



ORIGINAL RESEARCH PAPER

Clinical Research

COMPARATIVE EVALUATION OF EFFICIENCY, EFFICACY, AND PATIENT PERCEPTION OF CARIES EXCAVATION BURS IN PEDIATRIC PATIENTS: A RANDOMIZED CLINICAL TRIAL

KEY WORDS:

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ABSTRACT

Introduction: The present in vivo randomized clinical trial was conducted to thoroughly compare and evaluate the performance of three distinct rotary instruments—ceramic burs, diamond burs, and carbide burs in the context of dentin caries excavation in primary molars of pediatric patients. Specifically, the study focused on three primary outcome measures: efficiency (total time taken for the procedure), efficacy (completeness of carious dentin removal), and patient perception (comfort and pain experienced). **Materials and Methods:** A total of 33 primary molars affected by occlusal carious lesions (ICDAS score 4) were selected from children aged 6–10 years and were systematically and randomly divided into three experimental groups (N=11 each). All caries excavation procedures were standardized and performed under rubber dam isolation using a slow-speed contra-angle handpiece. Efficiency was quantified in seconds using a stopwatch. Efficacy was assessed clinically after the application and rinsing of a caries detector dye, with the outcome noted as the presence or absence of infected dentin discoloration. Patient comfort was evaluated immediately post-excitation using the validated Visual Analog Scale (VAS) and the Face, Legs, Activity, Cry, Consolability (FLACC) scale. **Results:** Statistically significant differences ($P < 0.05$) were observed across the three groups for both efficiency and patient acceptance (FLACC score). For efficacy, the Ceramic Bur and Carbide Bur groups demonstrated superior performance, with 90.9% of cases showing no remaining dentin discoloration, compared to 72.7% for the Diamond Bur group. In terms of patient acceptance, the Ceramic Bur group demonstrated significantly less discomfort than the Diamond Bur group as measured by the FLACC score ($P = 0.009$). **Conclusion:** The findings suggest that the ceramic bur is a highly effective instrument for dentin caries excavation in pediatric primary molars. Its ability to achieve high levels of caries removal while demonstrating favorable patient comfort makes it a recommended and viable alternative to conventional diamond and carbide burs within the context of minimally invasive pediatric restorative dentistry.

INTRODUCTION

The traditional approach to restorative dentistry, often summarized by the G.V. Black principle of "Extension for Prevention," involved the aggressive removal of tooth structure, frequently extending beyond the carious lesion to prevent potential future decay¹⁸¹⁸¹⁸. While foundational, this philosophy is now seen as overly destructive in light of modern adhesive techniques and a deeper understanding of carious disease.

The contemporary paradigm is Minimally Invasive Dentistry (MID), a concept that necessitates the maximum conservation of sound, remineralizable tooth structure. This approach is predicated on the understanding that carious dentin consists of two distinct layers: an outer layer (infected dentin) that is irreversibly damaged and must be removed, and an inner layer (affected dentin) that is less contaminated, capable of remineralization, and should ideally be preserved.

The primary instruments for carious dentin removal have historically been rotary tools, predominantly tungsten carbide and diamond burs. While highly efficient, these burs present several limitations, particularly in pediatric dentistry:

- **Non-Selectivity and Over-Preparation:** Tungsten carbide burs are indiscriminate in their removal of tissue, often removing both infected and affected dentin, potentially extending into sound dentin. This over-preparation compromises the remaining tooth structure, a critical

concern given the naturally thinner dentin layer in primary teeth.

- **Lack of Tactile Feedback and Control:** The high cutting efficiency of conventional burs on dentin often results in little tactile feedback, making them difficult to control and increasing the risk of iatrogenic damage, particularly pulp exposure
- **Patient Discomfort and Pain:** The cutting action, high speed, and associated vibration and sound of conventional rotary instruments are frequent sources of pain, discomfort, and aversive behavior in children, often requiring local anesthesia.

To overcome these issues, alternative mechanical instruments were sought. This led to the introduction of the ceramic bur (CeraBur), a new rotary cutting instrument made of a special alumina-based ceramic with stabilized zirconia. Ceramic cutting tools, in general, are recognized in technology for their excellent wear resistance, cutting ability, good mechanical properties, and hardness. The ceramic bur is designed to be used in a slow-running handpiece and claims several key advantages for dentin caries excavation like selective Cutting, patient Comfort and Corrosion Resistance.

Previous in vitro work by Dammaschke et al. (2008) initially suggested that ceramic burs were as effective as tungsten carbide burs in dentin caries excavation, albeit without

confirming the manufacturer's claim of selective cutting over sound tissue. An in vivo study comparing it to hand excavation found the ceramic bur offered better efficacy in less time.

Given the promising but limited clinical data, the present study was undertaken to provide a direct, comprehensive in vivo comparison of the Ceramic Bur against the routinely used Diamond and Carbide Burs in a pediatric setting, focusing on the crucial clinical outcomes of efficiency, efficacy, and patient comfort.

MATERIALS AND METHODS

This study is a single-blinded randomized clinical trial. It included patients aged 6 to 10 years who required restorative treatment and had no history of systemic illness or prior hospitalization. Written informed consent was obtained from the parents of all participating children. The study was approved by the Institutional ethical committee.

Inclusion Criteria: Children aged 6–10 years and primary molars presenting with occlusal carious lesions penetrating the dentin, specifically classified as ICDAS score 4 (extensive dentin involvement), were included. Only cooperative children were selected.

Exclusion Criteria: Primary molars with caries deeper than ICDAS score 4, clinical or radiographic signs of pulpal pathology, grossly decayed teeth, and non-cooperative children were excluded.

Sample Size and Randomization: A total of 33 primary molars were selected. The teeth were randomly assigned into three equal groups (N=11 each) for the different burs to be used during the excavation process.

Group 1: Ceramic Bur (CeraBur® Komet USA)

Group 2: Diamond Bur (MANI®)

Group 3: Carbide Bur (MANI®).



Figure 1: Ceramic Bur, Diamond Bur and Carbide Bur

Clinical Procedure: All procedures were performed by a single, trained operator to maintain consistency.

1. **Isolation:** The selected teeth were isolated using a rubber dam for enhanced visibility and optimal working field.
2. **Access:** Unsupported enamel was removed using a high-speed handpiece with water cooling to expose the underlying carious dentin.
3. **Excavation:** Caries removal was performed using a slow-speed contra-angle handpiece and the allocated bur for each tooth. The operator ceased excavation upon reaching what was clinically perceived as hard, sound dentin, using visual and tactile criteria (hardness on probing and sound of unaffected dentin—cri dentaire).

Outcome Variables and Assessment Tools

The study assessed three primary outcome variables: efficiency, efficacy, and patient comfort.

1. **Efficiency (Time Taken)**
 - **Assessment:** Efficiency was defined as the total time taken for the mechanical removal of carious dentin.
 - **Measurement:** Time was recorded in seconds using a stopwatch by an assistant, starting when the handpiece began rotation until the final probing for dentin hardness
2. **Efficacy (Caries Removal Completeness)**
 - **Assessment:** Efficacy was defined as the ability to remove infected dentin while preserving the integrity of healthy dentin. Clinical excavation was primarily guided by visual and tactile criteria.
 - **Confirmation:** To objectively confirm the endpoint and

overcome the subjectivity of clinical assessment, a caries detector dye (Kuraray® Caries Detector) was used. The dye was applied to the cavity floor for 10 seconds and then thoroughly rinsed off. The presence or absence of remaining infected dentin (dentin discoloration) was scored by a blinded examiner.

3. Patient Perception of Pain (Comfort)

- **Assessment:** Patient comfort during the procedure was assessed immediately after caries excavation. This is a critical parameter in pediatric dentistry, as comfort is often equated with less invasive procedures.
- **Tools Used:** FLACC Scale (Face, Legs, Activity, Cry, Consolability): ranging from 0 (relaxed/content) to 10 (worst pain possible/difficult to console), was used by the operator to score the child's behavior during the procedure.
- **Visual Analog Scale (VAS):** Children were asked to rate their pain on a 10-point scale where 0 is "No Pain" and 10 is "Worst Pain Possible".



Figure 2: Removal of Unsupported Enamel Using High Speed Handpiece



Figure 3: Caries Excavation Using Ceramic Bur

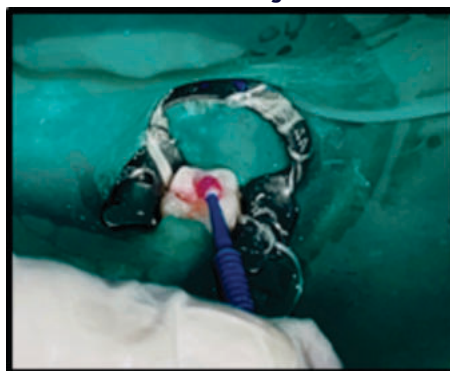
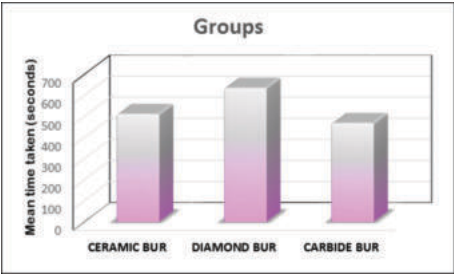


Figure 4: Application of Caries Detector Dye

RESULTS

The study successfully enrolled and analyzed all 33 primary molars across the three groups. The primary results of intergroup comparisons are summarized below:



Graph 1: Intergroup Comparison of Efficiency Among Three Groups

Table 1: Intergroup Comparison of Efficacy Among Three Groups

Groups	Count (N=11)	Dentin Discoloration Absent (Caries-Free)	Dentin Discoloration Present
Group 1 (Ceramic Bur)	11	10 (90.9%)	1 (9.1%)
Group 2 (Diamond Bur)	11	8 (72.7%)	3 (27.3%)
Group 3 (Carbide Bur)	11	10 (90.9%)	1 (9.1%)
Total	33	28 (84.8%)	5 (15.2%)

Table 2: Intergroup Comparison of Patient Acceptance Among Three Groups

Variable	Group vs group	Mean difference	P value
FLACC	Group 1 vs 2	1.18	0.009
	Group 1 vs 3	0.64	0.14
	Group 2 vs 3	0.54	0.30
VAS	Group 1 vs 2	0.36	0.57
	Group 1 vs 3	0.18	0.80
	Group 2 vs 3	0.18	0.78

DISCUSSION

The findings of this clinical trial offer substantial support for the use of ceramic burs in pediatric restorative dentistry, particularly within a minimally invasive framework. The superior efficacy observed with the Ceramic Bur (90.9% caries-free) and Carbide Bur (90.9% caries-free) underscores that both tools are highly capable of removing the stained, infected dentin layer, meeting the clinical requirement for restoration. The slightly lower performance of the Diamond Bur (72.7% caries-free) suggests a potential limitation of this particular instrument type or protocol in achieving the clinical endpoint as defined by the caries detector dye.

The equivalent high efficacy of the ceramic and carbide burs is supported by the earlier in vitro study by Dammaschke et al. (2008), who concluded that "ceramic burs were as effective as conventional tungsten carbide bud burs in dentin caries excavation".

The Ceramic Bur's proven capability contrasts with the outcomes for less aggressive methods like hand excavation, where studies have confirmed that the Ceramic Bur offers better caries removal efficacy. Furthermore, the speed and efficiency of the ceramic bur (despite being a low-speed instrument) are a significant advantage in managing appointment time with children, as shown in studies comparing it with the hand excavation method, where the ceramic bur group required less time. The most compelling finding relates to patient comfort, where the Ceramic Bur demonstrated a statistically significant advantage over the Diamond Bur in the objective FLACC pain scores (P=0.009).

The lower mean FLACC score for the ceramic bur suggests it is indeed meeting the manufacturer's claim of a smooth, pleasant operation with less discomfort. This is critical for improving the experience of anxious children and reducing the necessity for local anesthesia, which is supported by comparable low pain scores found in other studies.

While the carbide bur achieved equal efficacy (completeness of removal) to the ceramic bur in this trial, the major philosophical disadvantage of conventional burs (like carbide) is their non-selective nature, often removing healthy, sound dentin. The core benefit of ceramic is posited to be its "optimal cutting efficiency" on soft dentin with "minimal reduction of the sound, hard tooth structure". An earlier study by Ahmed Z El Hoshy (2023) supported this, noting that the Ceramic Bur's design provided a minimal reduction of the sound, hard tooth substance.

Ceramic vs. Polymer Burs: The ceramic bur emerges as a superior rotary option when compared to other non-conventional selective methods, such as the polymer bur (SmartPrep/Smart Bur). Studies have often found that polymer instruments are significantly less efficient than conventional burs, are slower, and can require multiple burs due to rapid abrasion upon contacting hard dentin. The inefficiency of the polymer bur often leads to longer procedure times, which in turn causes lesser patient acceptance and greater discomfort due to prolonged vibration and sound. The Ceramic Bur, by contrast, is highly efficient and durable, and does not require repeated bur changes for a single excavation, making it a more practical and patient-friendly tool than the polymeric alternatives.

While the clinical utility of the Ceramic Bur is supported, future research should focus on Pre- and post-excitation Remaining Dentin Thickness (RDT) analysis using techniques like micro-CT or Scanning Electron Microscopy (SEM) to quantify the amount of sound dentin preserved below the cavity floor.

CONCLUSION

1. Efficacy: The Ceramic Bur demonstrates superior efficacy in achieving complete clinical caries removal (stain-free dentin) comparable to the Carbide Bur and better than the Diamond Bur in the tested population.
2. Patient Comfort: The Ceramic Bur is associated with significantly better patient acceptance (lower FLACC score) compared to the Diamond Bur.
3. Efficiency: Ceramic burs proved to be highly efficient, although the full comparative analysis of time across all three groups needs further detail, the literature confirms its faster operation compared to hand excavation or polymer burs.

REFERENCES

1. Ardeshtana, A., Bargale, S., Karri, A., Patel, N. G., Tailor, B., & Sura, S. (2020). Evaluation of Caries Excavation Efficacy with Ceramic Bur and Hand Excavation in Primary Teeth: An Experimental Study. *Journal of South Asian Association of Pediatric Dentistry*, 3(2), 60–64.
2. Dammaschke, T., Vesnic, A., & Schäfer, E. (2008). In vitro comparison of ceramic burs and conventional tungsten carbide bud burs in dentin caries excavation. *Quintessence International*, 39(6), 495–499.
3. Dammaschke, T., Rodenberg, T.N., Schäfer, E., & Ott, K.H.R. (2006). Efficiency of the polymer bur SmartPrep compared with conventional tungsten carbide bud bur in dentin caries excavation. *Operative Dentistry*, 31(2), 256–260.
4. Goyal, A., Srivastava, M., Khanduja, R., & Bharti, K. (2022). Comparative Evaluation of Efficiency, Efficacy, and Patient Perception of Caries Excavation Burs in Pediatric Patients: A Randomized Clinical Trial. *Journal of South Asian Association of Pediatric Dentistry*, 5(1), 11–16.
5. Kochhar, G. K., Srivastava, N., Pandit, I. K., & Sharma, A. (2011). An evaluation of different caries removal techniques in primary teeth: A comparative clinical study. *Journal of Clinical Pediatric Dentistry*, 36(1), 5–9.
6. Maarouf, R., Badr, S., & Ragab, H. (2018). Clinical efficiency of polymer burs in caries removal in primary molars and relevant pain perception: a randomized controlled trial. *International Arab Journal of Dentistry*, 9(1), 9–14.
7. Neves, A. A., Coutinho, E., De Munck, J., & Van Meerbeek, B. (2011). Caries-removal effectiveness and minimal-invasiveness potential of caries-excitation techniques: a micro-CT investigation. *Journal of Dentistry*, 39(2), 154–162.
8. Prabhakar, A., & Kiran, N. K. (2009). Clinical evaluation of polyamide polymer burs for selective carious dentin removal. *Journal of Contemporary Dental Practice*, 10(4), 26–34.
9. Rajakumar, S., Mungara, J., Joseph, E., Varghese, J., & Joseph, B. (2013). Evaluation of three different caries removal techniques in children: a comparative clinical study. *Journal of Clinical Pediatric Dentistry*, 38(1), 23–26.
10. Soni, H. K., Sharma, A., & Sood, P. B. (2015). A comparative clinical study of various methods of caries removal in children. *European Archives of Paediatric Dentistry*, 16(1), 19–26.