

Comparative Evaluation of the Efficacy of Chemomechanical Caries Removal Agent Containing Papain Gel with Conventional Hand Instrument Method in Removal of Dentinal Caries in Deciduous Molar Teeth: An In Vitro Study

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Abstract

Background and Objective: The concept of Chemomechanical caries removal, a Minimal Invasive Dentistry (MID) technique has been gaining popularity with the development of newer materials for restorations, better understanding of the caries process and the tooth's potential to remineralize. The technique has been applied with the prime intention to preserve the healthy tooth tissue by removal of adequate quantities of carious dentin and thereby offer more patient-friendly care to fearful patients.

Recently, Carie care - a product containing papain gel has been introduced. The ease of application and the patient acceptance of the Carie Care have been well documented in various studies. But only a few studies have discussed on the amount of caries excavated and the remaining dentin thickness. Therefore, the aim of our study was to compare, in vitro, the remaining dentin thickness after using CMCR and hand excavation.

Methodology: Twenty human carious primary molar teeth which were about to shed were extracted and stored in 0.05 M phosphate buffered saline. Tooth with a DIAGNOdent Reading greater than 30 were included in the study. The selected teeth were decoronated and sectioned in a mesiodistal direction. One half of each tooth was randomly excavated by hand instrument and the other half with Carie Care gel. After complete removal of the carious lesion, the amount of remaining dentin was measured under stereo microscope. The remaining dentin thickness were recorded and compared between the two groups using the Students paired t – test.

Results: The dentin thickness was preserved more in Carie Care when compared to Hand excavation. The p value obtained from Students 't' test was 0.200 indicating that there is no statistical significance between the two groups.

Conclusion: The caries removal was found to be better with Carie care in retaining the tooth structure when compared to that of hand excavation. The remaining

dentin thickness over the pulp was more in the experimental group though not significant statistically. The Carie care can be used as an alternate to hand excavation especially in apprehensive children with deep carious lesions.

Keywords: Chemomechanical Caries Removal Method, Minimal Invasive Dentistry, Papain Gel, Carie –Care.

Introduction

Dental caries has always been a public health challenge worldwide, especially amongst the younger generations. It has been and still remains the most prevalent disease worldwide, burdening billions of people, especially children with pain and subsequently poorer quality of life and general wellbeing.¹

Restoration of carious teeth in children with conventional drill is considered traumatic mainly due to the fear and anxiety among them.² The aversion to the noise of rotary instruments and dental anesthesia are the main factors for this situation, which results in delay of the treatment leading to the advancement of the caries process to emergency situations.³

Dental cares management has evolved drastically from G.V. Black's "Extension for prevention" to "Construction with conservation."⁴

The concept of Minimal Invasive Dentistry (MID) has gained popularity with the development of newer dental restorative materials, caries removal agents, better understanding of the caries process and the tooth's potential to remineralize.⁵

Chemo-mechanical caries removal (CMCR) is based on the concepts of MID. The CMCR technique removes the carious dentin adequately preserving the healthy tooth tissue and offering a more patient-friendly care to fearful patients.⁶

This idea of chemo-mechanical caries removal was developed in 1970s by Goldman, who was an endodontist, while using sodium hypochlorite (NaOCl) in removing organic materials in the root canals.⁷

Over the years, various chemomechanical caries removal agents were introduced, some of which required specialized training, specialized instruments for preparation, more preparation time and above all, the expense.^{8,9}

The introduction of Papacarie in which the basic ingredient was papain changed the view on CMCR.¹⁰ The advantages of this product was ease of application and no need for specialized equipments or instruments.¹¹

Carie – Care is another product which has papain as its active ingredient. It also includes essential oils from plant sources, which provides an anti-inflammatory and mild anaesthetic effect. The gelling agent added to the product helps to reduce the spillage when applied over the tooth.¹² The ease of application and the patient acceptance of Carie - Care have been well documented in various studies. But very few have discussed regarding the amount of caries excavated and the remaining dentin thickness. Therefore, we decided to compare, in vitro, the remaining dentin thickness after using CMCR and hand excavation.

Methodology

Twenty human carious primary molar teeth based on the inclusion and exclusion criteria which were about to shed, were extracted and stored in 0.05 M phosphate buffered saline. In an attempt to standardize the lesion, teeth with occlusal carious lesion extending till the middle third of the dentin and with a DIAGNOdent (KaVo, Biberach, Germany), readings were recorded.

Tooth with DIAGNOdent reading greater than 30 were included in the study. Those teeth with evident pulpal exposure were excluded from the study. (Figure 1)



Figure 1: Tooth Sample

As per the manufacturer's instructions, calibration of the DIAGNOdent was performed with a ceramic standard provided by the company. The preselected teeth were air dried using a three way syringe and the Probe A of the DIAGNOdent was used for the examination. The tip of the laser device (Probe A) was placed perpendicular to the surface being examined and the readings were recorded.

The DIAGNOdent device has two readings; one is the moment reading and the other the peak reading. The moment reading indicates the real time value that the probe tip measures during the scanning of the tooth surface. The peak reading is the highest level scanned on the tooth surface.

The peak reading for each tooth was recorded. The readings were then interpreted according to the criteria put forward by the manufacturer (KaVo, 2001) (Table 1).

Value	Diagnosis
0 – 13	No Caries (No active care advised)
14 – 20	Enamel Caries (Preventive Care Advised)
20 – 30	Dentinal Caries (Preventive/ Operative care advised depending on patient risk)
>30	Dentinal Caries (Operative Care advised)

Table 1: DIAGNOdent Pen Value Interpretation (Lussi et al. 2009)

The selected teeth were decoronated (Figure 2) and sectioned using diamond disc and water coolant in a mesiodistal direction. (Figure 3)

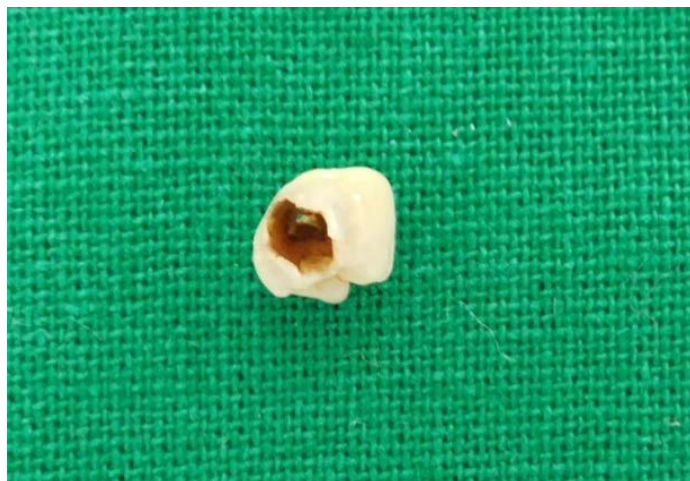


Figure 2: Decoronated Tooth



Figure 3: Tooth Sectioned Mesially

One half of each tooth was randomly excavated by hand instrument which comprised the control group and the other half with Carie- Care gel which comprised the experimental group.

For the experimental group, the required amount of Carie-Care gel was dispensed directly from the syringe on to the sectioned tooth. After application, the tooth was left undisturbed for 60 seconds for the gel to act.

After removing the gel with a moist cotton pellet, the softened carious dentin was excavated with a spoon excavator without applying pressure. The method was

repeated until the surface was felt hard with a hand instrument. After complete caries removal was obtained, the remaining gel was rinsed away with water.

For the control group, the caries was excavated using a spoon excavator alone. The excavation was done till until the cavity floor was felt hard with a hand instrument.

To improve the efficiency of caries removal, a Caries detecting dye was used to reveal the extent of carious lesion at each stage of excavation. The caries detecting dye was applied frequently with an applicator tip for 10 seconds and rinsed with water spray. The application was repeated till no staining of the cavity was noted.

After complete removal of the carious lesion, the samples were mounted on wax bases and the amount of remaining dentin was measured under stereo microscope using the Leica Application suite (LAS). Three values were taken at different points from the cavity floor to the pulp chamber and their average was calculated for both experimental and control group and comparison was done between the two groups. (Figure 4)

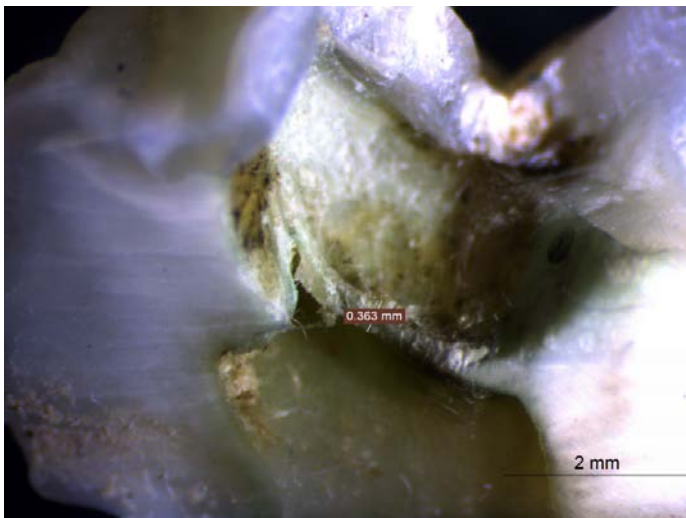


Figure 4: Image under Stereo Microscope

The obtained measurements were statistically analysed using the Students paired t – test.

Results

The DIAGNOdent readings recorded for the selected teeth are given in table 2. The readings ranged from 38 to 99 with a mean reading of 68.45.

Samples	DIAGNOdent Readings
1	52
2	73
3	38
4	79
5	44
6	58
7	61
8	67
9	57
10	81
11	74
12	77
13	69
14	86
15	56
16	99
17	72
18	74
19	71
20	81

Table 2: DIAGNOdent Readings

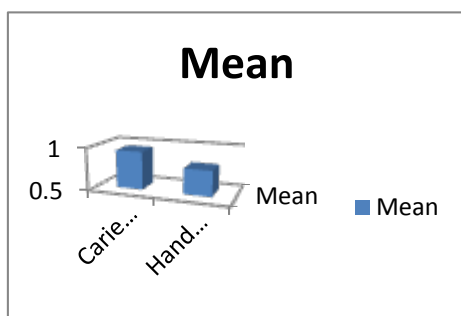
The remaining dentin thickness of the sectioned teeth was measured under stereomicroscope and the results obtained are given in table 3.

Samples	Carie-Care	Hand Excavation
1	1.325	1.006
2	0.885	0.995
3	1.557	0.787
4	0.832	0.893
5	1.455	0.983

6	1.365	1.389
7	1.265	1.123
8	1.095	1.274
9	1.270	1.320
10	0.560	0.649
11	0.785	0.763
12	0.667	0.537
13	0.882	0.642
14	0.363	0.309
15	1.346	0.438
16	0.324	0
17	0.892	0.446
18	0.778	0.601
19	0.762	0.623
20	0.557	1.171

Table 3: Remaining Dentin Thickness Values

The remaining dentin thickness obtained for Carie-Care and Hand excavation were statistically analysed. The mean obtained for Carie-Care was 0.9483 and for hand excavation was 0.7974 which explains that the dentin thickness was preserved more in Carie- Care when compared to Hand excavation (Graph 1)



Graph 1: Mean Value

The *p* value obtained from Students‘t’ test was 0.200 indicating that there is no statistical significance between the two groups.

Discussion

CMCR involves the application of a chemical solution to the carious dentine followed by gentle removal with hand

instruments and is a method for minimally-invasive, gentle dentine caries removal based on biological principles.^{8,13}

Carie care, a CMCR product has its main ingredient from papaya extract – papain an endoprotein.

Caries removal with Carie care even though more time consuming, is known to be a less painful method and is therefore known to produce less anxiety and fear in children.¹⁴

Since primary molars are more prone to decay, they have been used in the present study. As natural lesions were used, it was not possible to standardize all variables of the sample, e.g. shape and activity status of the lesions. Hence DIAGNOdent was used to standardize the depth of the lesion to an extent and the split-tooth methodology was used to minimize these variables as the source of carious dentin, thus allowing for comparisons to be made between different, paired excavation methods.

Papain is an endoprotein similar to human pepsin. It is extracted from latex of leaves and fruits of adult green papaya, *Carica papaya*, cultivated in the tropical regions such as Brazil, India, South Africa, and Hawaii, and is largely used in the food, beverage, and drug industries.¹⁵

Papain acts as debridant anti-inflammatory which does not damage the healthy tissue and accelerates the cicatricial process.⁵

Researches have proved that papain is indicated in all phases of the cicatricial 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 cicatrization 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.¹⁶

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*).¹⁶

Chloramine is the second and another major constituent of Carie-care formed during reaction between chlorine and ammonia. They 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, the coloring agent added was found to be highly effective against *Streptococcus mutans*. It is a photosensitive pigment that fixes into the bacterial membrane.

Carie-care also contains Clove oil which has an anti-inflammatory and mild anesthetic effect.⁶ 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.¹⁶

Various authors have compared the efficiency of chemo mechanical technique with conventional methods and has found it to be a better treatment protocol which can be adopted in School based dental programmes.¹⁷ Also, the pain perception and the time required for caries excavation has been well documented,^{18,19} but very few studies have shown the amount of dentin preserved after the use of chemo mechanical technique.

In the present study, it was observed that the Carie-care was more efficient in retaining the maximum dentin thickness when compared to that of hand excavation, but the results were not statistically significant.

Research outcome of few other studies which compared chemo mechanical technique with conventional methods also concluded that caries removal by hand excavation was least.^{18,20,21}

In chemomechanical caries removal some amount of infected dentin is left at the cavity base. It is still hard to accept the concept of leaving infected dentine as not deleterious. Even the complete caries removal does not guarantee total elimination of the bacteria.²² After partial caries removal, some bacteria still remain within the affected dentine tissue, but this bacteriological content is compatible with health.²³ The use of Carie-Care for caries removal adds to antibacterial effect. If there is recurrence of caries, it cannot be attributed exclusively to the residual bacterial counts in dentine, since other factors may represent a more relevant influence on the recurrence of secondary caries, like marginal failure and presence of gap on remaining restored/sealed carious dentin, leading to leakage and infiltration of bacteria and carbohydrates.²⁴

In a study by Ammari et al.²⁵ hand excavation helped to remove the necrotic and highly infected dentin when compared to Chemomechanical method. In the present study, in both groups, the excavation was done till a firm dentin was obtained [i.e., complete removal of infected

dentin]. Though in comparison between group I and group II we did not get a statistically significant result in the amount of dentin present after caries removal, there was a definite difference in value of the dentin thickness with chemomechanical technique with a mean value of 0.9483 and 0.7974 respectively.

Since softening of dentine occurs with 60 second application of Carie- Care, caries removal can be done with no exertion of force. The application was done till the gel no longer turns cloudy with dentin, which means that, all the disintegrated collagen is removed just by the application of the gel and a simple cleaning of cavity base is required before placement of a restoration. But in the mechanical technique some amount of pressure needs to be applied to remove the infected dentin completely thus increasing the chances of pulp exposure and increasing the amount of discomfort experienced by the patient.

Conclusion

The introduction of papain gel covered all the disadvantages of the initial Chemomechanical products, was easier to use and less expensive. Carie care is a product which contains papain as the main ingredient. It was found to be as effective as any other chemomechanical caries removal agent in removing the carious lesion.

In the present study, the caries removal was found to be better with Carie care in retaining the tooth structure when compared to that of hand excavation. The Carie care can be used as an alternate to hand excavation especially in apprehensive children with deep carious lesions.

Since this was an in vitro study, further in vivo studies would be suggested to conclude the effect of Carie care on the pulp tissues over long term.

Clinical Significance

Removal of carious lesion and restoring the tooth to its normal form and function is always considered a traumatic

experience for the children. This often leads to delay in accepting dental treatments which later on results in a more traumatic situation.

Though the chemomechanical caries removal was there earlier with other materials, the system with papain gel is a recent addition to Dentistry. It helps to soften the carious dentin when applied and makes the excavation easier than normal hand excavation. Various researches have shown the efficiency of papain gel in caries removal over mechanical method, but only a few studies have been done to assess the remaining dentin thickness after excavation.

Carie – Care is a CMCR product which contains Papain as its major constituent. This study was taken up to compare the effectiveness of Carie– Care in removal of carious tissue from primary teeth to that of hand excavation and assess the remaining dentin thickness and it has been concluded that the Carie care can be used as an alternate to hand excavation especially in apprehensive children with deep carious lesions.

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