Original Article

Efficacy and Efficiency of Papacarie versus Conventional Method in Caries Removal in Primary Teeth: An SEM Study

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Abstract

Background: Chemomechanical methods such as Papacarie were developed as alternate dental caries removal methods to overcome major disadvantages of the conventional drilling technique. However, few studies have demonstrated the efficacy of Papacarie for caries removal using scanning electron microscope (SEM).

Objectives: The purpose of this study was to compare the efficacy and efficiency of Papacarie and the conventional bur method in caries removal from primary teeth.

Materials and Methods: In this *in vitro* study, 30 freshly extracted, human primary molars with dentinal caries were obtained from the outpatient clinics at the Dental Hospital of Imam Abdulrahman Bin Faisal University, Dammam, Saudi Arabia. Each tooth was sectioned mesiodistally into two halves through the center of the lesion, and each half was randomly subjected to caries removal by Papacarie (Group I) and excavation using the conventional bur method (Group II). Time taken (efficiency) for removal of caries was noted using a stopwatch. Samples were then examined under SEM for presence of bacterial colonies (efficacy). For efficiency, data were analyzed using chi-square, and for efficacy, using *t*-test.

Results: There was no significant difference in the presence of bacteria in both groups under SEM (Papacarie = 23.3%; conventional method = 16.7%; $P = 0.52$). However, significantly more time was taken for caries removal with Papacarie (mean = 351.56 s) than with the conventional bur method (mean = 158.41 s) ($P < 0.0001$).

Conclusion: Papacarie is as effective in removing dentinal bacteria as the conventional caries removal method but is less efficient, as the time taken for excavation was longer.

Keywords: Dental caries, Papacarie, primary teeth, scanning electron microscope

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INTRODUCTION

Caries excavation has traditionally been performed using drills and sharp-edged hand instruments. These methods, although often effective, have some major disadvantages. First, it is often difficult to establish the amount of dentine to be removed because of the possibility of unnecessary removal of sound tooth structure in addition to decayed tissue. Second, local anesthesia is needed to alleviate the pain and discomfort caused by mechanical methods.[1] To circumvent these drawbacks, alternative dental caries removal methods were proposed.[2]

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Alternative caries removal methods such as air abrasion, sonoabrasion, ultrasonic instrumentation and laser are expensive, and hence less frequently used.[3-5] In contrast, chemomechanical elimination of carious dentine is a promising alternative treatment procedure, particularly in pediatric dentistry and for anxious or medically compromised patients.[6] Chemomechanical caries removal was the first such method introduced in 1975 by Habib *et al*.[7] and used 5% sodium hypochlorite. This was followed by the introduction of GK-101, Caridex system and Carisolv, which consisted of sodium hypochlorite, glutamic acid, leucine and lysine.[7-9] Of these, only Carisolv was found to be effective in removing infected carious tissue,[10-13] but it failed to become a practical alternative to the conventional drilling method because of its high cost, special instrument requirements and time consumption.[3,14] Further, children disliked its chlorine taste and odor.

In consequence of such disadvantages, Papacarie (Fórmula and Ação, São Paulo, Brazil) was developed by Bussadori *et al*.[15] for removal of caries. It contains 10% papain, 0.5% chloramine, toluidine blue, salts and a thickening vehicle. Papain is responsible for its bactericidal, bacteriostatic and anti-inflammatory properties. Ease of application and no special device requirements are added advantages.

Cytotoxic studies of Papacarie have suggested that it is safe for use in pediatric patients.[16] A number of studies have compared the efficacy of chemomechanical methods with the conventional bur method and highlighted the merits of the former with respect to reduced pain and need of anesthesia as well as patient acceptance.[7,17-20] A few studies have used scanning electron microscope (SEM) to demonstrate the efficacy of Carisolv in removing infected primary[21,22] and permanent dentine.[23-26] However, to the best of the author's understanding, only Kotb *et al*.[26] have used SEM for demonstrating the efficacy of Papacarie in removing infected primary dentine. Therefore, this study was conducted to evaluate and compare the efficacy of Papacarie and the conventional method (bur) for caries removal in primary molars using SEM.

The null hypotheses tested for this study were that there was no difference in (1) efficacy of caries removal and (2) time required for caries removal, following the two caries excavation techniques.

MATERIALS AND METHODS

The present study was approved by the Institutional Review Board (IRB-2019-02-122) of Imam Abdulrahman Bin Faisal University (IAU), Dammam, Saudi Arabia. All tooth samples were collected from outpatient clinics at the Dental Hospital of IAU.

Experimental design

In this *in vitro* study, the method of carious dentine removal is the independent variable, and time (in seconds) required to remove dentine (efficiency) and the detection of bacteria after carious removal (efficacy) are the response or dependent variables.

Sample selection

Thirty freshly extracted, human primary molars with occlusal caries extending into the dentine, with cavity opening diameter ≥2 mm and with accessibility to hand instruments were collected over a period of 3 months from the Pediatric Dentistry clinics at the Dental Hospital. The sample size was determined using the Dinam 1.0 program, and calculations were performed considering time and colony-forming bacteria.

These teeth were extracted due to exfoliative mobility and/or orthodontic reasons. A written consent was taken from the patient's parent/guardian before the extraction procedure. The primary molars with occlusal caries extending into dentine were confirmed through intraoral periapical radiograph, whereas teeth involving pulpal and/or periapical pathology, multisurface carious lesions and teeth with developmental anomalies were excluded. The teeth were stored in phosphate-buffered saline containing 0.2% (w/v) sodium azide at 4°C.[26]

Specimen preparation

All soft tissue and extrinsic deposits were removed from the teeth using hand scalars, and the debris was cleaned with a slurry of pumice and water followed by rinsing in distilled water and drying with compressed air for 5 s.[26] Each tooth was sectioned through the center of the lesion into two halves mesiodistally using a diamond circular disc on a slow-speed handpiece with water spray. The cut surface of both pieces of each tooth was visually examined to see the extent of carious lesion. Only teeth in which carious lesion extended up to the dentine were included in the study. The two halves of each tooth were randomly assigned to Group I (caries removal by Papacarie) and Group 2 (conventional bur method) for evaluation of ultrastructure of residual dentine.

Caries removal

Group I consisted of 30 samples; carious tissue was removed for each sample using the Papacarie gel (Fórmula and Ação, Laboratório Farmacêutico Ltda Me, Sao Paulo, Brazil).

Dental caries was excavated using hand instruments after initial gel application for 30–60 s. The technique was continued until the lesion surfaces felt hard. The cavity was dabbed with a cotton pellet and washed with water spray.

Group II consisted of 30 samples; carious tissue was removed for each sample by conventional method, using a high-speed handpiece under water spray with a number 330 carbide bur, followed by a Hu-Friedy spoon excavator for any remaining infected dentine. The cavity was rinsed with water and wiped with a sterile cotton pellet.

Efficacy of caries removal

The completeness of caries removal was judged by visual (absence of any discoloration) and tactile (smooth passage of the explorer and absence of a catch or a tug-back sensation) methods in both groups by a pediatric dentist who was blinded to the group status.[26]

Time required for caries removal

The time for each caries removal technique was noted using a stopwatch. For Group I, time was calculated from the start of gel application until it was no longer cloudy. For Group II, time was calculated from the beginning of caries removal with a bur until it was free from caries.

SEM examination

Each sample was washed with distilled water and placed in 2.5% glutaraldehyde in 0.1 M phosphate buffer (pH 7.4) for 24 h, then washed and dehydrated in a series of graded alcohol solutions for 10 min each. The specimens were then mounted on aluminum stubs for gold sputter coating. Surfaces of the remaining dentine were examined under SEM (Hitachi S3000N, Tokyo, Japan) at 20 KV, and images were taken to analyze the presence or absence of bacterial deposits or smear layer in primary dentine after caries excavation in both groups.[26] All SEM observations were performed by a single examiner blinded to the grouping of the teeth.

Statistical analysis

The presence/absence of bacteria was compared between the two groups using chi-square test, and the time (in seconds) taken for caries removal was compared using *t*-test. The analysis was done using SPSS version 17.0 software (SPSS Inc., Chicago, IL, USA). Significance level was set at the 5% level.

RESULTS

The SEM analysis showed that the presence of bacterial colonies after caries removal with Papacarie ($n = 7$; 23.3%) was slightly higher than that with the conventional method ($n = 5$; 16.7%) ($P = 0.52$) [Table 1 and Figures 1, 2]. Further, significantly more time was taken for caries removal with Papacarie (mean = 351.56 s) than that with the conventional bur method (mean = 158.41 s) ($P < 0.0001$) [Table 2].

DISCUSSION

Removal of dental caries using rotary instruments is frequently associated with thermal and pressure effects on the pulp, which produces pain. Moreover, drilling may also involve the removal of sound tooth tissue adjacent to the affected caries area.[10,26,27] Due to the shortcoming of the drill, alternative techniques such as chemomechanical caries removal were developed.

The chemomechanical agents of caries removal have a disintegrating effect on caries tissue, while leaving healthy dentine largely intact. The affected tissue consists of mostly demineralized, partly disrupted collagen fibers together

Table 1: Comparison between two groups for the presence of bacteria

Dependent variable	Conventional group, *n* (%)	Papacarie group, *n* (%)
No bacteria	25 (83.3)	23 (76.7)
Bacteria present	5 (16.7)	7 (23.3)
χ^2, *P*	0.42, 0.52	

Table 2: Comparison between two groups for time taken to excavate caries

Dependent variable	Mean (SD)	
	Conventional group	Papacarie group
Time (s)	158.41 (17.86)	351.56 (18.48)
t-test, *P*	41.16, <0.0001*	

*Statistically significant at $P<0.0001$. SD – Standard deviation

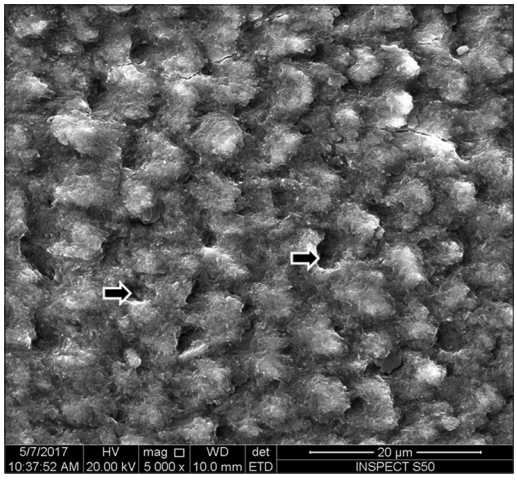

Figure 1: Scanning electron micrograph high magnification (×5000) of dentin surface in Group I showing open dentinal tubules (arrows pointing) with no bacterial colonies after caries removal with Papacarie gel

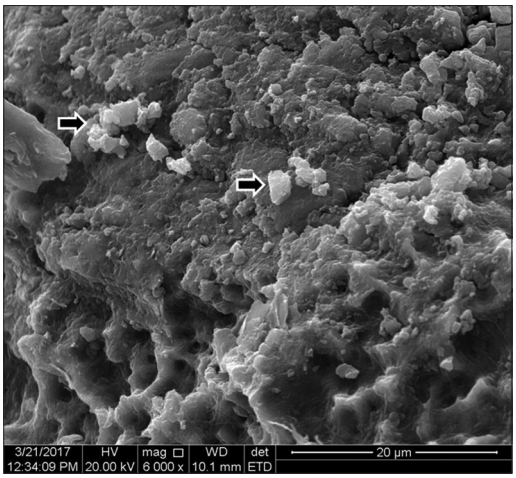

Figure 2: Scanning electron micrograph high magnification (×6000) of dentin surface in Group I showing amorphic layer indicative of smear layer (arrows pointing) at dentino-enamel junction (DEJ) after caries removal with Papacarie gel

with other components of the dentine extracellular organic matrix.[26] Papacarie acts by breaking the partially degraded collagen molecules. It breaks the polypeptide chains and hydrolyses the crosslinks of collagen fibrils. The appearance of bubbles on the surface and blearing of the gel during the clinical procedure indicate that the degradation is occurring, and oxygen is being released, and thus demonstrate that the removal process has begun.[20]

In this study, only caries-infected dentine was removed, and visual and tactile criteria were used to evaluate the efficacy of caries removal, as proven in previous studies evaluating the efficacy of chemomechanical methods.[10-12,25,28] The difference in the efficacy between Papacarie and drilling was found to be statistically insignificant (23.3% vs. 16.7%; $P = 0.52$). These results support those of previous studies.[28,29] Hence, the first hypothesis of this study was accepted: there is no significant difference in the efficacy of caries removal between the two caries excavation techniques.

In the present study, the mean time for caries removal in primary teeth using Papacarie was significantly higher than that using carbide bur (351.56 s vs. 158.41; $P < 0.0001$). These results corroborate the results of Singh *et al.*,[19] who reported that the time taken for caries removal with Papacarie was three times more than the conventional method. Requirement of multiple gel applications to complete caries removal could also account for the longer time. Thus, the second hypothesis was rejected, as there was a significant difference in the time required for caries removal between the two caries excavation techniques.

The slightly higher presence of bacterial colonies in the smear layer after the caries removal with Papacarie may have been because of the conservative preparation in this method compared to the conventional drilling with 330 carbide bur. This chemomechanical method preserves the sound tooth structure where the remaining bacteria can be found in the dentinal tubules. These findings are in contrast with the results of Kotb *et al.*,[26] who reported the absence of bacteria and open tubules due to the proteolytic effect of Papacarie, which enhances the disrupting effect of chloramines on degenerated collagen of carious dentin, thereby facilitating its removal. Our study results corroborate with those of Thakur *et al.*,[30] who found that use of Papacarie gel resulted in a minimal smear layer with the patent dentinal tubules.

A limitation of this study is that the visual and tactile measures used to evaluate the completion of caries removal are subjective. In addition, a single trained operator in a laboratory conducted this study, and this may result in variation when these techniques are used with multiple operators. Therefore, the author suggests validating this study's results with multiple operators in clinical studies in the future.

CONCLUSION

This study found that there was insignificant difference in the presence of bacterial colonies after caries removal with Papacarie and the conventional drilling techniques. This indicates that Papacarie can be used as a possible alternative to conventional methods for caries removal, particularly in highly active or anxious children. However, the longer excavation time with Papacarie gel should be considered during the selection of this caries removal method.

Ethical considerations

This study was approved by the Institutional Review Board (IRB-2019-02-122) of IAU, Dammam, Saudi Arabia. Parents/guardians of all patients provided a written consent for use of the extracted teeth in this study. This study was also conducted in accordance with the ethical standards in the Declaration of Helsinki, as revised in 2013.

Peer review

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Conflicts of interest

There are no conflicts of interest.

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