

Chemomechanical Caries Removal: A Review & Study of an Indigenously Developed Agent (Carie Care™ Gel) In Children

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ABSTRACT

The invention and application of engine driven or rotary instruments in operative treatment of carious lesions has resulted in removal of considerable tooth structure. However, with the introduction of adhesive materials for restorations, and the advent of minimal cavity design this principle has been challenged and is now considered to be too destructive to the tooth structure during caries removal. A number of techniques are available for cutting tooth tissue. The chemo mechanical method of caries removal/treatment is considered to be less painful when compared to the traditional treatment method (use of drill). The present study was carried to study the effect of an indigenously developed caries removal agent viz. Carie Care™ & its effectiveness as a chemo mechanical caries removal agent.

Key Words: Chemo mechanical Caries Removal, Dental Caries, Primary Teeth, Papain gel.

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Introduction

The invention and application of engine driven or rotary instruments in operative treatment of carious lesions has resulted in removal of considerable tooth structure¹. Since GV Black in 1893, proposed the 'Principle for prevention, the techniques used in caries removal has undergone a lot of development. He had initially proposed that the removal of sound tooth structure at sites that would otherwise encourage stagnation of plaque (like occlusal fissure, approximal contacts, etc.) would help minimize caries onset and progression. However, with the introduction of

adhesive materials for restorations, and the advent of minimal cavity design this principle has been challenged and is now considered being too destructive to the tooth structure during caries removal².

Techniques of tissue Removal

A number of techniques are available for cutting tooth tissue. While some claim, to remove demineralized dentin selectively, others are unable to distinguish this and are not able to remove the softened dentin effectively¹.

Certain factors which satisfy both operator and the patient must be fulfilled by the ideal cutting instruments which include:

- Ease and comfort of use
 - Ability to Identify, discriminate & remove the involved tissue
 - Requiring minimal pressure and at the same time being painless and silent
 - Being able to generate the minimal amount of vibration or heat during use
- Excavators, handpieces and burs
 - It is a known fact that the rotary bur is in universal use. Having said this there are problems that need to be overcome. There are a few factors which are potentially responsible for the pain and discomfort which is associated with cavity preparation³⁻⁴ which include,
 - Sensitivity
 - Pressure sensation on the tooth
 - Bone conducted noise & vibration
 - High pitched noise of air turbine hand piece
 - High temperature build up

The rotating bur cuts through carious dentine to open up healthy dentinal tubules deeper in the tissue and this in conjunction with water stimulation of odontoblast processes will result in the pain associated with cavity preparation using this technique. In current practice, having gained access to the carious dentine using the high speed handpiece & bur, the slow speed bur or hand excavator can be used for excavation.

Air Abrasion:

RB Black in 1945 started preliminary investigations into an alternative pseudo-mechanical method of caries removal which involved bombarding the tooth surface with high-velocity particles (Aluminum oxide), carried in a stream of air⁵. The coarseness of the abraded surface was determined by the size of the abrasive particle – larger the size and harder the particles, greater is the kinetic energy to the surface & thereby rougher the final finish^{4,6-7}.

Air Polishing:

This is a process of adding tricalcium phosphate (to improve the flow) to water soluble particles of sodium bicarbonate and applying this mix to the tooth surface using air pressure coupled with a concentric water jet⁸⁻⁹ which is the contrasting difference between this technique and air abrasion. The interesting fact that the abrasive is water-soluble ensures that it does not escape from the operating field¹⁰. But as this is non selective, its overzealous use could easily remove a considerable amount of tooth structure especially in the cervical margin¹¹⁻¹².

Ultrasonic Instrumentation:

The possibility of using an ultrasonic instrument for cutting tooth tissue was indicated the studies by Nielsen et al in the 1950's¹³⁻¹⁴. A magnetostrictive instrument with a 25KHz oscillating frequency was developed for this purpose which was used in conjunction with a thick aluminium oxide and water slurry. The kinetic energy of the water molecules was transferred to the tooth surface via the abrasive through high speed oscillations of the tip. However the results were inconclusive due to erratic and unpredictable performance of the instrument¹⁴.

Sono-Abrasion:

It is the use of high frequency, sonic, air-scalers with modified abrasive tips. Favorable results from laboratory studies using sono-abrasion to remove softened, carious dentine have indicated possible use for this technique in the future¹⁵⁻¹⁶.

Chemo-mechanical methods:

Caridex & Carisolv

In 1976, Goldman & Kronman, reported an alternative to tooth tissue removal – the possibility of removing carious material chemically using N-monochloroglycine (NMG, GK-101)¹⁷. After subsequent modifications the caridex system, containing N-monochloro D, L-2-aminobutyrate (NMAB, GK-101E), was introduced¹⁸. This system was developed as a chemo-mechanical method for caries removal. Carious dentine, softened further by NMAB (GK-101E), should have been readily removed by lightly abrading its surface with the applicator tip. Many studies have indicated that in permanent teeth,

the ability of carious dentine removal using NMAB was no greater than using a control of isotonic solution. In deciduous teeth, however, addition of urea to the solution significantly improved carious dentine excavation compared with the some control solution without urea¹⁹⁻²⁰.

A gel based system was then developed and the carisolv gel was introduced to be used with specially designed non-cutting hand instruments to abrade the carious dentine surface. This gel consists of two carboxymethylcellulose based gels: a red gel containing 0.1M amino acids (glutamic acid, leucine and lysine), NaCl, NaOH, erythrosine (added in order to make the gel visible during use); and a second containing sodium hypochlorite (NaCl – 0.5% w/v). The two are thoroughly mixed in equal parts at room temperature before use and then applied, using hand instrument onto the exposed carious dentine to leave a hard, caries free cavity. The solution has a pH of around 11 & it is postulated that positively and negatively charged groups on the amino acids become chlorinated and further disrupt the collagen cross linkage in the matrix of carious dentine. The gel consistency will allow the active molecules access to dentine for a longer period than the equivalent irrigating solution in the caridex system. It is also highly probable that the gel has a mechanical lubricating action for the hand instrument which will also aid in the removal of the softened tissue. Results from various clinical trials have indicated increased patient compliance to this technique over the use of the dental drill to excavate carious dentine²¹.

More recently proteolytic agents, such as papain and sodium hypochlorite can be used to further degrade the partially demineralized and altered dentin matrix that has been previously exposed to bacterial action (infected dentin), thus facilitating its removal and preventing damage to the underlying remineralizable tissue (affected dentine)¹. The papain enzyme particularly, a plant derived cysteine protease of broad proteolytic activity has been used as a chemo-mechanical material since its introduction. The papain gel has been suggested to act by exclusively breaking down the partially degraded collagen molecules & contributing to the degradation and elimination of the

fibrin “mantle” formed by the carious process, without damaging intact collagen fibrils. This selective interaction of the enzyme with the affected components of the carious dentin has been suggested to be due to the lack of an antiprotease of 1-anti-trypsin, which inhibits protein digestion in sound collagen – based tissues²²⁻²⁴. This paper introduces a new papain based chemomechanical caries removal agent – Carie Care.

Carie Care

In Chemo mechanical method partially degraded collagen in carious dentine will be chlorinated by chemomechanical caries removal solutions. This chlorination affected the secondary and/or quaternary structure of collagen, by disrupting hydrogen bonding. Carious material removal was thus facilitated. The main advantage of this method is that it does not require complete patient cooperation. Carie care - a product that has been locally introduced has as its main active ingredient from papaya extract - an endoprotein, chloramines and dye. In addition the preparation contains specific percentages of essential oils from plant sources, which has anti-inflammatory and mild anesthetic effect. The preparation also contains explicit gelling agent in accurate percentage to give exact consistency to the gel so that when applied there is no spill over.

The main agents in all these existing gels used in chemo mechanical caries removal consists of a mixture of sodium hypochlorite and three amino acids (lysine, leucine and glutamic acid) in a gel preparation. It softens the carious dentine which is then hand excavated and claims that it will not affect the underneath healthy affected dentine. The liquids are mixed just before the treatment and then applied on carious cavity. The mixture cannot be stored and reused. However present gel preparation does not contain sodium hypochlorite or any other strong chlorinating agent instead has most of the ingredients from natural sources. None of earlier preparations including Papacarie contain essential oils which we have incorporated in our preparation for the first time and which act as anti-inflammatory agent. Carie Care not only softens infected dentine but gives additional advantage of anti-inflammatory activity and aroma.

Carie Care is applied directly onto the tooth having caries by means of a disposable applicator tip; soon gel changes the color in the affected area. After 1 minute the gel along with dissolved caries is removed by means of a Sharp Spoon Excavator. Carie Care is in the form of single preparation, which can be stored at 4°C for more than 6 months.

Aim & Objective

- To evaluate a new CMCR method using Carie Care for deciduous & permanent teeth of children comparing it with traditional caries removal using traditional drill.
- To determine the need of anesthetics

Materials & Instruments

- Carie Care
- Mouth mirror
- Probe
- Tweezer
- Sharp spoon excavator
- Restorative instrument
- Type II GIC
- Lignocaine

Methodology

- The subjects were children visiting an exclusive pediatric dental practice & treated by a pediatric dentist.
- The subjects selected were in the age group of 5-7 years.
- Children which had 2 or more same caries lesions in the same group of teeth eg. 35 & 65 those were on different sides of the same jaw.
- One of the chosen tooth was treated by drilling and excavating the usual way & the other (experimental tooth) was treated with Carie Care gel.
- Informed and consent was taken from the parents before commencement.
- The dentist treated teeth using Carie Care gel or the usual way during one visit & the other way during the next visit.

- The cavity was checked after removing the caries to determine if the cavity is free of caries using a sharp probe.
- Teeth were filled with type II GIC
- Local anesthesia was administered if the patient asked for it or if the treatment was not possible to continue because of the pain.
- The following observations were noted
 - Number of teeth, the method, previous experience to treatment, complaints of pain, bad taste, smell or other inconvenience, use of anesthesia & time for caries removal.
- The following occurrences were analyzed
 - Structure of complaint in chemo mechanical & traditional treatment groups.
 - Usage of anesthetics in both groups.
 - Comparison of cleaning duration in both groups.

Results

The subjects were divided into experimental (CMCR) and control group (traditional way).

Diagnosis in primary teeth: A total of 30 children (60 teeth, 30 in each group) in the age group of 5-7 years were included in the study after obtaining informed consent from their parents when they visited the exclusive pediatric dental practice. Large carious lesion was found in 18 teeth & medium carious in 12 teeth.

Structure of complaints in CM & traditional treatment groups: The children were asked to choose from the following descriptions for their complaints:

- Pain
- Unpleasant taste
- Unpleasant smell
- Others
- No complaints

In the chemomechanical treatment group the biggest part of cases was those without complaints (to add %age) 18 from 30 answers. The complaints for pain was (%age) 6 cases. There were no complaints about unpleasant taste/smell or pain. The rest of the cases were the other complaints (%age) with a total of 6 cases (Table 1). The other complaints included:

- A little pain - 2 cases
- Some sensitivity - 2 cases
- Sound of scarping instrument on feeling - 2 cases

Table 1: Complaints within Chemo-mechanical Treatment Group

Sl. No.	Valid	Frequency	Percent	Valid percent
1	Pain	6	15	20
2	Others	6	15	20
3	No complaints	18	45	60
4	Unpleasant taste & smell	0	0	0
5	Pain & unpleasant taste	0	0	0
	Total	30	75	100
	Missing system	10	25	
	Total	40	100	

Table 2: Complaints within Traditional Group

Sl. No.	Valid	Frequency	Percent	Valid percent
1	Pain	16	40	53.33
2	Others	8	20	26.67
3	No Complaints	6	15	20
4	Unpleasant taste & smell	0		
5	Pain & unpleasant taste	0		
	Total	30	75	100
	Missing system	10	25	
	Total	40	100	

Table 3: Use of Anesthetics in Chemo-mechanical Treatment Group

Sl. No	Frequency	Percent	Valid Percent
Positive	1	2.5	3.33
Negative	29	72.5	96.67
Total	30		100
Missing system	10	25	
Total	40	100	

Table 4: Use of Anesthetics in Traditional Treatment Group

Valid	Frequency	Percent	Valid percent
Positive	11	27.5	36.66
Negative	19	47.5	63.34
Total	30		100
Missing system	10	25	
Total	40	100	

Table 5: Cleaning Duration in Chemo-mechanical and Traditional Treatment Group

	Chemo-mechanical Treatment Group	Traditional Treatment Group
Minimum of cleaning duration	3	1
Maximum of cleaning duration	20	20
Mean of cleaning duration	10.5	5.9

In the traditional treatment group, there were (%age) 16 cases who complained of pain. (%age) 8 children had other complaints & (5age) 6 children had no

complaints (Table 2).

The other complaints included

- A little pain

- 6 cases

- Some sensitivity - 2 cases
- Usage of anesthetics in chemomechanical & traditional treatment groups

Local anesthesia in both groups was used if patient asked for them or if the treatment was not possible to continue because of pain.

In chemomechanical treatment group, local anesthetic was used once (%age) (Table 3) and in the traditional group anesthetics were used for 11 cases (%age) (Table 4).

- Comparison of cleaning duration in chemomechanical & traditional treatment groups. A big variance was observed between cleaning in both the groups (Table 5)

Discussion

The chemomechanical method of caries removal/treatment is considered to be less painful when compared to the traditional treatment method (use of drill)²⁵. The results obtained from this study using a newer CMCR gel - Carie Care has once again proved that the chemomechanical method is effective & more comfortable for patients than the traditional method.

A big multi-centre study²⁶ was done which a new CMCR method was compared to traditional treatment in which only 3 patients needed anesthetic from the experimental group & 11 from the control group. 74% of all patients had no complaints at all or very little discomfort in comparison to our present study it was 1 patient from 30 who needed anesthetic administration in the experimental group and 11 out of 30 in the control group. This was less remarkable as compared to Ericson's Study²⁶ but there were lesser complaints about the procedures.

There have been complaints of bad smell & taste of other CMCR gels²⁶. Our study is more comparable to the study of Maragatis et.al²⁷. Most of the results between our studies correlated. Our study has shown that even in deep cavities, chemomechanical treatment is less painful.

Some studies have suggested that chemomechanical caries removal takes longer time than the drilling or excavation²⁸ while some other studies suggest otherwise²⁶

In our study the cleaning time with Carie Care gel was 10.5 min & 5.9 min with drilling. These correlates to the results obtained by Ericson & by Maragatis²⁶⁻²⁷.

Conclusion

From the present study we can conclude that even though Carie Care gel (CMCR) may not be able to replace the use of traditional instruments (drill) for caries removal, but can be an alternative to many cases especially in children who are anxious about dental procedures. We can also conclude that with very few products available, this newly developed product will enhance the use of chemo mechanical caries removal agents.

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