

# EVALUATION OF POLYMER BUR FOR CARIOUS DENTIN REMOVAL IN PRIMARY TEETH

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## Abstract:

**Introduction:** The development of a self-limiting caries removal technique would be of great clinical importance. Smart bur II is a relatively new bur in the dental market and its manufacturer is claiming that it is the ultimate bur for selective caries removal.

**Objectives:** The aim of this study was to evaluate caries removal time and efficacy of Smart bur II in comparison with conventional carbide bur.

**Material and methods:** Twenty-three children, each with bilateral primary canine showing comparable class V carious lesions were selected for this study. They were randomly divided into two groups. Group I (n=30): caries was removed using the Smart bur II, Group II (n=30): caries was removed using the conventional carbide bur. The efficacy of caries removal was evaluated by "tug-back" sensation. Time needed for caries removal in both groups was recorded in seconds. An additional group of seven extracted carious primary canine were randomly selected for the in vitro study. Teeth were cut into 2 halves through center of the lesion, one half was subjected to caries removal using Smart bur II as in group I and conventional carbide bur was used in the other half as in group II. The specimen were prepared and topographic features of dentin after caries removal was evaluated using the scanning electron microscope.

**Results:** The comparison of caries removal efficiency between smart bur II and carbide bur showed that the smart bur II completely removed caries in 11 cases accounting for 36.6% and incompletely removes caries in 19 cases accounting for 63.4%. While the carbide bur completely removed caries in 28 cases accounting for 93.3% and incompletely remove caries in 2 cases accounting for 6.7%. Caries removal time ranged between 192 seconds to 380 seconds for smart bur II, while caries removal time ranged between 198seconds to 361 seconds for carbide bur (control group). The mean  $\pm$  SD caries removal time was 271.16 $\pm$  26.78 for Smart bur II and 235.16 $\pm$  27.37 for carbide bur. The results of both caries efficiency and caries removal time were significantly different at  $p \leq 0.05$  and  $p \leq 0.05$  respectively.

**Conclusions:** The smart bur II had significantly lower caries removal efficiency when compared to conventional carbide bur. The smart bur II required significantly longer caries removal time when compared to conventional carbide bur.

**Keywords:** Polymer bur, conventional carbide bur, caries removal efficiency, caries removal time.

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## INTRODUCTION

Over the last decades, dental research has notably improved restorative techniques and materials with the purpose of producing, as reliably as possible, the characteristics and appearance of lost dental tissue. Moreover, the development of adhesive restorative systems minimized the need for resistance form or additional retention and enabled cavities to be prepared without excessive reduction and extension into sound tooth structure (1).

Dentin caries can be divided into two layers. The superficial or outer layer (infected dentin) is contaminated with bacteria, which dissolves the mineralized tissue of dentin and damages the collagen matrix so that remineralization becomes impossible. This layer must be completely removed during caries excavation. However, the inner layer (affected dentin) is invaded by bacteria, which dissolves the mineralized tissue, but the cross-banded ultra-structure of the collagen matrix remains. If these bacteria and their metabolic products which are the main cause of caries are removed, the inner layer of dentin caries can remineralize (2).

Traditional methods of caries removal, such as burs and spoon excavators, tend to remove affected as well as infected dentin, because it is difficult clinically to distinguish between the two. However, total removal of all caries may not be necessary to control progression of the lesion, provided that the restoration is sealed adequately from the oral environment (3). Hence, mechanical caries

excavation may have the disadvantage of leaving residual caries or preparing over extended cavities (4). Recent developments in caries removal have therefore involved removal of only soft infected dentin (5).

Moreover, the use of the drilling as the conventional caries removal and cavity preparation method, other than being painful, can cause deleterious thermal (6) and pressure effects on the pulp (7), thus lowering the regenerative potential of the pulp-dentin complex.

Because conventional carbide burs may result in excessive loss of sound tissue, alternative techniques have been researched for their caries removal efficacy (8). Chemomechanical systems utilize solutions or gels to selectively dissolve carious dentin. These methods however are quite time consuming (9). Another selective method for removal of carious dentin is air abrasion. Removal of carious dentin can be controlled by varying the hardness and sizes of the abrasive particle, the cross sectional area of the fluid stream, and the shape of the abrasive particles. The drilling method is preferred for deep caries removal due to air abrasion's inability to remove soft carious dentin (10).

The sonoabrasion technique provides the removal of the carious tissue using diamond-coated oscillating tips. This method, however, tends to under prepare cavities. (11) These approaches apparently have not superseded conventional methods, including burs and hand excavation, among dental practitioners.

Boston in 2000 (12), has described a polymer bur that only removed softened and infected dentin but not the

affected dentin. The cutting elements of the bur were made of a softer polyamide polymer material different than the traditional carbide bur. This minimally invasive excavation has the advantage of fewer dentinal tubules being cut and, thereby, less pain sensations being triggered compared to using conventional burs. Polymer bur instruments look like conventional burs, but they are not manufactured from metal, instead, they are manufactured from a special polymer material. The cutting edges are not spiral-like but shovel-like straight. The polymer material has a Knoop Hardness of 50 and was developed with the aim to be harder than carious, softened dentin (Knoop Hardness 0–30) but softer than healthy dentin (Knoop Hardness 70–90). The manufacturer aim was to remove carious dentin selectively, whereas, healthy dentin is not affected. The polymer cutting edges will wear down in contact with harder materials, such as healthy dentin, and will go blunt (13).

Allen et al in 2005 (14) showed that using polymer burs without local anesthesia was accepted by patients. Silva et al in 2006 (15) found that dentin surfaces of permanent teeth prepared by polymer burs exhibited significantly lower bond strengths than with carbide burs. An in-vitro study by Hauman and Kuzmanovic in 2007 revealed that polymer burs remove significantly less sound dentin than stainless steel burs and concluded that polymer burs do not cut affected, sound dentin (16).

However, Silva et al in 2006 evaluated tooth surfaces prepared by polymer burs with transmission electron microscopy and found incompletely removed infected dentin in extracted permanent molars (15).

Due to these advantages and few studies reported, the purpose of this study was to determine the polymer bur's efficacy for caries removal in the primary teeth in comparison with the conventional carbide bur.

The null hypothesis was that, the smart bur II is as efficient as the conventional carbide bur in carious dentin removal.

## MATERIALS AND METHODS

The study consisted of a clinical trial and an in vitro study.

Thirty bilateral primary carious canines in children aging 4-8 years were selected from the Pediatric Dentistry and Dental Public Health out-patient clinic at the Faculty of Dentistry, University of Alexandria after securing necessary consents.

The selected children fulfilled the following criteria: Children aged 4-8 years. Children definitely positive or positive according to Frankl Behavior Rating Scale (17). The teeth inclusion criteria were as follows: Class V dentinal carious lesions accessible to rotary instrument (18), caries with medium or soft consistency according to Bjorndal (19), and asymptomatic vital teeth with no proximal caries as evidenced by bite wing radiograph. Teeth exclusion criteria were as follows: Carious lesions with clinical or radiological signs and symptoms of pulpal involvement (interfere with sleeping, history of spontaneous throbbing pain, sensitivity to percussion, gingival redness, swelling or fistula).

Pre-operative examination was done to assure proper

case selection, including: (History taking, clinical examination and radiographic examination.)

The researcher was trained and calibrated on the use of smart bur II, intra-examiner reliability was then assessed using Kappa statistics. The Kappa value was 0.8 revealing high strength of agreement (20).

The sixty teeth were randomly assigned to two groups of 30 teeth each as follows:

**Group I:** (n=30) caries was removed using the smart bur II (SS White).

**Group II:** (n=30) the control group, caries was removed using the conventional carbide bur (SS White).

Treatment was carried out according to the following steps: (No local anesthesia was given, unless required, partial isolation was done using cotton rolls and saliva ejector, caries removal was performed using either of the two methods)

In group I (test group) removal of carious dentin was carried out employing smart bur II mounted on a low speed handpiece without water spray. Caries removal proceeded until the smart bur II becomes dull after repeated contact with healthy dentin (21).

In group II (control group) carious dentin was removed using a low speed handpiece without water spray (21), and different sized Tungsten carbide burs, appropriate to cavity size.

Caries removal was terminated when no dentin discoloration was observed visually, under adequate light (22).

Following cavity preparation, each tooth was examined by visual inspection and tactile sensation using a mirror and an explorer to assess caries removal efficiency. Caries was considered to be removed when the explorer did not stick in dentin and did not give a tug-back sensation. The efficiency of caries removal was graded as complete or incomplete and numerically scored 0 or 1 respectively (23).

For both groups, the duration taken for caries removal for each sample was recorded in seconds using a stopwatch. Time taken for caries removal was calculated from the actual start of caries removal until complete carious dentin removal (24).

A total of seven freshly extracted carious deciduous teeth fulfilling the tooth criteria in the clinical trial, were collected for the in vitro study. Each tooth was sectioned longitudinally through the center of the carious lesion into two halves. In one half, caries was removed using the smart bur II, test group (Group I). In the other half, caries was removed using the conventional carbide bur, control group (Group II).

In both groups, caries was removed following the same steps as in the clinical study.

After caries removal, all specimens were dehydrated by passing through ascending grades of ethyl alcohol, 50%, 70%, 95%, then absolute alcohol. Specimens were then vacuumed and gold sputter coated with gold-palladium layer prior to examination (25). The topographical features of the dentin was examined using scanning electron microscope (SEM).

Data concerning caries removal efficiency and time required for caries excavation were tabulated and fed to the

computer and analyzed using statistical software (SPSS pc+ version 16.0). Comparison between the two groups was done using Fisher's exact test for caries removal efficiency. Two-Tailed paired T test was used for time required for caries excavation. Significance of the obtained results was judged at 5% significance level.

**RESULTS**

**A. Results of Clinical Study:**

The present study included 23 patients, they had thirty bilateral primary carious canines, to compare the caries removal efficiency and time of smart bur II to that of carbide bur. From the 23 patients participating in the study, 14 (60.8%) were females and 9 (39.2%) were males. Patients' ages ranged between 4-7 years with mean ± SD age of 5.39 ± 0.94 years.

The study included 16 carious bilateral primary maxillary canines, and 14 carious bilateral primary mandibular canines (a total of 30 bilateral primary canines).

Table (1) shows the comparison of caries removal efficiency between smart bur II and carbide bur showed that the smart bur II completely removed caries in 11 cases accounting for 36.6% and incompletely removed caries in 19 cases accounting for 63.4%. Whereas, the carbide bur completely removed caries in 28 cases accounting for 93.3% and incompletely removed caries in 2 cases accounting for 6.7%. Fisher's exact test revealed significant difference between both groups (P ≤ 0.05).

**Table 1:** Comparison of caries removal efficiency between smart bur II and carbide bur.

	Smart bur II	Carbide bur
Tug back score	n (%)	n (%)
0	11(36.6%)	28(93.3%)
1	19(63.4%)	2(6.7%)
total	30(100%)	30(100%)
P	<0.0001*	

\*: Statistically significant at p ≤ 0.05.

Table (2) shows the comparison of caries removal time between Smart bur II and carbide bur. Caries removal time ranged between 192 to 380 seconds for smart bur II (test group), whereas caries removal time ranged between 198 to 361 seconds for carbide bur (control group). The mean ± SD caries removal time for smart bur II was 271.16 ± 26.78 (test group) and for carbide bur was 235.16 ± 27.37 (control group). Two-Tailed paired T test revealed significant difference between both groups (P ≤ 0.05).

**B. Results of scanning electron microscope:**

Examination of the dentin surface at the floor of the cavity following caries removal using the smart bur II revealed the following:

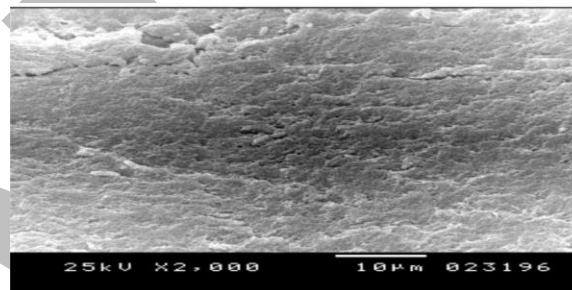
Most of the specimens showed an irregular globular surface, almost completely covered by smear layer (Figure 1).

**Table 2:** Comparison of caries removal time between smart bur II and carbide bur

	Smartbur II(seconds)	Carbide bur (seconds)
Min-max	192-380	198-361
Mean	271.1667	235.1667
(SD)	26.78	27.372
P	<0.0001*	

p: p value for Two-Tailed paired T test comparing the two studied groups

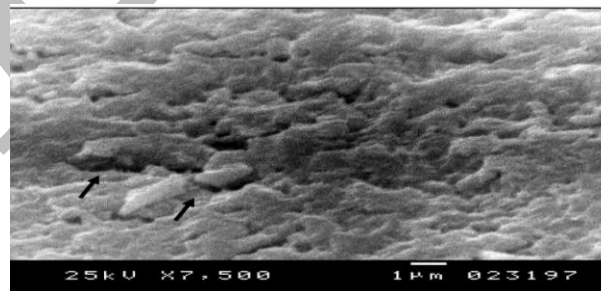
\*: Statistically significant at p ≤ 0.05.



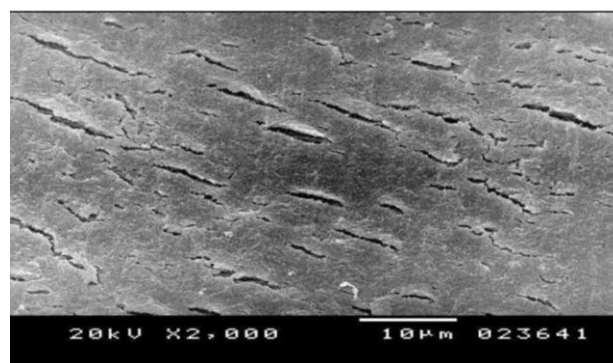
**Fig. 1:** Scanning electron micrograph (SEM) of dentin surface following caries removal by smart bur II (Mag. x2000)

The smear layer gave the dentin floor a cloudy appearance with very few, barely detected dentin tubules orifices (Figure 2).

Other cavities appeared with obvious fissures within their floor, certain areas showed clearly exposed dentinal tubules openings with little amount of smear debris haphazardly scattered (Figure 3).



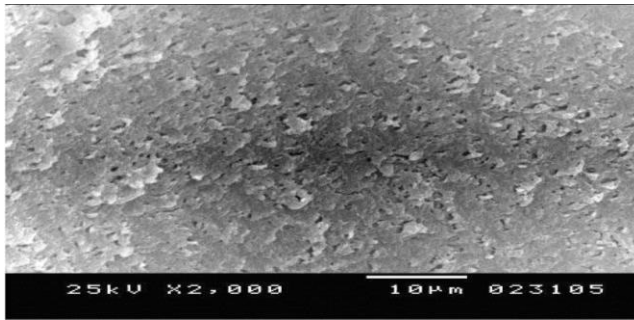
**Fig. 2:** Scanning electron micrograph (SEM) of dentin surface following caries removal by smart bur II (Mag. x 7500)



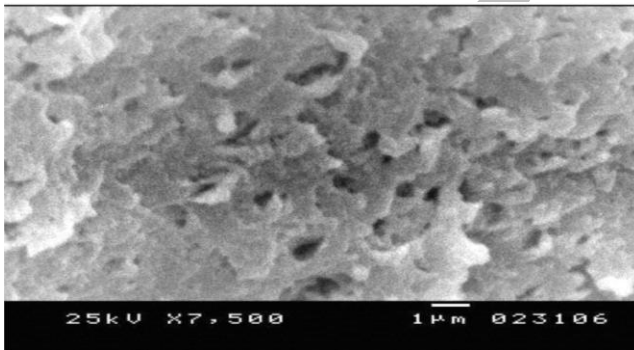
**Fig. 3:** Scanning electron micrograph (SEM) of dentin surface following caries removal by Smart bur II. (Mag. x2000)

Examination of the dentin surface at the floor of the cavity following caries removal using the carbide bur revealed the following:

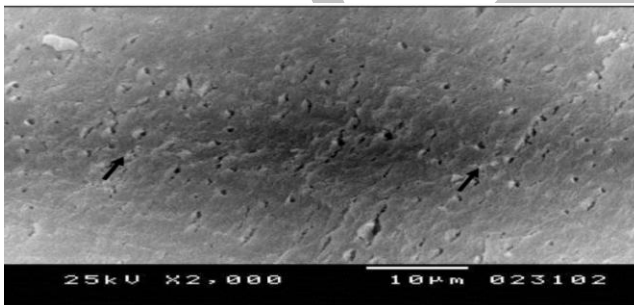
Most of the specimens showed an irregular porous surface (Figure 4), with almost complete removal of the smear layer (Figure 5). Obvious cracking and scratches were seen traversing the floor of the cavity. The openings of dentinal tubules were evidently exposed with fissures and grooves passing from them into the adjacent peritubular and intertubular dentin (Figure 6). Bacterial deposits were barely detected in carbide bur specimens.



**Fig. 4:** Scanning electron micrograph (SEM) of dentin surface following caries removal by carbide bur. (Mag. x2000)



**Fig. 5:** Scanning electron micrograph (SEM) of dentin surface following caries removal by carbide bur. (Mag. x7500)



**Fig. 6:** Scanning electron micrograph (SEM) of dentin surface following caries removal by carbide bur. (Mag. x2000)

## DISCUSSION

As the principles of minimal invasive approach indicate the need to remove only dental tissue to the extent that is strictly necessary for treatment. The development of a self-limiting caries removal technique would be of great clinical importance.

Smart bur II is a relatively new bur in the dental market and its manufacturer is claiming that it is the ultimate bur for

selective caries removal. The current study found an interest in comparing caries removal efficiency and time needed for caries removal between Smart bur II and conventional carbide bur in primary teeth. Also the present study assessed the topographic features of dentin after caries removal with the smart bur II compared with the conventional carbide bur in primary teeth. The study consisted of two parts, a clinical trial and an in-vitro study. In both studies self-control study design was employed.

The clinical trial included 30 primary canines, inclusion and exclusion criteria aimed to ensure that all studied teeth were vital with no pulpal involvement. Therefore, no pulpal treatment was needed. To ensure standardization, each primary canine was used as test control. Class V cavity design was considered the most appropriate cavity design for comparing caries removal efficiency and time between smart bur II and conventional carbide bur in primary teeth. Class V cavity does not have any macro-mechanical undercut eliminating the need of access gaining before employing smart bur II. In the present study, sample characteristics concerning lesion location and consistency were comparable to exclude any variable that could affect the final results.

Rubber dam was not used in the present study to avoid any possible discomfort that could be associated with clamp placement, since treatment was initiated without local anesthesia. Also, according to manufacturer's instruction, smart bur II doesn't necessitate complete isolation. Allen et al in 2005 stated that when dentin cutting is limited to the superficial layer of infected dentin, sparing the odontoblast reaction zone, caries removal can be completed without the need for local anesthesia (26).

In the present study the visual and tactile criteria were adopted because it is the most widely used clinical criterion to evaluate complete caries removal (27).

The results of the present study revealed significant difference between smart bur II and conventional carbide bur in both caries removal efficiency and time needed to remove caries. Smart bur II was significantly less efficient in caries removal and required more time for caries removal.

El Nasri et al in 2015 evaluated the efficacy of caries removal by hand excavation (ART), chemo-mechanical caries removal agent (carisolve) and polymer bur (smart bur II). The results of El Nasri study showed that smart bur II had significantly lower caries removal efficiency when compared to either carisolve, or hand excavation (ART), the lower caries removal efficiency of smart bur II reported by El Nasri is in agreement with our results (28).

Celiberti et al in 2006 assessed caries removal effectiveness of 4 different dentin excavation methods, one of them was polymer bur in primary molars. The study revealed that polymer bur and Er:Yag laser left the largest amount of decayed tissue unexcavated in agreement with our results. However, both hand excavator and chemomechanical caries removal showed effective caries removal (29).

The results of the present study regarding time needed for caries removal were in agreement with Prabhakar et al in 2009 (30), and Allen et al in 2005 (26). The polymer bur

caries excavation time was significantly longer when compared to conventional bur in both of the previous studies. The former studies attributed the longer excavation time of polymer bur to the lower hardness number of the polymer bur, the path taken by the instrument and the need to change the bur when it becomes dull following contact with sound dentin.

Vijay et al in 2012 concluded that polymer bur was more time consuming than conventional burs, but at the same time the polymer bur was more conservative and selective in removing carious dentin (31).

The in vitro study included 7 primary canines. The methodology of the in vitro part of current study was conducted to simulate the clinical situation as closely as possible. Thus natural primary teeth were employed, following the same teeth selection criteria used in the clinical trial. To ensure standardization each primary canine was used as test control. The scanning electron microscope was employed to evaluate the topographic characteristics of the dentin surface following the smart bur II and the conventional bur caries removal.

The scanning electron microscope showed different topographic characteristics of the dentin surface in both tested groups. The dentin surface following the smart bur II caries removal showed irregular globular surface, almost completely covered by smear layer. However, the dentin surface following conventional bur caries removal showed an irregular porous surface with almost complete removal of the smear layer.

The topography of the prepared dentin surface influence the bonding of the adhesive restorative materials. After mechanical removal of caries with rotary instruments a smear layer is formed (32). The smear layer is an amorphous layer of organic and inorganic debris which is formed on the dentin surface after accomplishment of cavity preparation and removal of the carious tissue. It adheres firmly to the dentin surface from where it cannot be removed by the ordinary water spray and prevents resin from adhering to dentin, thus the smear layer has to be removed or modified prior to the placement of the restoration (33).

The topographic study also showed very few, barely detected dentinal tubules orifices, with numerous bacterial deposits on dentin surface following the smart bur II caries removal. Whereas the openings of dentinal tubules were evidently exposed, with clearly obvious peritubular and intertubular dentin, and bacterial deposits were barely detected on dentin surface following the conventional bur caries removal. This probably indicates that the conventional bur removes both the infected and affected dentin reaching to the underlying sound dentin, while the smart bur II removes only the infected dentin and preserves the affected dentin.

A possible limitation of the present study was comparing caries removal with smart bur II to a single type of minimal invasive caries removal methods (conventional carbide bur), on the other hand comparing smart bur II to different minimal invasive caries removal methods might have revealed a wider range of results. However, further studies with special attention to restorative and adhesive

characteristics following the use of smart bur II are needed.

## CONCLUSIONS

Within the limitations of the present study, the following was concluded:

- In comparison to the conventional carbide bur the smart bur II had less caries removal efficiency when compared to conventional carbide bur.
- In comparison to the conventional carbide bur the smart bur II required longer caries removal time when compared to conventional carbide bur.
- The dentin floor topography varied between the tested materials indicating more dentin removal by carbide bur.

## CONFLICT OF INTEREST

The authors declare that they have no conflicts of interest.

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