ISSN: 2581-5989
PubMed - National Library of Medicine - ID: 101738774

International Journal of Dental Science and Innovative Research (IJDSIR)

IJDSIR : Dental Publication Service

Available Online at: www.ijdsir.com

Volume – 5, Issue – 6, November - 2022, Page No. : 22 - 29

Efficacy of Polymer Smart Burs compared with Conventional carbide burs in dental caries removal

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Citation of this Article: Nagham Khoury, Mohannad Laflouf, Saleh Al Kurdi, "Efficacy of Polymer Smart Burs compared with Conventional carbide burs in dental caries removal", IJDSIR- November - 2022, Vol. – 5, Issue - 6, P. No. 22– 29.

Type of Publication: Original Research Article

Conflicts of Interest: Nil

Abstract

Introduction: Advances in cariology and dental materials have brought new approaches to the field of dentistry in terms of caries treatment modalities in the last few decades. Smart Burs are polymer burs with self-limiting ability.

Materials and Methods: A total of 40 carious primary mandibular molars were selected for the study from schools. They were equally assigned to two groups according to caries removal technique. In Group 1, caries was removed using Smart burs and in Group 2, with Conventional carbide bur. The efficacy of caries removal was evaluated using Ericson scale. An additional group of seven extracted carious primary molars 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 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 and carbide bur showed that the smart bur completely removed caries in 5 cases accounting for 25% and incompletely removes caries in 9 cases accounting for 45%. While the carbide bur completely removed caries in 19 cases accounting for 95% and incompletely remove caries in 0 cases accounting for 0%.

Conclusion: The smart bur had significantly lower caries removal efficiency when compared to conventional carbide bur $p<0.05$.

Keywords: Smart burs, Polymer burs, Conventional method.

Introduction

Dental caries represents a major problem in Pediatric dentistry. It is a multifactorial disease, resulting from the

interplay between environmental, behavioural, and host factors. It results in demineralization of inorganic part and destruction of organic part of the tooth structure(1). 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(2).The conventional treatment of dental caries using rotary instruments is problematic in Pediatric dentistry. It has many disadvantages as the perception of unpleasantness by patients, use of local Anesthesia, and removal of both infected and affected dentin leading to unnecessary weakening of the tooth structure. Furthermore, it has deleterious thermal effects on pulpal tissue and there is a possibility of iatrogenic pulp exposure.

Although the pain associated with caries excavation can be managed through local Anesthesia, fear of the needle, noise, and vibration of mechanical preparation remains a cause of discomfort for the patient (3–5).

Moreover, these techniques present the risk of easily removing healthy dental tissues or damaging the pulp through temperature rise, which may be in the origin of discomfort (thermal stimulation) (4). Because conventional carbide burs may result in excessive loss of sound tissue, alternative techniques have been researched for their caries removal efficacy(6). The current practice is to keep the size of cavities as small as possible using minimal cavity preparation designs with adhesive restorations. Thus, the goal is to preserve the tooth structure as much as possible(3).

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 .Smart Burs came in three different sizes – 004, 006, 008 used in slow speed rotary hand piece at 500–800 rpm which can easily remove soft carious dentin(7,8).

Materials and Methods

A total of 40 carious primary mandibular molar teeth in children aging 6-8 years were selected for the study from schools after taking written consent from parents.

Inclusion criteria

- Children definitely positive or positive according to Frankl Behaviour Rating Scale.
- Healthy children of both sexes from 6 to 8 years of age who are willing to participate in the study

- Patients with asymptomatic carious lesions with distinct dentin involvement, which was verified by radiograph in relation to mandibular primary molars
- Carious lesions without any pulpal involvement.

Exclusion criteria

- Uncooperative
- Grossly decayed teeth
- Deep carious lesions with pulpal involvement.

Pre-operative examination was done to assure proper case selection, including: (History taking, clinical examination and radiographic examination.)

The selected subjects were assigned to two groups according to the caries removal technique. Each group comprised of 20 carious primary mandibular molars. Isolation was done by rubber dam. After caries removal, the cavity was restored with (GC Fuji IX GP), glass ionomer cement.

- Group 1 - caries removal using Smart burs.
- Group 2 - caries removal with carbide conventional rotary drill.

A total of seven freshly extracted carious deciduous molars 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, 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 (9).

The topographical features of the dentin was examined using scanning electron microscope (SEM).

Methodology

Group 1 procedure

The involved tooth was isolated with rubber dam, Caries detecting Nishika s (Caries Detector: containing 1% acid red in propylene glycol) was applied using an applicator tip and was washed with water. Caries was excavated with Smart Burs in slow speed hand piece with circular movements starting from the periphery to the Center of the lesion Caries removal was verified by caries detector. After the caries was removed by using different methods, the caries-detector (propylene glycol) was again applied on carious lesion for one minute.

Washing was done with water and the efficacy was evaluated during the caries removal by Ericson D et al. scale*. The drill was used to adjust the periphery, and the tooth was restored with (GC Fuji IX GP), glass ionomer cement. [Figure 1].

Group 2 procedure

The involved tooth was isolated with rubber dam, Caries detecting Nishika s (Caries Detector) (containing 1% acid red in propylene glycol) was applied using an applicator tip and was washed with water. Caries was excavated with rotary drill with high-speed hand piece. Caries removal was verified by caries detector.

After the caries was removed by using different methods, the caries-detector (propylene glycol) was again applied on carious lesion for one minute. Washing was done with water and the efficacy was evaluated during the caries removal by Ericson D et al. scale*.

The drill was used to adjust the periphery, and the tooth was restored with (GC Fuji IX GP), glass ionomer cements the tooth involved was isolated with a rubber dam. [Figure 2]. Efficacy of caries removal was evaluated by assessing the amount of remaining caries left by following scores given by Ericson set al.(5)

0 - Caries removed completely.

1 - Caries present in base of the cavity.

2 - Caries present in base and/or wall.

3 - Caries present in base and/or two walls.

4 - Caries present in base and/or >2 walls.

5-Caries present in base, walls, and margins of cavity.

The obtained data were subjected to statistical analysis Chi-Square test accomplished by Fisher's Exact Test. SPSS 17.

Results

A. Results of Clinical Study

The present study included 40 patients, they had forty primary carious molars, to compare the caries removal efficiency of smart bur to that of carbide bur. Patients' ages ranged between 6-8 years. The study included 40 carious primary Mandibular second molar and Table (1) shows the comparison of caries removal efficiency between smart bur and carbide bur showed that the smart bur completely removed caries in 5 cases accounting for 25% and incompletely removed caries in 9 cases accounting for 54%. Whereas, the carbide bur completely removed caries in 19 cases accounting for 95% and incompletely removed caries in 0 cases accounting for 0%. Chi-Square Fisher's exact test revealed significant difference between both groups ($P \leq 0.05$). Statistically significant $p= 0.000 < 0.05$

	Smart burs	Carbide burs
Caries removal	n (%)	n (%)
Completely	5(25%)	19(95%)
Good	4(20%)	1(5%)
Partial	2(10%)	0
Incompletely	9(45%)	0

B. Results of scanning electron microscope:

Examination of the dentin surface at the floor of the cavity following caries removal using the smart bur revealed the following: Most of the specimens showed an irregular globular surface, almost completely covered by smear layer. The smear layer gave the dentin floor a cloudy appearance with very few detected dentin tubules orifices (Figure 1).

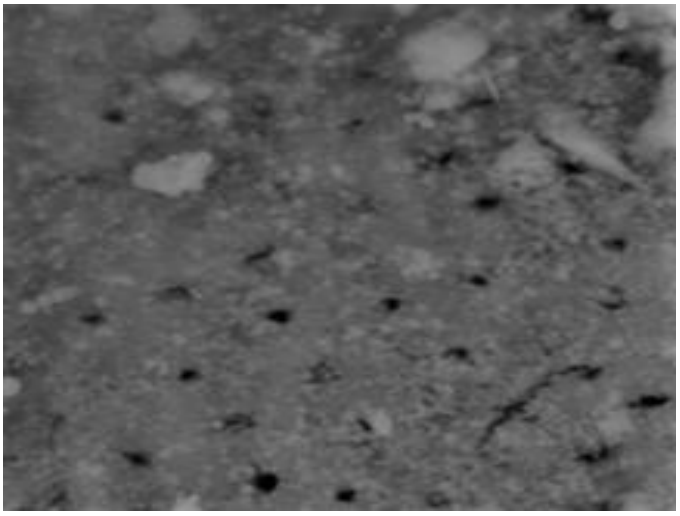

Fig. 1: Scanning electron micrograph (SEM) of dentin surface following caries removal by smart bur (Mag. X5.00).

Other cavities appeared with obvious fissures within their floor, certain areas covered with smear. This cavity showed clearly remnants of polymer bur randomly placed all over the cavity floor (Figure2).

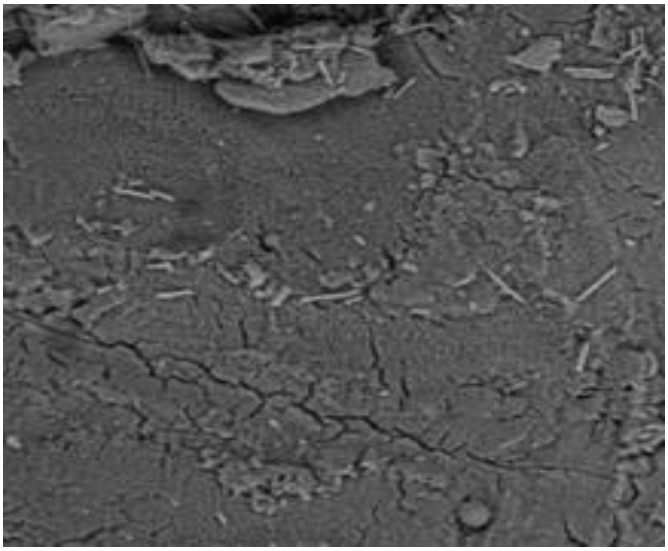

Fig.2: Scanning electron micrograph (SEM) of dentin surface following caries removal by Smart bur. (Mag. X400)

This cavity showed clear remnants of polymer bur and Bacterial deposits with few exposed dentin tubules (Figure3)

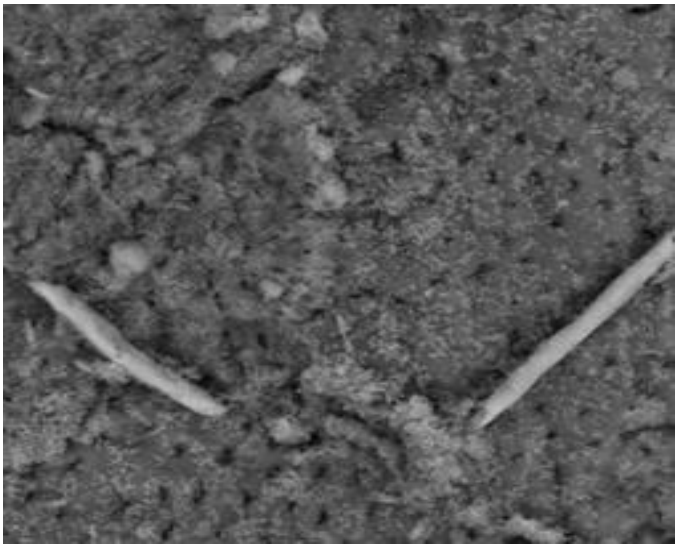

Fig. 3: Scanning electron micrograph (SEM) of dentin surface following caries removal by smart bur (Mag. X2.00)

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, with almost complete removal of the smear layer (Figure4).

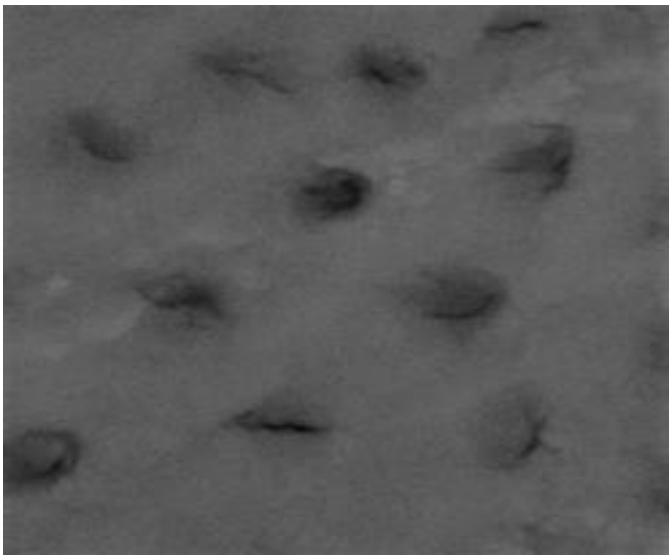

Fig. 4: Scanning electron micrograph (SEM) of dentin surface following caries removal by carbide bur. (Mag. X10.00)

Obvious cracking and scratches were seen traversing the floor of the cavity. The dentinal tubules were evidently exposed and bacterial deposits were barely detected in carbide bur specimens (Figure5).

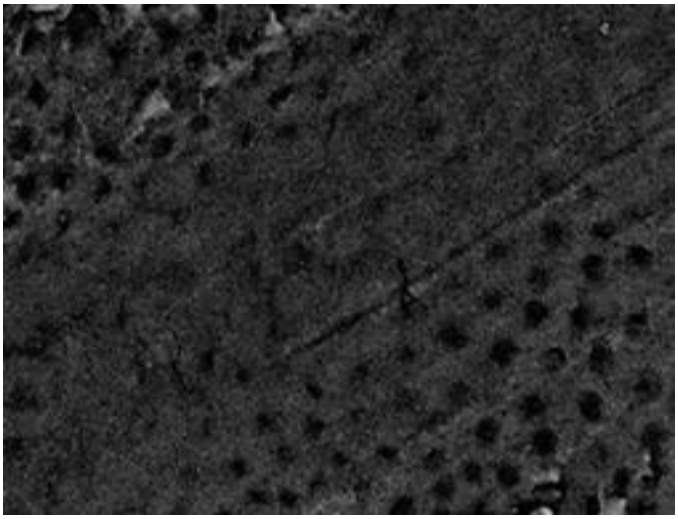

Fig. 5: Scanning electron micrograph (SEM) of dentin surface following caries removal by carbide bur. (Mag. X1.00)

Discussion

Advances evolved in the field of dentistry that made conservation of tooth structure to the maximum. Polymer bur is a minimally invasive technique, which selectively remove the infected dentin while preserving affected dentin and sound tooth structure. They also help to eliminate the pain associated with the removal of carious dentin, thus introducing dental treatment to children in a painless manner. Smart bur 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 for caries removal between Smart burs and conventional carbide burs in primary teeth. Also, the present study assessed the topographic features of dentin after caries removal with the smart bur compared with the conventional carbide bur in primary

teeth. The study consisted of two parts, a clinical and an in-vitro study.

The clinical study included 40 primary molars, 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 molar was used as test

control. 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 used in the clinical study. In the present study Ericson scale was adopted to evaluate complete caries removal(5).

The results of the present study revealed significant difference between smart burs and conventional carbide bur in caries removal efficiency. Smart bur was significantly less efficient in caries removal. Wahba et al in 2015 evaluated the efficacy of caries removal by polymer bur (smart bur II) and conventional carbide burs. The results of Wahba study showed that smart bur II had significantly lower caries removal efficiency when compared to carbide bur. The lower caries removal efficiency of smart bur II reported by Wahba is in agreement with our results(2). Asal et al 2021 assessed efficacy of caries removal using smart burs, Carisolv gel and conventional burs. The study revealed that the clinical efficacy of caries removal was lowest with smart burs group comparing with other groups in agreement with our results (1).

Attiguppe et al 2009 assessed the efficacy of caries removal using smart burs and carbon steel bur in permanent first molars. The study revealed that carbon steel bur is more effective in removing caries than smart burs in agreement to our study(10). 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(11). The in vitro study included 7 primary molars. 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 molar was used as test control. The scanning electron microscope was employed to evaluate the topographic characteristics of the dentin surface following the smart bur 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 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. The topographic study also showed very few, barely detected dentinal tubules orifices, with numerous bacterial deposits on dentin surface following the smart bur 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 removes only the infected dentin and preserves the affected dentin.

A possible limitation of the present study was comparing caries removal with smart bur to a single type of minimal invasive caries removal methods (conventional carbide bur), on the other hand comparing smart bur 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 are needed.

Also the shocking result that SEM revealed finding debris or remnant of smart burs randomly placed around the prepared cavity which may cause pain after treatment and more problems need to investigate.

Conclusions

Conclusions Within the limitations of the present study, the following was concluded.

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

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Figures

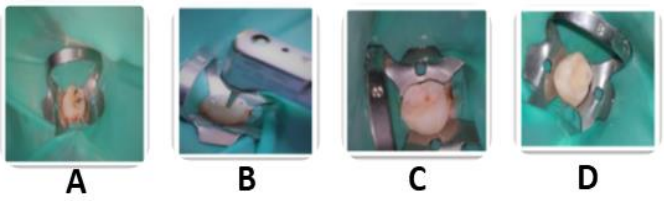

Fig 1: (a) Carious 85, (b) Caries excavation with Smart Burs, (c) after Caries excavation, (d) after GIC restoration.

Figure 2

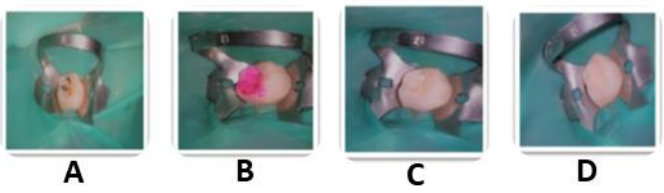

Fig 2: (a) Carious 75, (b) Caries detector application, (c) after Caries excavation with carbide bur, (d) after GIC restoration.