



Chemico Mechanical Versus Drilling Methods Of Caries Removal- An In Vitro Study

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ABSTRACT

Context: The conventional method for caries removal is drilling with dental burs can cause anxiety and fear especially in children. Different methods of caries removal can be tried in such cases. Papain and bromelain gel being proteolytic can be used as a caries removal agent.

Aim: To evaluate the efficacy of caries removal, time taken for caries removal and surface changes using Polarized light microscopy of self-made Papain Gel and Bromelain gel with that of conventional Drilling group.

Methods and Material: Papain and Bromelain gel were self prepared in the laboratory and used as caries removal agent in the study. Fifteen permanent extracted molar teeth with class I dental caries were taken and divided into three groups randomly. Group A- Bromelain Group B- Papain Group C- Drilling. Caries removal was done, teeth restored with composite and sectioned. The teeth were mounted on slides and observed under polarized light microscopy.

Results: The time taken for caries removal using drilling method was 1.46 ± 0.1817 minutes, that for bromelain gel group was 7 ± 0.695 , for papain gel also it was 6.4 ± 0.56 . Based on the observation made under polarized light microscopy, surface roughness and irregularities were more in Drilling group. No significant difference between papain and bromelain group was seen in time taken for caries removal.

Conclusions: There was no significant difference in the caries removal efficacy of the papain, bromelain and the drilling methods. The time taken for caries removal is more in the papain and bromelain group compared to the drilling group. However there is no significant difference between papain and bromelain. Surface irregularities and roughness is more in the drilling group compared to other groups

Keywords: *chemico mechanical caries removal, drilling, papain gel, bromelain gel, Tree species, Children*

INTRODUCTION

Dental caries are the most commonly seen disease in the oral cavity. Dental caries continue to affect a significant portion of the world population. Various methods have been used for dental caries management. The widely accepted method of caries removal in the past was “Extension for prevention” by Dr. G V Black. In recent times, this phenomenon has been considered a very destructive method for caries removal (1).

The traditional method of caries removal was making use of dental burs and drilling the caries. This method had many biological adverse effects. Importantly, drilling can cause anxiety, fear, and pain in patients, especially children.

There has been considerable interest in developing alternate methods for caries removal. Air abrasion, lasers, and chemical mechanical caries removal are a few of the well-known alternative methods of caries removal. (2) One of the chemico mechanical caries removal methods is the use of papain gel (3). Papain is a proteolytic enzyme extracted from the raw fruit of papaya plants. Proteolytic enzymes help to break down the protein into smaller fragments. Papain contains bactericidal, bacteriostatic, and anti-inflammatory properties. (4,5)

Bromelain is a proteolytic enzyme that belongs to a group of protein-digesting enzymes obtained commercially from fruit or stem of pineapple. (6) Bromelain is the latest addition to chemico mechanical caries removal agent. Both

of them can be used as caries removal agents as an alternative to conventional drilling methods.

There are few studies in the literature on papain gel but very sparse evidence is available on Bromelain gel. The aim of the study was to evaluate the efficacy of caries removal, time taken for caries removal, and surface changes using Polarized light microscopy of self-made Papain Gel and Bromelain gel with that of a conventional Drilling group.

MATERIALS AND METHODS

The study was approved by the Ethical Committee of Saveetha Dental College, Chennai, India. In the study, 15 class 1 cavitated human extracted permanent molars were taken as samples and divided randomly into three groups.

Group A: Bromelain Group

Group B: Papain Group

Group C: Drilling Group

Papain/Bromelain Gel Preparation

Papain and bromelain gels were prepared in the laboratory, Saveetha Dental College, Saveetha University, Chennai. The same ingredients were used for the preparation of papain and bromelain gels to prevent bias.

Both papain and bromelain gels which were prepared in the laboratory have a shelf life of 1 year and can be stored at room temperature. The composition is given in Table 1 below.

TABLE 1: Composition of Papain/ Bromelain Gel

Ingredients	Concentration For 5 Grams	Function
Bromelain/Papain powder	250mg	Proteolytic agent
Alpha-d-tocopherol	0.5ml	Antioxidant
Carbopol+distilled water	200mg+2ml	Gelling agent
Methyl paraben	100mg	Preservative

Caries Removal Procedure

The selected 15 extracted human permanent molar teeth were divided randomly into three groups, five in each group. The teeth were stored in 10% formalin, for a period of 2 weeks according to guidelines for infection control of extracted teeth used for research and teaching given by the Centers for Disease Control and Prevention (CDC). After that, they were mounted

on wax blocks and labeled with the respective group names.

For Group A and Group B Bromelain and papain, gels were applied respectively and left in the cavity for 60 seconds. When the gel turned cloudy, it was removed gently by scraping with a sharp-ended spoon excavator without applying pressure, after which additional fresh gel was applied on the site and caries were removed with

a spoon excavator. Both the gels were reapplied until it presented a light color, indicative of the nonexistence of soft caries. The gel in the cavity was flushed with water and the cavity was wiped with a moistened cotton pellet. Complete carious tissue removal was checked using the visual-tactile method. Complete caries removal was confirmed using a sharp dental explorer by passing it easily over hard sound dentin which did not catch or give a tug back sensation. The time taken for caries excavation using papain and bromelain gels in their respective groups were recorded with a stopwatch.

For Group C, Drilling group, caries removal was done using airtor and round bur. Carious tissue removal was checked using the visual tactile method. Complete caries removal was confirmed using a sharp dental explorer by passing it easily over hard sound dentin which did not catch or give a tug back sensation. Similar to other groups, for the drilling group, the time was recorded from the beginning of drilling until the completion of the caries removal procedure. The caries removal was confirmed by two dentists.

Restoration

A single operator performed the restorations

according to the manufacturer's instructions. The teeth to be restored were etched with 36% phosphoric acid and bonding agent(Ivoclar Vivadent Te Econom)was applied. All the teeth were restored with composite(Ivoclar Vivadent TE-Econom Plus).

All the specimens were mounted individually onto an acrylic resin base. Then, using a hard tissue microtome, each tooth was sectioned buccolingually to a thickness of 0.5mm. The specimens were further reduced to 0.1mm thickness using Arkansas stone. Finally, the sectioned segments of about 0.1mm thickness were mounted on a slide and viewed under polarized light microscopy for surface discrepancies.

Polarized Light Microscopy

Individual slides were viewed under polarized light microscopy and the surface discrepancy was checked. Two trained pathologists evaluated the slides and the results were cross-verified. Both the evaluators were blinded about the study in order to avoid bias. Coding was given for each specimen based on the scoring criteria in the table 2.

TABLE 2: Scoring criteria for Polarized Light Microscopy

Coding	Surface Discrepancy
0	No discrepancy
1	Surface smoothness moderate
2	The irregular, rough surface
3	Irregular, rough surface with the gap between restoration and tooth surface

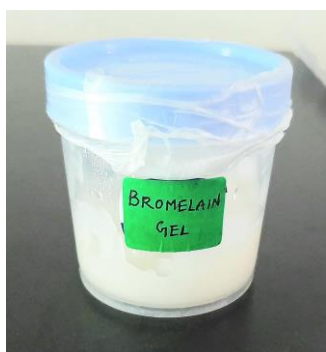


FIGURE 1: Bromelain Gel prepared in the laboratory



FIGURE 2: Papain gel prepared in the laboratory



FIGURE 3: Extracted teeth mounted on wax.



FIGURE 4: Restored teeth mounted on acrylic resin base.

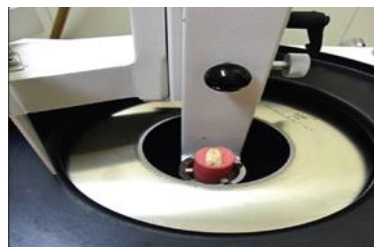


FIGURE 5: Hard tissue microtome used for sectioning of teeth



FIGURE 6: Teeth sectioned and reduced to required thickness using Carborundum stone.



FIGURE 7: Sectioned tooth mounted on a slide.

Statistical Analysis

The data obtained were tabulated on an excel sheet and the same data was transferred to SPSS

software version 23.0 and the analysis was carried out

TABLE 3 : Statistical Analysis

Group	n	Mean ± Standard Deviation(Minutes)	Range
Bromelain	5	4.8 ± 0.495	3.9 - 5.5
Papain	5	4.9 ± 0.495	4 - 5.9
Drilling	5	1.5 ± 0.395	1.3 - 3

RESULTS

Efficacy of caries removal

The results showed that caries removal was complete in all the three groups. The completeness of caries removal was evaluated by two trained dentists based on the visual-tactile method using sharp dental explorer. There was no significant difference between papain and bromelain gel in terms of efficacy of caries removal.

Time taken for caries removal

The average time taken for the removal of caries using papain gel was 4.9 minutes with a standard deviation of 0.495 and that of bromelain gel was 4.8 minutes with a standard deviation of 0.495. The average time taken for caries removal in the drilling group was 1.5 minutes with a standard deviation of 0.395. The time taken for removal of caries was significantly higher in chemico mechanical caries removal group compared to that of the drilling group.

Time taken for caries removal (minutes)

Group	Mean (Sd)
Bromelain	4.8 (+/- 0.495)
Papain	4.9 (+/- 0.495)
Drilling	1.5 (+/- 0.395)

Polarized Light Microscopy

Polarized light microscopy of the surface after caries removal and restoration with composite showed rougher and irregular surfaces with the

drilling group. Based on the scoring criteria mentioned above in table 2, each of the specimens was scored. All the slides were viewed under 10x magnification.

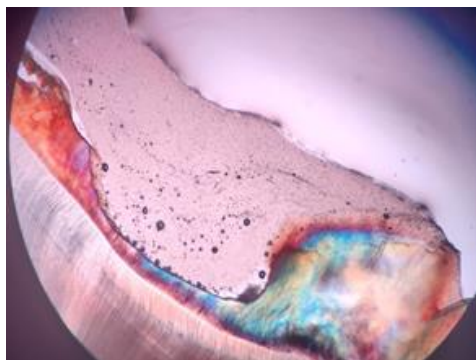


FIGURE 8: Polarized light microscopy view of sample in papain group

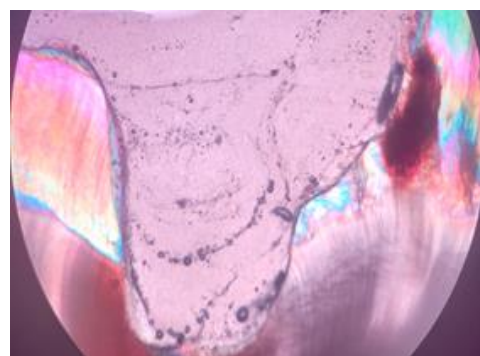


FIGURE 9: Polarized light microscopy view of sample in papain group

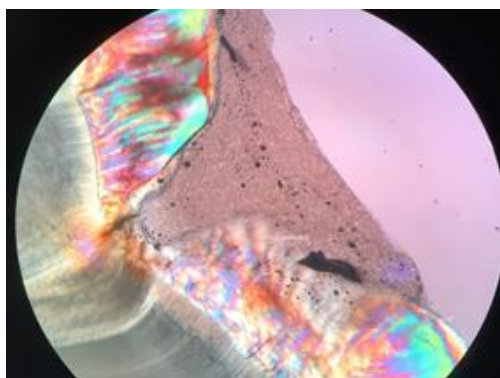


FIGURE 10: Polarized light microscopy view of sample in bromelain group

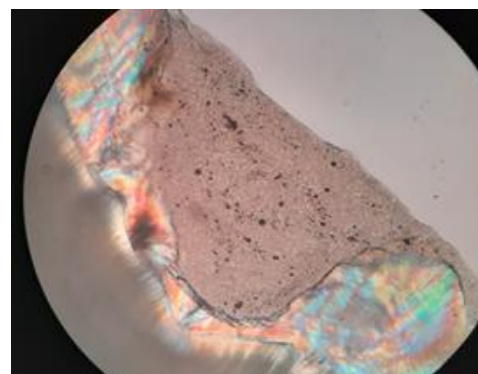


FIGURE 11: Polarized light microscopy view of sample in drilling group

In the papain group, two samples scored 0, two samples scored 1 and one sample scored 1. In the bromelain group, one sample scored 0, two samples scored 1 and two samples scored 2. In the drilling group, one sample scored 1, two samples scored 2 and two samples scored 3. The papain group showed better surface features compared with the other two groups. The drilling group showed more surface irregularities, microcracks, and gaps in the interface between restoration and tooth surface compared with the other two groups. The Bromelain group performed intermediate between the papain and drilling groups. No significant difference was seen between papain and bromelain groups.

DISCUSSION

Dental caries is one of the most common oral diseases and affects a considerable portion of the

population throughout the world. Different methods have been tried for managing dental caries. (7)The conventional method is drilling. Though caries removal through drilling can be achieved at a faster pace, it has potential side effects like adverse biological effects that can be caused to the dental pulp(8).(9) Above all, the main drawback is that it causes anxiety and fear, especially in children, thereby reducing patient compliance.

In order to overcome all these side effects, different methods have been tried. One such method tried in our study is the chemico mechanical method of caries removal which has been tried especially in children(10). Herbal formulations have been used for different purposes in dentistry. (11–13)Papacarie is one of the products used as a caries removal agent. This gel contains papain and chloramine(14). Papain

is an enzyme that is similar to human pepsin that acts as a debriding agent with no harm caused to healthy tissue. This substance accelerates the healing process and exhibits bactericidal, bacteriostatic action, and is an anti-inflammatory in nature.(15). Carisolv is another such chemico mechanical means of caries removal that has been used. It is composed of sodium hypochlorite and three amino acids: glutamic acid, leucine, and lysine. Application of this gel to the cavity produces a selective softening of the dentin, facilitating removal of the denaturalized dentin with manual instruments. This was usually tried for root caries in elderly patients (16).(17)

Recently bromelain has been tried as a caries removal agent. Bromelain is an extract derived from the stems of pineapples, although it exists in all parts of fresh plants and fruit. Bromelain has anti-inflammatory, bacteriostatic, and bactericidal properties similar to that of papain (18).

In our study both papain and bromelain gels were self-made in the laboratory and effectiveness was tested against the conventional drilling method. The composition and functions of the ingredients in the gels are given in above table 1. The efficacy of caries removal, time taken for caries removal, and surface discrepancies on the gel treated surfaces have been evaluated and compared with that of the conventional drilling group. Similar study was conducted by Kitsahawong et al. 2015. In this study, Papacarie was compared with the drilling method of caries removal (19)

In our study, the caries removal efficacy was evaluated. This was confirmed by a visual-tactile method using a sharp dental explorer and was cross-verified by two trained interpreters to avoid bias and errors in the results. This is similar to the results obtained in a study conducted by Kitsahawong et al. There was no statistically significant difference between papain and bromelain groups.

Caries removal time has also been evaluated in our study, which said the time taken for caries removal is considerably higher in chemico mechanical groups compared to drilling groups. This is in accordance with a study conducted by Santos et al. (20) in which the conventional drilling group was compared with Papacarie Duo and Brix 3000. Brix 3000 is a new papain-based gel introduced to the market. This gel is a dental

product for non-traumatic caries treatment involving an enzymatic activity (3000 U/mg*) in which the papain is bio-encapsulated by using EBE Technology (Encapsulating Buffer Emulsion) exclusive technology. According to the manufacturer, due to encapsulation and higher concentrations of papain, this product was able to remove the carious tissue more easily and without causing damage or pulp cytotoxicity. Another study conducted by Correa et al.(21) in which Papacarie was compared with the conventional group. It was a study in which microhardness was compared between Papacarie and drilling groups after caries removal. It also stated that the time taken for caries removal through the chemico mechanical group was longer than that of the conventional drilling group. Efficacy and tolerance of papain gel were compared in one study conducted by Goyal et al (22). The author showed similar results stating that the time taken for caries removal is longer in papain gel compared to the drilling method.

Bromelain is widely used in the medical field. In dentistry, bromelain has been used for the purposes of reducing post-operative swelling in third molar extraction cases(23) as bromelain is known to have bactericidal, bacteriostatic, and anti-inflammatory effects. There are studies in literature for its use in the removal of extrinsic stains as a tooth whitening agent(24). So, in recent times, bromelain has been tried in restorative dentistry as well. Bond strength has been studied by Chauhan et al. (25) and also by Khatib et al. (26) .One study(6) compared bromelain and papain gel for caries removal. No significant difference was obtained between the two. This was similar to the results obtained in our study.

In our study, we evaluated the surface discrepancies using polarized light microscopy in all three groups. Polarized light microscopy provides unique opportunities for analyzing at the molecular level in systems such as living cells and tissues, without using exogenous dyes or labels (27). (28,29)The results in our study were based on the scoring criteria as mentioned in Table 2. The surface irregularities and micro cracks were observed to be more in the drilling group compared to papain and bromelain gel. Papain gel showed smoother caries removal with the majority of samples scoring 0 and 1. Bromelain performed intermediate between drilling and papain with the majority of scores as

1 and 2. None of the samples in either papain and bromelain scored 3 that is the worst of the scoring criteria whereas in the drilling group two of the samples scored 3. The results obtained in our study were opposite to that by (19) in which the drilling group showed better results.

In spite of the fact that the time taken for caries removal was higher in papain and bromelain groups, the caries removal efficacy was comparable with that of the drilling group. Also, the adverse effects to the pulp and other biological effects were less in papain and bromelain groups. This is in accordance with the study conducted by Fure et al.(30) in which pain was evaluated between carisolv and drilling methods. Most importantly the level of anxiety and fear would be considerably less in papain and bromelain gel when used on patients. This can be an advantage for its use especially among children.

This study was conducted in a laboratory setting. A single trained operator performed all the experiments in order to minimize inter operator variability. This study had certain limitations. First, the operator could not be blinded, due to the evident differences of the intervention techniques. Next, the visual and tactile criteria used to evaluate the completion of caries removal are subjective. So, further clinical trials with more sample size must be considered to get better and appropriate results.

Our team has extensive knowledge and research experience that has translate into high quality publications(31–40)

CONCLUSION

- There was no significant difference in the caries removal efficacy of the papain and bromelain gel with that of the drilling methods.
- The time taken for caries removal is more in papain and bromelain group compared to the drilling group. However, there are no significant differences between papain and bromelain.
- Surface irregularities and roughness are more in the drilling group compared to other groups.
- Although it is difficult to employ any single method to achieve clinical excellence, chemico mechanical group shows patient-friendly and promising results.

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CONFLICT OF INTEREST

No conflict of interest

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