

Comparative evaluation of BRIX3000, CARIE CARE, and SMART BURS in caries excavation: An *in vivo* study

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Abstract

Background: Chemomechanical caries removal has been a new leaf for caries excavation in this ultraconservative era of dentistry. BRIX3000 & Carie Care are papain based gel formulations while Smart Burs are polymer burs with self limiting ability.

Aim: To compare & evaluate the caries excavation efficacy of BRIX3000, Carie Care & Smart burs.

Materials & Methods: 45 patients with wide class 1 carious lesions were selected and equally divided into 3 groups: BRIX 3000, Carie Care & Smart Burs. Caries excavation was performed in accordance with manufacturer's instructions in each group & evaluation for reduction in bacterial count & mean working time was done.

Statistical Analysis: Data was analysed by One way ANOVA, Paired t-Test & Tukey's Post Hoc test.

Results: The highest reduction in bacterial count was achieved by BRIX3000(156.93×10^4) followed by Smart Burs(139.07×10^4) & Carie Care(135.80×10^4) with $p > 0.5$. Mean working time in minutes for excavation was : BRIX3000(13.66), Carie Care(18.30) & Smart Burs(20.60) with $p < 0.5$.

Conclusion: All the techniques reduced bacterial count potentially. BRIX 3000 proves the most effective among three.

Keywords: BRIX3000; Carie care; colony forming units; chemomechanical caries removal; smart bur

INTRODUCTION

The goal of modern approaches in operative dentistry revolves around the concept of sound tissue preservation. Minimally invasive techniques have gained popularity with the advancements in adhesive dentistry, which turns to be a farewell for the traditional perceptions of "extension for prevention."

Dental caries is a multifactorial, infectious disease that contributes to the major burden of oral disease globally. The superficial zone of dentinal caries is filled with

microbes and degraded collagen matrix, while the deeper zone contains fewer microbes and partially degraded collagen with intact cross banded ultrastructure, which has a potential to remineralize.^[1]

The conventional method for caries excavation includes the use of high-speed drills, which has been proved to be highly effective for ages. However, it comes along with several drawbacks such as deleterious thermal effects on pulp, need for local anesthesia, excessive removal of sound dentin, and discomfort to the patients.^[2] In an attempt to overcome these shortcomings, newer ideas like the use of air abrasives, lasers, sonoabrasion, and chemomechanical caries removal (CMCR) have been proposed for excavation of caries.^[1,3]

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CMCR involves the use of solutions or gels that selectively removes the softened, infected dentin, which aids in enhancing the ease of manual caries excavation. This technique provides a patient-friendly aspect to the treatment of dental caries, which can be a windfall for anxious, medically compromised patients and children.^[4]

BRIX3000 is an innocuous papain-based gel formulation, introduced in 2012 by Brix Medical science, Argentina. The unique features of this product include the high concentration of papain (3000 U/mg) and bioencapsulation (EBE) technology, which provides the gel with the optimum pH to immobilize the enzyme at the moment of exerting proteolysis in collagen hence, increasing its activity.^[4]

Carie care gel, an innovation of Indian origin, contains papaya extract as its key ingredient together with chloramines, dye, and clove oil. It acts as a debris removing agent with no harmful effect on sound tissues because of the enzyme specificity with additional benefits of clove oil inducing mild analgesic, antiseptic, and anti-inflammatory effect.^[5]

Smart Burs are paddled shaped polymer burs, made up of polyether-ketone-ketone. The hardness of Smart Bur (50KHN) is higher than infected dentin (15-20KHN) and less than healthy dentin (68KHN), which allows it to selectively cut the infected dentin, leaving behind affected dentin intact.^[6] Smart bur dulls and vibrates when in contact with healthy calcified tooth structure.^[4]

Literature documents various studies comparing BRIX3000 with Smart bur, Carie care with Smart bur, and Smart bur with the conventional technique, but there is a lack of comparison of these agents with each other. The study focuses on the intergroup comparison of BRIX3000, Carie care, and Smart Burs, which is unique. Very few studies evaluated the effectiveness of CMCR agents in the adult population. A lot of emphases has been given on promoting the conservation of tooth structure theoretically, but seldom is it used in regular practice. Hence, in an attempt to bridge this gap, this study was conducted to evaluate the efficacy of these conservative methods in caries excavation to find the best option to be used routinely in clinical practice.

We hypothesized that there is no difference in the efficacy of caries excavation of BRIX 3000, Carie-care, and Smart burs.

Aim

To compare and evaluate the efficiency in caries excavation using BRIX3000, Carie Care, and Smart burs.

MATERIALS AND METHODS

This prospective study was conducted in the Department of Conservative Dentistry of our institution for a total duration of 3 months, after obtaining ethical clearance by the institutional review board. The sample size was calculated by G*Power 3.1.9.2 software, Dusseldorf, Germany keeping alpha at 0.05 and power at 80%.

Patient selection

A total number of 45 healthy participants between the age group 18–40 years were selected and randomly divided into three groups.

Inclusion criteria

- Wide Class 1 deep carious lesion on permanent molars (Score 3; Ekstrand *et al.*^[7])
- No pulpal involvement as evident on a radiograph
- Good oral hygiene
- Co-operative patient.

Exclusion criteria

- Pulpal exposure or bleeding during the excavation procedure
- Pain during the excavation procedure
- Periodontal problems
- Pregnancy
- Patients with underlying systemic diseases
- Lack of compliance.

A preoperative radiograph was useful in standardizing the depth of the lesion, assessing the proximity of the lesion to the pulp, and detection of proximal involvement of the carious lesion. Radiographically, lesions that belong to score 3 of the radiographic examination criteria by Ekstrand *et al.* (radiolucency in dentin, involving the middle third of dentin) were selected.^[7] In the case of pulpal exposure or pain during excavation, the procedure was aborted, routine treatment protocols such as pulp capping or root canal treatment were followed, and the participants were excluded from the study.

Randomization was done through the chit system. The procedure involved was explained in detail to the participants, and written informed consent was obtained before the study.

The clinical evaluation of caries excavation was done by an experienced faculty member for all the samples.

The recruited patients were distributed equally into three groups:

- Group I - BRIX3000
- Group II - Carie Care
- Group III - Smart Burs.

Procedure

Rubber dam (Coltene, Hygiene) was used for isolation, and no local anesthesia was administered in each case. Before sampling, the outermost layer of carious dentin was removed with a sterile spoon excavator (Hu Friedy) and discarded to avoid surface contamination.^[8] To obtain the base line microbial sample, carious dentin was scraped from the floor of the cavity with a sharp, sterile spoon excavator (Hu Friedy) before excavation. Same sized spoon excavator was used to avoid sampling bias. Samples were scraped sufficient enough to cover the surface of the spoon excavator and placed into sterile screw cap vials containing phosphate buffer saline (Himedia) and transported to the microbiological laboratory within 2 h.^[8]

Caries excavation was done with the respective agents, and the working time was calculated using a stopwatch from the beginning of caries excavation to confirmation of complete excavation of caries clinically.

Group I: BRIX3000 (Brix Srl Argentina) was applied with a blunt spoon excavator allowing it to work for 3 min. Once the applied gel turned turbid, it was removed by using spoon excavator. This procedure was repeated till the healthy dentin was obtained. When applied for a second or third time, no color change in the gel was observed, which indicates that there is no presence of carious infected tissue [Figure 1].

Group II: Carie Care (Eco works Inc., Bengaluru, Karnataka, India) was applied to the carious dentin according to the manufacturer's instructions. After 3 min, the gel turned cloudy, which was then removed with spoon excavator along with the softened carious tissue. The gel was repeatedly applied to eliminate carious dentinal tissue completely [Figure 2].

Group III: Caries excavation with Smart Burs (SS White Burs, Inc., Lakewood, NJ, USA) was done using a slow speed handpiece (500–800 rpm) in circular movements starting from center to periphery of the carious lesion [Figure 3]. Each Smart Bur was replaced when it became visibly abraded and nonfunctional. The procedure was continued till complete caries excavation was achieved.

Clinical evaluation of caries excavation was done using Ericson's visual and tactile criteria for the absence of discoloration and smooth passage of a dental explorer with no tug back or catches.^[9]

A second microbial sample collection was done as described earlier, soon after confirming complete clinical excavation in each group. For all the samples, the drill was used to adjust the unsupported enamel margins, and the tooth was restored with GIC-Composite sandwich restoration.

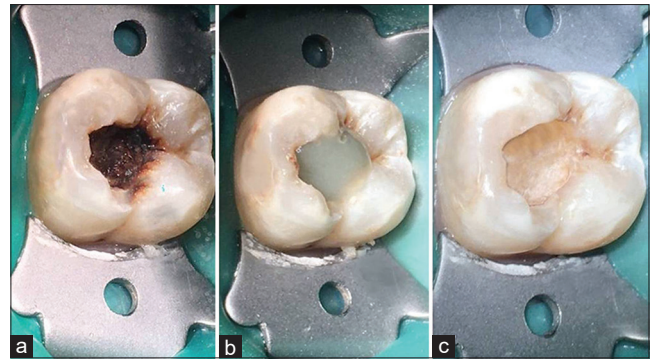


Figure 1: Caries excavation with BRIX3000. (a) Before excavation. (b) BRIX3000 Application. (c) After complete excavation

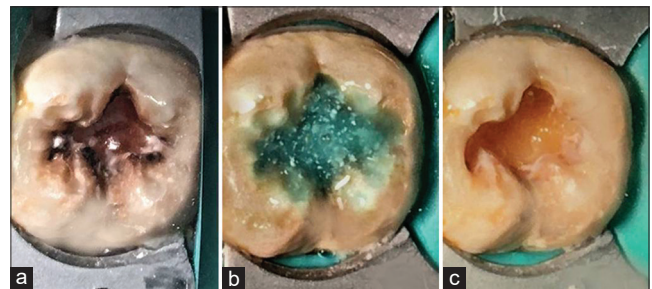


Figure 2: Caries excavation with CarieCare. (a) Before excavation. (b) CarieCare Application. (c) After excavation

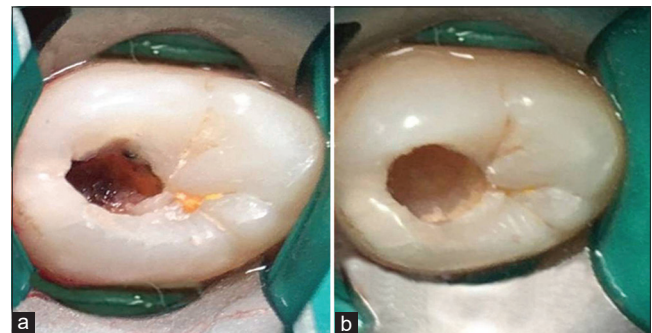


Figure 3: Caries excavation with Smart Burs. (a) Before excavation. (b) After excavation

Microbiologic investigation

All the samples were serially diluted to achieve 10^4 dilution. A sterile loop full of samples (0.1 ml) was cultured on blood agar plates (Himedia) in a laminar chamber. The plates were incubated aerobically at 37° for 48 h. Using digital colony counter, the total viable count was determined and expressed as colony-forming units (CFU) per ml of the sample [Figure 4].

All the samples were evaluated for a total reduction in the bacterial count (CFU) and mean working time.

Statistical analysis

Data analysis was performed using IBM SPSS Statistics

for Windows, Version 23.0. (IBM Corp. Armonk, NY) The normality was determined using Kolmogorov–Smirnov test. The difference in CFU counts before and after caries excavation in each group was analyzed using a Paired *t*-test. In contrast, the difference between the three groups for CFU was analyzed using one-way ANOVA test. The difference in the time taken for the caries excavation was analyzed using one-way ANOVA followed by Tukey's *post hoc* test. The significance was kept at $P < 0.05$.

RESULTS

The results of Paired *t*-test showed a statistically significant difference in the mean CFU before and after excavation in all the groups [Graph 1]. The comparison between the groups based on the mean difference in CFU values before and after the procedure is depicted in Table 1.

The comparison of mean working time required for caries excavation in minutes [Graph 2], was found to be statistically significant with $P = 0.0001$.

The comparison within groups based on working time is shown in Table 2. The difference in working time between

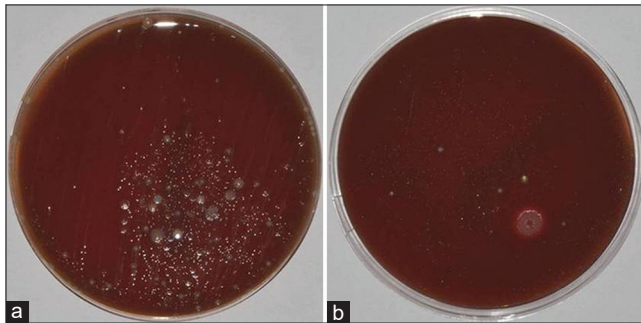


Figure 4: Blood agar plates showing colony forming unit. (a) Colony-forming unit before excavation. (b) Colony-forming unit after excavation

Table 1: Comparison between study groups based on mean difference in colony-forming unit before and after caries excavation (ANOVA test)

Caries excavation procedure using	Mean difference in CFU before and after excavation	Standard deviation	<i>P</i> (ANOVA)
Brix	156.93×10^4	59.12	0.461
Carie care	135.80×10^4	45.75	
Smart bur	139.07×10^4	42.32	

CFU: Colony-forming unit

Table 2: Comparison within study groups based on the mean working time required for caries excavation (Tukey's *post hoc* test)

Comparison group	<i>P</i> (<i>post hoc</i> Tukey's test)
Brix versus carie care	0.001
Brix versus smart bur	0.001
Carie care versus smart bur	0.076

Brix versus Carie Care and Brix versus Smart Bur was statistically significant with $P = 0.001$. However, the difference in working time between Carie Care and Smart Bur was statistically insignificant with $P = 0.076$.

DISCUSSION

The journey of CMCR covers the ground so far from GK 101 to BRIX 3000, consistently improving in quality. Certain gaps such as increased time consumption, cost factor, and limited marketing when compared to the highly efficient, cost-effective, and quick high-speed drills make it a hidden gem in clinical practice. However, the drawbacks of high-speed drills, together with growing demands for more conservative and biological methods of caries excavation, derive the central objective of this study.

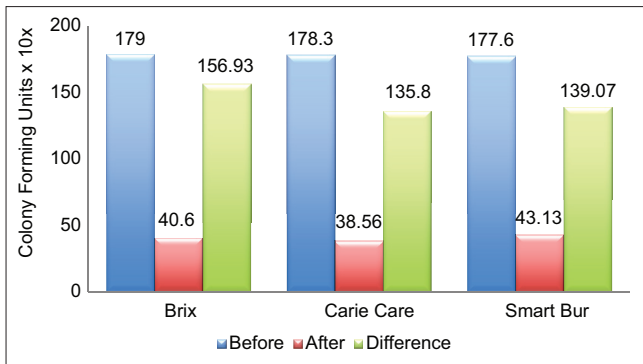
This study was performed on permanent molars as they are comparatively more caries susceptible.^[10] Class I lesions were selected for the accessibility of CMCR gel to the carious tissue that avoided the need of drills to modify the cavity. Visual and tactile method for detection of caries was used for clinical assessment as it is considered a standard method.^[11] Numerous methods are documented in the literature to evaluate the efficacy of caries excavation, such as Caries-disclosing Dyes, Fluorescence-aided Caries Excavation, DIAGNOdent, and Micro-CT evaluation.^[12,13] Microbial flora of dental caries is the prime etiologic factor, and it is necessary to reduce it to control the disease process. Thus, the microbiologic analysis was preferred in this study to assess the efficacy of caries excavation.

Here, the reduction in CFU before and after caries excavation was statistically significant. This was in accordance with the studies conducted by Ismail and Al Haidar,^[4] Modimi *et al.*,^[8] Azrak *et al.*^[14] and Garcia-Contreras *et al.*^[15] The highest reduction observed was with BRIX3000 (156.93×10^4), which might be due to higher papain concentration (30000 IU/mg) and EBE technology used in this gel, which makes it more effective. This was in agreement with Ismail and Al Haidar.^[4]

The variations in CFU value depend on the method of evaluation of caries excavation.

Previous studies documented no significant difference in the reduction of CFU when conventional techniques were compared to CMCR.^[16] However, the CMCR technique proves promising due to additional advantages such as patient comfort and preservation of sound tooth structure over the conventional technique.

In this study, the reduction in bacterial count indicates the bacteriostatic and bactericidal potential of CMCR agents. In the case of Smart Bur, however, the reduction in bacterial



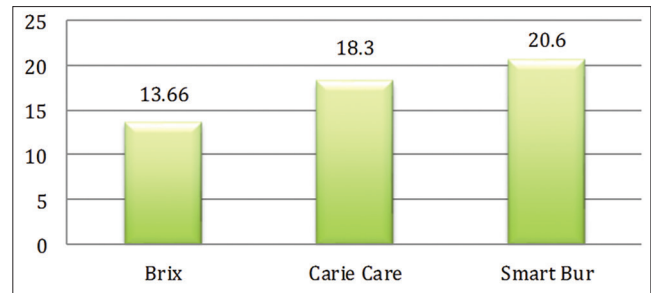
Graph 1: Comparison of colony-forming unit before and after caries excavation procedures (Paired *t*-test: $P = 0.0001$)

count correlates with its ability to remove infected carious tissue effectively. When the bacterial reduction was compared between the groups, no statistically significant difference was found. This might be because the CMCR gels and Smart burs were used to obtain a uniform clinical outcome regardless of the number of applications and the time required. This was in accordance with Ismail and Al Haidar results.¹⁴

Comparable studies by Zakirulla *et al.*¹¹⁷ and Subramaniam *et al.*¹¹⁸ reported the effectiveness of the conventional technique, carbide bur, and polymer bur; Carisolv and conventional technique, respectively.

However, Aswathi *et al.*¹¹⁹ observed that Smart bur showed a significant reduction in bacterial count than Carie Care. The difference in the findings between our study and Aswathi *et al.*¹¹⁹ probably due to various facts like the use of high-speed drills to prepare the outline form before excavation, use of caries detector dye for evaluation of completeness of caries excavation, which would have resulted in the potential reduction of the bacterial count. Baseline microbial sample was collected superficially in Aswathi *et al.*¹¹⁹ study while in our study, the outermost layer of the carious lesion was discarded before taking the baseline sample to avoid microbial contamination. This study was based on the principles of ART, so no drills were used to assist CMCR agents and Smart burs in caries excavation, which resulted in multiple applications of the agents to achieve complete excavation from slightly inaccessible areas. Drills were only used at the end of the procedure to remove the unsupported enamel. Furthermore, Aswathi *et al.*¹¹⁹ study was performed on primary molars, which might have contributed to the difference in lesion size and depth compared to this study.

BRIX3000 took the least time (13.66 min), and Smart bur was the slowest (20.6 min), which was in accordance with other studies.^{14,11,19} The time required by Smart burs was longer as it became nonfunctional after touching the



Graph 2: Comparison of mean working time required for caries excavation in minutes

calcified tooth structure; hence, needed replacement. To overcome this issue, the method of excavation from center to periphery was followed.

Santosh Kumar KVK¹²⁰ reported working time of 7 and 6.66 min by using Carie Care in dental clinic and field setting, respectively, while smart bur consumed 5.85 min, which was significantly less than the Carie Care technique.

The difference in working time may be due to the extent, consistency, and accessibility of the carious tissue, the variations in study designs, and the isolation techniques.

Few limitations of this study include lack of comparison with conventional drills; lack of standardization of the lesion size. The use of caries detector dye would have provided an accurate idea about the extent of caries.

CONCLUSION

BRIX3000, Carie Care, and Smart bur all reduced the bacterial count potentially. With respect to the working time, BRIX3000 is the best choice, followed by Carie Care and Smart bur.

The clinicians should note the fact that CMCR techniques might require the use of high-speed drills when there is no direct access to the carious lesion. Further long-term clinical studies are recommended comparing these newer CMCR agents with high-speed drills with the addition of pain as a parameter.

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Conflicts of interest

There are no conflicts of interest.

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