Evaluation of Caries Excavation Efficacy with Ceramic Bur and Hand Excavation in Primary Teeth: An Experimental Study

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ABSTRACT

Purpose: To compare the caries removal efficacy, time span, and evaluate pain experience during the caries excavation with ceramic bur and hand excavator in primary teeth of children aged between 4 years and 9 years.

Materials and methods: This study consisted of 26 subjects with bilateral occlusal carious lesions on primary molars. Caries excavations were performed with hand excavation and ceramic bur. The time taken for caries removal for both the techniques were measured with a stopwatch. The patient perception of pain during the treatment was evaluated with verbal pain scale and visual analog scale (VAS). The unpaired t-test was used for statistical analysis.

Results: Mean value of time taken for the removal of caries by hand excavation was 6.17 ± 0.99 minutes and for the ceramic bur, it was 4.35 ± 1.32 minutes and it was found to be significant. There was no significant difference found between verbal pain scale and VAS. Mean value of the caries excavation score for hand was 2.00 ± 1.17 and for ceramic bur was 0.69 ± 0.93.

Conclusion: The ceramic bur had better caries removal efficacy with less time compared to hand excavation method. The ceramic bur may be considered as a possible alternative technique for caries excavation in children.

Keywords: Caries removal efficacy, Ceramic bur, Hand excavation, Pain perception.

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INTRODUCTION

The pervasive conception of “Minimal Invasive Dentistry” implies that irreversibly denatured infected carious dentine should be removed selectively and preserved as much as possible potentially sound mineralizable tooth structure. The rules for operative dentistry were coined by Dr G. V. Black, the father of modern dentistry in the late 1800s. Among the various principles he set, the conception of “extension for prevention” is very important. The thought behind the principle was to eliminate the likelihood of further decay on the tooth surface, which was usually implicated for removal of a considerable amount of healthy tooth structure.1

At ultrastructural level, a carious dentine has been described as consisting of two distinct layers with different chemical characteristics.2 A wet and soft carious dentine contain significantly more bacteria compared to hard and/or dry dentine, so that clinicians are generally advised to excavate soft carious dentine up to the level where “firm” consistency of caries is achieved.3

Caries excavation with the use of the conventional technique is frequently associated with patients’ discomfort and pain, which subsequently leading to necessitate of administrating local anesthesia. The use of airotor is a more painful method for caries excavation compared to other methods in pediatric patients. Use of airotor involves efficient and quickly caries removal; however, at the same time, it may result in avoidable removal of the sound or even the affected dentine that shows the potential for remineralization.4–6

Chemomechanical caries removal (CMCR) technique is one of the noninvasive methods, which preserves healthy tooth structures and eliminates infected tissues without pulp irritation and patient discomfort. Chemomechanical caries removal technique is less painful but required more caries excavation time compared to conventional rotary method.7 Another alternative technique like air abrasion, ultrasonic instrumentation, and lasers was developed for caries removal to decrease the pulpal responses. Due to the economic concerns, these techniques are less often used by the pediatric dentists.8

In light of minimal-invasive tooth preparation and with the aim to simplify caries-removal procedures, new rotary cutting instrument, ceramic bur introduced for slow-speed caries excavation.9 A new ceramic bur manufactured of a special alumina-
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Materials and Methods

The study was carried out in the Department of Paedodontics and Preventive Dentistry. The experimental study was approved by the institutional ethics committee (SVIEC/ON/DENT/BNPG14/D15028). The detailed information regarding the study was explained to the participant and their parents and written consent was obtained from the participant’s parents.

The study was carried out in 4–9 years age group children. The inclusion criteria were: (1) Bilateral occlusal carious lesions on the maxillary and/or mandibular either first or second primary molars, (2) The teeth were selected based on the Mount and Hume classification that is 1.2 which was confirmed by radiograph to check extend of caries in to dentine, and (3) Children whose parents gave written consent for the study. Children with following criteria were excluded: (1) Molars with clinical or radiological signs and symptoms of pulpal, periodontal, and soft tissue pathology, (2) Non-vital teeth, and (3) Children with systemic disease and congenital abnormality.

After considering all the inclusion and exclusion criteria, total 26 subjects were selected for the study who had a bilateral active carious lesion on the occlusal surface. All the participants were thoroughly examined by the principal investigator on their first visit. The consistency of the carious lesion was assessed by straight explorer. The periapical radiograph (70 ekV, 10 mA, 1 second) was taken using Radio Visio Graphy (RVG, Owendy Radiology, France) to check the presence of any pathology and assess the depth of caries penetration toward the pulp. Remaining dentine thickness was checked according to RVG grid measurement for proper selection of the teeth.

The caries excavation procedure was performed under rubber dam isolation after selecting the proper size of clamp. In each patient, the teeth were divided randomly into group I and group II by flip coin method. All the procedures were performed by a single principal investigator only at the same appointment.

In the control group, the caries was excavated using brand new sterile spoon excavator (EXC 18, Hu-FriedyMfg.Co. Rockwell St., Chicago, USA), using round scooping movements of spoon excavator around the long axis of the instrument (Fig. 1). The caries excavation was stopped when hard dentine was detected with the straight explorer.

In the experimental group, the caries excavation was performed, using a ceramic bur (CeraBur, K1SM, Komet Dental, Lemgo, Germany) size 012 with slow speed (1,000–1,500 RPM) handpiece (Fig. 2). International Organizations for Standardization size 012 ceramic bur was used as their sizes were appropriate for occlusal caries according to the selection criteria. The carious tissue was excavated with circular movements starting from the center of the cavity to the periphery from the occlusal aspect without water coolant. The caries excavation was being terminated after hard dentin was detected.

The amount of time required for caries removal process was noted from starting of handpiece or using a spoon excavator until the final probing for dentin hardness. The time duration was assessed for the both the groups with the assistance using the stopwatch.

Patient evaluation regarding the discomfort was carried out immediately after the caries excavation. Pain threshold of the patient during the caries excavation was evaluated by visual analog scale (VAS) and verbal pain scale after removal of rubber dam. For the recording of VAS, patient was asked to make a mark on the horizontal line of scale (Fig. 3). For verbal pain scale, the patient was asked regarding the pain and discomfort and score ranged from 0 to 4 (Fig. 4).

The caries removal efficacy of both the techniques was verified using caries detector dye (Snoop, Pulpdent, USA) as recommended by the manufacturer. The dye was applied for 10 seconds and was rinsed off with sterile saline. The efficacy was graded from 0 to 5 by the coinvestigator using the criteria proposed by Ericson et al. (Fig. 5). After the grading for caries excavation efficacy, proper cleaning and toileting of the cavity was performed. In the deepest area of the cavity, wherever remaining dentin thickness was questionable, calcium hydroxide (DENTSPLY DycaI, Ivory, LD Caulk, USA) base was applied and restoration performed with glass ionomer cement (GC Fuji II, GC Corporation, Tokyo, Japan) in both the treatment groups.

Results

The data were analyzed using unpaired t-test. Level of significance was set at \( p < 0.05 \). The caries excavation procedure was carried out in total 26 patients (52 teeth) who had a bilateral carious lesion in these 14 males and 12 females were selected.
Table 1 shows the time required for caries excavation with both the techniques. The ceramic bur group had shown less time (4.31 minutes) for the caries excavation compared to hand excavation (6.17 minutes). These result data showed a significant difference in the caries excavation time in-between both the groups (\(p < 0.05\)). Table 2 shows a comparison of VAS in both the groups. The mean value of VAS for hand excavation was 2.46 and for ceramic bur it was 2.27. Ceramic bur was shown comparatively less mean value for VAS than hand excavation, but the difference between the mean VAS scores of both the groups was statistically not significant (\(p > 0.05\)).

Table 3 shows the comparison of verbal pain score in both the groups. Mean value of verbal pain scale for hand excavation was 1.04 and for ceramic bur it was 0.88. The mean difference between both the groups was 0.16 but, the mean score for ceramic bur was less compared to hand excavation, but there was no significant difference found between both the groups (\(p > 0.05\)).

Table 4 shows the comparison of caries excavation efficacy score between both the groups. Mean value of the caries excavation efficacy score for a group I was 2.00 and for group II was 0.69 with a mean difference of 1.31. The mean value of the caries excavation efficacy score for group II was less compared to group I. This difference was statistically significant (\(p < 0.05\)). These result data suggested that ceramic bur showed higher caries excavation efficacy compared to hand excavation.
DISCUSSION

New caries excavation techniques have always been a foremost intent in the field of dental research to get a probable alternative to available conventional methods. Newly developed techniques, such as, air abrasion, laser, and chemomechanical caries excavation, have been shown to be more or less success to overcome these problems. Most of the techniques are almost more time-consuming compared to bur preparation, investment, and space.

Ceramic cutting tools have excellent resistance to wear and cutting ability which also has good mechanical properties and hardness. The ceramic burs are made of an alumina-yttria ceramic. Alumina-yttria ceramic seems as promising ceramic for a highly efficient cutting tools. Only in vitro studies have been performed till date to check the caries removal efficacy using a ceramic bur by Dammaschke et al. and Neves Ade et al. In the present in vivo study, ceramic bur was used as an experimental group to check the clinical caries removal efficacy.

In our study, the time taken for caries excavation with both the methods were recorded using a stopwatch. The teeth treated with hand excavation (6.17 minutes) required more time for caries excavation compared to teeth treated with a ceramic bur (4.31 minutes). The caries excavation time required by ceramic bur in the present study was less compared to hand excavation and Carisolv group result which had been shown in the studies by Pandit et al., Kochhar et al., Goomer et al., and Soni et al. showed that caries removal efficacy of polymer bur was 0.47. In the present study, efficacy of ceramic bur was 0.69 which is higher than the polymer bur result shown by other studies.

According to Dammaschke et al., the time consumption for excavation with ceramic bur was the same comparable to carbide bur. In their study, caries excavation time required for ceramic bur was 159 seconds, while in our study it was 4.31 minutes. This difference was seen due to different clinical setup because our study was performed with the patient. The patient cooperation during the procedure is one of the factors, which requires more time with clinical setup as compared to in vitro study.

Soni et al. and Divya et al. have reported that polymer bur required 354 and 344 seconds, respectively, for the caries excavation whereas, in our study, ceramic bur required 258 seconds indicating less time taken for caries removal compared to polymer bur.

The reason for requiring more time utilization with polymer burs may be because the bur gets abraded when with hard dentin and attachment of another bur was required to the handpiece for complete caries excavation. Such abrasion is not expected with a ceramic bur that is made of alumina-yttria ceramic when compared to polymer bur.

The assessment of the pain was measured in the present study by VAS and verbal pain scale. Children, as young as 5 years of age, are able to use VAS, in which they mark a line so its length matches the strength of their perceptions, in a reliable and valid manner to rate their pain intensity. Use of the verbal pain scale offers the clinician some practical advantages over other pain measurement tools. In the present study, this scale was used as it was short, simple for the patient to complete, and easy for the investigator to score and analyze the type of pain.

Chemomechanical caries removal and polymer bur were less painful procedure whereas airotor was most painful procedure. In the present study, mean value of verbal pain scale for ceramic bur was less and which was comparable with chemomechanical caries removal and polymer bur group study by Pandit et al., Soni et al., and Goomer et al. During the caries excavation, removal of carious dentine generally elicits little or no sensation, while removal of sound dentine often results in some level of pain. The use of high-speed instrument associated with vibration, sensitivity of the vital dentin, and the development of high temperature at the cutting surface leads to thermal stimulation. In the present study, less pain was associated with ceramic bur as this was a low-speed rotary instrument which may give fewer number of cutting dentinal tubules where less pain sensations are triggered compared to the use of conventional carbide burs and an airotor.

Caries Removal Efficacy

In the present study, the efficacy of caries removal was checked with caries-detecting dyes. The caries removal efficacy score was measured by using Ericson scale, which was also used in various studies. In the present study, mean caries removal efficacy for hand excavation was 2.00 and for ceramic bur it was 0.69 which was statistically significant.

Ceramic bur was shown that caries removal efficacy was higher than hand excavation and comparable with Carisolv technique, but less than airotor technique. Kochhar et al., Goomer et al., and Soni et al. showed that caries removal efficacy of polymer bur was 0.47. In the present study, efficacy of ceramic bur was 0.69 which is higher than the polymer bur result shown by other studies.

According to Shivasharan et al., more than one polymer bur was required for the complete excavation of dental caries. Another disadvantage with polymer bur is difficult to use in small cavities as it easily touched the enamel by chance and the polymer bur become blunt. Ceramic bur can be used in the small size cavity as it does not abrade and caries removal can be accomplished with a single bur only.

Dammaschke et al. had shown that ceramic bur tended to leave more caries on the floor of the cavity as compared to a tungsten-carbide bur but this difference was not statistically significant. Neves Ade et al. compared ceramic bur and different other caries excavation technique, Er/YAG laser, Carisolv, Caries-Detector Dye, Cariex (oscillating sono-abrasion), and Tungsten-carbide bur. The analysis was to check caries-removal efficacy and minimal-invasiveness, potential of these caries-extraction techniques through micro-CT. Ceramic bur and Cariex which showed a tendency for under-preparation with leave residual caries at the cavity floor and walls, respectively. Among the all techniques, ceramic bur and Cariex are the most conservative caries removing methods.

Neves Ade et al. observed the largest area of “unprotected” collagen when caries was excavated with a ceramic bur. This zone may represent residual caries that may have remained after the cavity preparation with ceramic bur. Ceramic bur may have left some carious tissue behind in some samples, at least when used without any other caries-removal endpoint indication. This also supports the minimal invasive potential of ceramic bur.

Ismail and Haidar stated that chemomechanical caries removal might not able to restore the use of rotary instruments for caries removal, although it could be used as an alternative treatment in the cases who required multiple restorations as well as those who have difficult behavior in the toddler children.

The use of ceramic bur provides better tactile control over the airotor, it removes soft dentine smoothly and when it reaches sound dentine, we feel some resistance and vibration which is suggestive of no further removal of caries. The mean value for VAS and verbal pain scale was found less for ceramic bur in comparison to hand excavation.
There are few limitations of the study, the long-term follow-up with retention of restorative material, secondary caries formation, and microbial count assessment with ceramic bur and other caries excavation techniques. The future research can be performed with comparison of preoperative and postoperative remaining dentin thickness with ceramic bur and other techniques.

The previous in vitro study proved that some minimal invasive potential of ceramic bur. The present in vivo study evaluated whether sufficient amounts of soft carious dentine can be removed by ceramic burs with minimal time and discomfort in children. It is usually accepted that all soft, carious dentin should be excavated before restoration, which was achieved with ceramic bur.

**Conclusion**

The time taken to remove caries by ceramic bur was less as compared to the hand excavation method. There was no difference found regarding the painful experiences of the patients during caries excavation as both the techniques were less painful. The caries excavation ability of ceramic bur was better compared to the hand excavation technique. Thus, it was concluded that ceramic bur required less time for caries excavation, can be used as an alternative to hand excavation in anxious children.

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