.
4. A large reservoir with pump was needed for the application.
5. Shelf life of an open container was short.
6. The hand instruments were not optimal.
7. It was expensive.
8. Product was launched in an era when adhesive systems were not popular and conventional cavity designs were followed.

Shortcomings of the caridex system lead to the development of carisolv.

**Carisolv:**

**Background:**

During the 1980’s studies aimed at finding effective and tissue preserving methods for chemomechanical removal were initiated by Christer Hedward and Lars stride of Sweden. They have revealed that shortcomings of caridex system were related to the presence of single amino acid. Studies by Dan Ericson and Rolf Bornstein in collaboration with the above mentioned scientists resulted in the development of a new, patented system called carisolv.

**About the material:**

Carisolv consists of a red gel and a transparent fluid (fig.1). The red gel contains 3 amino acids (lysine, leucine, and glutamic acid) together with CMC (carboxy methyl cellulose), sodium hydroxide to make it viscous and erythrosine to make it readily visible in use. The transparent fluid contains sodium hypo chlorite. Equal parts of the two are mixed to form an active gel just before use. Carisolv gel is available in two different packages, carisolv gel multimix and carisolv gel single mix. Multimix contains gel and hypochlorite sufficient for 10-15 treatments, only the amount of gel needed for each individual treatment is mixed; single mix is delivered in a pack of five and used for the five separate treatments.

**Hand instruments for caries removal:**

Special hand instruments are available for use with carisolv gel (fig. 2). These instruments are available with permanent or interchangeable tips designed to access different types of lesions. Most of these instruments have a sharp edge and blunt cutting angles, resulting in a large area of support against the underlying surface coupled with
controlled and effective cutting depth. Other drills and excavators may tend to cut less precisely due to their aggressive cutting angle and smaller support area.

**Usage:**

Carisolv gel is applied to the carious lesion for 30 seconds; later carious dentine can be gently removed using one of the carisolv instruments. This procedure is repeated until no more carious dentine remains, a guide to this being the gel removed from the tooth is clear. The time required for this procedure is 10-15 minutes, and the volume of gel used is 0.2-1 ml (fig. 3)

**Mode of action:**

When the gel and fluid are mixed in the syringe, the amino acids bind with chlorine and form chloramines at high pH. The formation of chloramines reduces the reactivity of chlorine without altering its chemical function. This causes the breakdown of degraded collagen characteristically found in the demineralized portion of carious lesion. The gel softens only carious tissue and the healthy tissue is unaffected. The unaffected collagen is resistant to degradation, but the framework of degraded collagen within the porous mineral can easily be scrapped off. The efficacy of carisolv in reducing the cariogenic flora and removal of the dental caries is comparable to that of conventional drilling, however it is more time consuming.

**Cavity prepared with a drill:**

The cavity is symmetrical and follows the contours made by the drill. The structure of the dentine indicates that even sound tissue has been removed.

**Cavity prepared using carisolv:**

The cavity is uneven and follows the spread of the lesion. The dentine has a different structure and no healthy dentine has been removed.

**Papacarie:**

To overcome the disadvantages of the caridex and carisolv such as, short shelf life, high corrosiveness, requirement for specialized instruments, and high cost, a gel was developed in Brazil in 2003, by Bassadori et al, which is commercially known as papacarie (fig. 4) (a word that means “eating caries”).

Papacarie contains the main active ingredient papain, an enzyme, similar to human pepsin. Papain is an endoprotein which has bactericidal, bacteriostatic, anti inflammatory actions and is non toxic. Papain acts only on damaged tissues due to the absence of an antiplasmatic protease, alpha-1-antitrypsin, which hinders its proteolytic action on the normal tissues. The absence of Alpha-1-antitrypsin in infected tissues allows Papain to break down partially degraded molecules. Papacarie also contains Chloramine which acts as a disinfectant and softens the carious dentin due to chlorination of the partially degraded collagen.

**Usage:**

1) Carious lesion is covered with Papacarie gel and left undisturbed for 30 seconds.
2) It is removed gently by scrapping with spoon excavator without applying pressure.
3) Additional fresh gel is applied on excavation site and continued until the gel is no longer cloudy.
4) Gel is removed and the cavity is wiped with moistened cotton pellet and rinsed.

**Mechanism of Action:**

Papacarie when applied to the contaminated dentine has proteolytic, chlorinating and oxidating properties on the affected collagen, without acting on the sound dentine. It is able to remove the smear layer, which facilitates the penetration of adhesives, thereby enhancing the adhesional properties of restorative materials, without compromising on the shear bond strength.

**Advantages:**

1. It does not require special instruments or equipments.
2. Safe to use and biocompatible to the oral tissues.
3. Easy to manipulate
5. Ideal consistency.
6. Cost effective.
Comparison of Various CMCR Agents:

<table>
<thead>
<tr>
<th></th>
<th>CARIDEX</th>
<th>CARISOLV</th>
<th>PAPACARIE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Solution I</strong></td>
<td>1% NaOCl</td>
<td>0.5% NaOCl</td>
<td>Single Gel</td>
</tr>
<tr>
<td><strong>Solution II</strong></td>
<td>0.1M Amino butyric acid glycine</td>
<td>0.1 M Glutamic Acid/Leucine/Lysine</td>
<td>Endoprotein – Papain and Chloramines</td>
</tr>
<tr>
<td></td>
<td>0.1M NaCl</td>
<td>NaCl</td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.1M NaOH</td>
<td>NaOH</td>
<td></td>
</tr>
<tr>
<td><strong>Dye</strong></td>
<td></td>
<td>Erythocin</td>
<td>Toluidine Blue</td>
</tr>
<tr>
<td><strong>pH</strong></td>
<td>11</td>
<td>11</td>
<td>11</td>
</tr>
<tr>
<td><strong>Physical Properties</strong></td>
<td>Liquid</td>
<td>Gel</td>
<td>Gel</td>
</tr>
<tr>
<td><strong>Volume Needed</strong></td>
<td>100-500 ml</td>
<td>0.2-1.0 ml</td>
<td>0.2-1.0 ml</td>
</tr>
<tr>
<td><strong>Time Required</strong></td>
<td>10-15 minutes</td>
<td>10-15 minutes</td>
<td>5-8 minutes</td>
</tr>
<tr>
<td><strong>Equipment Required</strong></td>
<td>Applicator Unit</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td><strong>Instruments</strong></td>
<td>Applicator tips</td>
<td>Specially Designed</td>
<td>No Special Instruments Required</td>
</tr>
<tr>
<td><strong>Preparing remains active after mixing</strong></td>
<td>1 hour</td>
<td>20 minutes</td>
<td>No mixing</td>
</tr>
</tbody>
</table>

Limitations of chemo mechanical caries removal:

Rotary and hand instruments may still be needed for removal of tissue or material other than infected dentine collagen. This includes access to small or interproximal carious lesions, removal of enamel overlying the caries, removal of existing restoration etc as well as for cavity design when non adhesive restorative materials are used.

Conclusion:

Removal of decayed tissues with CMCR proves to be efficient, easy to perform, comfortable and less destructive to the dentinal tissue in selected cases. The restoration met functional needs, and was an easy, inexpensive solution in apprehensive patients. The ultimate goal of minimal intervention dentistry is to conserve tooth structure thereby increasing the strength of the restored tooth, which is fulfilled by CMCR method.

References:


Indian J Dent Adv 2011; 3(4): 668-672


