ORIGINAL RESEARCH PAPER
Volume - 15 | Issue - 06 | June - 2026 | PRINT ISSN No. 2277 - 8179 | DOI : 10.36106/ijsr
INTERNATIONAL JOURNAL OF SCIENTIFIC RESEARCH

COMPARATIVE ANALYSIS OF DIFFERENT CARIES EXCAVATION BURS IN PEDIATRIC DENTISTRY: A RANDOMIZED CLINICAL STUDY

Pediatric dentistry

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ABSTRACT

Background: Minimally invasive dentistry emphasizes selective removal of infected dentin while preserving healthy tooth structure in primary teeth. **Aim:** To compare the cutting efficiency, caries removal efficacy, and patient comfort using Smart Burs II, ceramic burs, and diamond burs in primary molars. **Materials and Methods:** A randomized clinical study was conducted among 99 children aged 5–12 years with occlusal carious lesions in primary molars. Cutting efficiency was assessed by excavation time, caries removal efficacy by visual, tactile, and caries detector dye criteria, and patient discomfort using the FLACC scale. **Results:** Diamond burs showed superior cutting efficiency and caries removal efficacy, whereas Smart Burs II and ceramic burs demonstrated lower FLACC scores and better patient comfort. **Conclusion:** Minimally invasive burs provide conservative caries removal with improved patient acceptance.

KEYWORDS

Minimally Invasive Dentistry; Smart Burs II; Ceramic Bur; Caries Excavation; FLACC Scale

INTRODUCTION

Dental caries remains one of the most prevalent chronic oral diseases in children and continues to be a major public health concern worldwide.[1] Management of caries in primary teeth presents unique clinical challenges because of thinner enamel and dentin, larger pulp chambers, and a greater risk of pulpal involvement. Conventional rotary instruments such as carbide and diamond burs are widely used for caries excavation because of their rapid cutting efficiency and ease of use. However, these instruments are non-selective and may remove healthy dentin along with infected tissue, leading to unnecessary loss of tooth structure and possible pulpal injury.[2]

Modern restorative dentistry has therefore shifted toward minimally invasive dentistry (MID), which emphasizes preservation of healthy tooth structure and maintenance of pulpal vitality. MID aims to selectively remove infected dentin while preserving affected remineralizable dentin. Among the newer minimally invasive rotary systems, Smart Burs II and ceramic burs have gained considerable attention. Smart Burs II are polymer-based self-limiting burs designed to selectively remove softer infected dentin, whereas ceramic burs provide controlled cutting action and better tactile feedback with minimal damage to sound dentin.[3]

Since patient comfort is crucial in pediatric dentistry, the present randomized clinical study was conducted to compare cutting efficiency, caries removal efficacy, and patient comfort among Smart Burs II, ceramic burs, and conventional diamond burs during caries excavation in primary molars.

MATERIAL AND METHOD

This double-blinded randomized clinical study was conducted in Department of Pedodontics and Preventive Dentistry, Government Dental College and Hospital, Ahmedabad, after Institutional Ethics Committee approval (IEC GDCH/PEDO.4/2025). The study was registered with the Clinical Trial Registry of India (CTRI/2026/02/104361). Written informed consent was obtained from parents/legal guardians before enrollment.

Inclusion criteria:

1. Healthy children aged 5–12 years of either sex.
2. Positive/definitely positive behavior on Frankel's Behavior Rating Scale.
3. Occlusal caries in primary molars with ICDAS II codes 4 and 5.
4. Radiographic lesion classified as RB4 according to ICCMS.
5. No clinical signs of pulpal pathology or infection.
6. No radiographic evidence of furcation involvement, periapical pathology, or pathologic root resorption.

Exclusion criteria:

1. Children with significant medical or systemic conditions.
2. Presence of furcal/periapical radiolucency or pathological root resorption.
3. Widened periodontal ligament space suggestive of pathology.
4. Root resorption exceeding one-third of root length.
5. Negative or definitely negative behavior on Frankel's Behavior Rating Scale

A total of 99 children fulfilling the eligibility criteria were enrolled and randomly allocated into three equal groups using lottery method. A double-operator protocol was followed, wherein one investigator performed the caries excavation procedure and a second blinded investigator independently evaluated caries removal efficacy and FLACC score to minimize assessment bias.

Intervention groups

Participants were randomly assigned into the following groups:
Group I: Smart Burs II (SS White, USA)
Group II: Ceramic bur (CeraBur, Komet, Germany)
Group III: Diamond point bur (API, India)

Clinical procedure

At the beginning of the appointment, the Tell–Show–Do behavior management technique was used to familiarize the child with the procedure and reduce anxiety. The selected tooth was isolated using cotton rolls and high-volume suction. Local anesthesia was not administered to evaluate patient comfort during caries excavation.

Initial access to the carious lesion was achieved using a high-speed

handpiece under water coolant. Depending on group allocation, caries excavation was then performed using the assigned bur in a slow-speed contra-angle handpiece with light intermittent strokes under continuous water irrigation. Excavation was continued until no softened dentin remained and the dentin surface appeared hard on tactile examination. Following complete excavation, the cavity was restored with Type IX glass ionomer cement.

Cutting Efficiency:
Cutting efficiency was assessed by recording the time required for caries excavation using a stopwatch. Timing commenced immediately after cavity access and ended upon complete removal of infected dentin.

Caries Removal Efficacy:
Caries removal efficacy was evaluated using visual, tactile, and dye-assisted methods. A caries detector dye (MAARC Find Fast Caries Indicator) was applied according to the manufacturer's instructions, and residual caries was scored using the criteria described by Munshi et al.

Table 1: Criteria for the assessment of the efficacy of caries removal (Munshi et al)

Score	Criteria
0	Caries completely removed
1	Caries present in the base of the cavity preparation
2	Caries present in the base and/or in one wall of the cavity preparation
3	Caries present in the base and/or two walls of the cavity preparation
4	Caries present in the base and/or more than two walls of the cavity preparation
5	Caries present in the base, walls, and margins of the cavity preparation

Patient Discomfort: Patient discomfort during the procedure was assessed using the FLACC (Face, Legs, Activity, Cry, Consolability) scale by a calibrated blinded examiner. Scores ranged from 0 to 10, with higher scores indicating greater discomfort.

Table 2: FLACC scale scoring criteria

	0	1	2
Face	No particular expression or smile	Occasional grimace or frown, withdrawn, disinterested	Frequent to constant Frown, clenched jaw, quivering chin
Legs Activity	Normal position or relaxed Lying quietly normal position moves easily	Uneasy restless sense Squirming, shifting back and forth tense	Kicking or legs drawn up Arched rigid or jerking
Cry	No cry awakes or sleep	Moans or whimpers occasional complaint	Crying steadily screams or sobs
Consolability	Content, relaxed	Reassured by occasional touching, hugging or taking to distractible	Difficult to console or comfort

Figure 1. Caries excavation burs

Figure 2. Group 1 – Smart Bur II

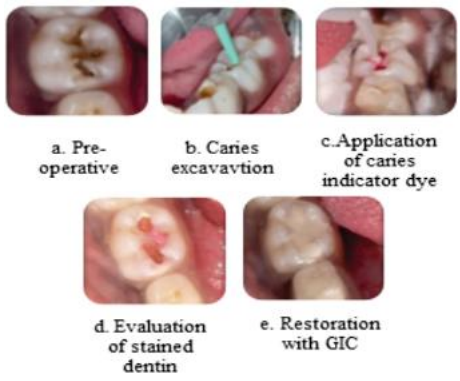


Figure 3. Group 2 - Cerabur

Figure 4. Group 3 – Diamond point bur

Statistical Analysis
Data were analyzed using SPSS software. As the data were non-normally distributed, the Kruskal–Wallis H test followed by Mann–Whitney U test with Bonferroni correction was used for intergroup and pairwise comparisons. Fisher's exact test was used for caries removal efficacy. Statistical significance was set at $p < 0.05$.

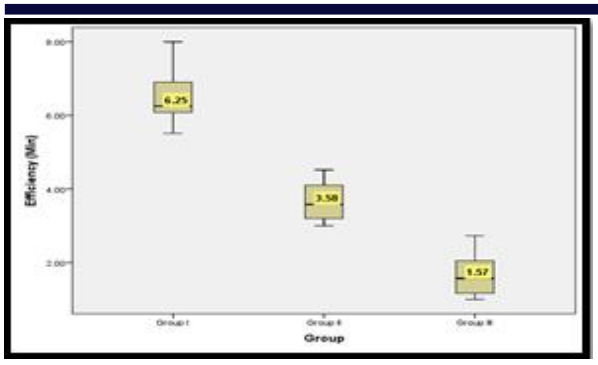
RESULT

Cutting efficiency comparison
A statistically highly significant difference in excavation time was observed among the groups ($p < 0.001$). Group III (Diamond point bur) showed the highest cutting efficiency with the shortest excavation time, followed by Group II (Ceramic bur), while Group I (Smart Burs II) showed the longest excavation time. Significant differences were found between all groups ($p < 0.001$) Graph 1 ----- .

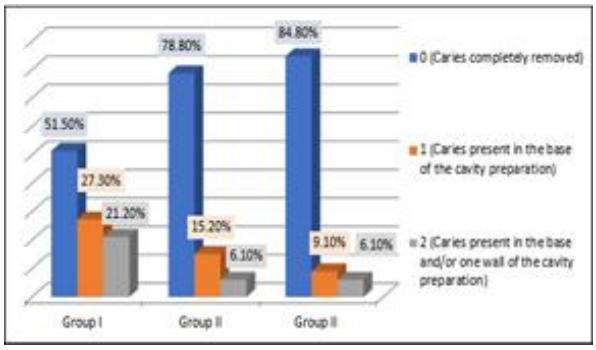
Caries removal efficacy comparison
A statistically significant difference in caries removal efficacy was observed among the groups ($p = 0.036$). Group III (Diamond point bur) showed the highest rate of complete caries removal, followed by Group II (Ceramic bur), while Group I (Smart Burs II) showed the lowest efficacy with more residual caries. Ceramic burs demonstrated efficacy comparable to diamond burs, whereas Smart Burs II showed a more conservative excavation pattern.

Graph 1. Intergroup comparison of cutting efficiency

PRINT ISSN No. 2277 - 8179 | DOI : 10.36106/ijsr



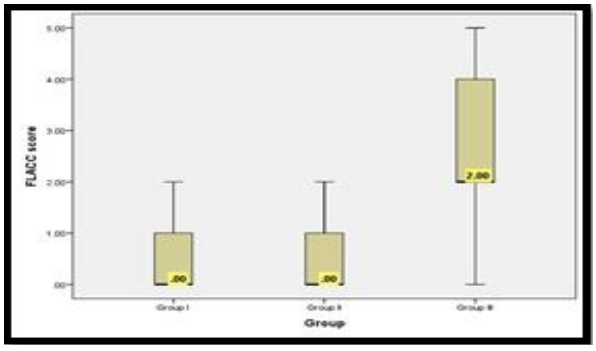
Graph 2. Intergroup comparison of caries removal efficacy



Patient discomfort comparison

FLACC scores showed a statistically significant difference among the groups ($p < 0.001$). Group I (Smart Burs II) and Group II (Ceramic bur) showed lower patient discomfort, while Group III (Diamond point bur) showed the highest discomfort. No significant difference was observed between Groups I and II ($p = 0.739$)

Graph 3. Intergroup comparison of FLACC score



DISCUSSION

Effective caries excavation is essential in pediatric restorative dentistry, where preservation of tooth structure and patient comfort are critical. Contemporary minimally invasive dentistry advocates selective removal of infected dentin while preserving affected remineralizable dentin to reduce unnecessary tooth loss and risk of pulpal exposure.[4]

The present randomized clinical study compared Smart Burs II, ceramic burs, and conventional diamond burs in terms of cutting efficiency, caries removal efficacy, and patient discomfort during excavation of primary molars. Significant differences were observed among the three systems.

With respect to cutting efficiency, conventional diamond burs demonstrated the least excavation time and therefore the highest cutting efficiency among the study groups. Ceramic burs showed intermediate cutting efficiency, whereas Smart Burs II required the longest excavation time. Similar findings were reported by Banerjee et al. (2000)[4], who observed that rotary burs required significantly less excavation time, with mean excavation times approximately 60–70% shorter than minimally invasive techniques.

The superior cutting efficiency of diamond burs may be attributed to their abrasive, non-selective cutting mechanism, which removes dentin irrespective of mineralization and facilitates rapid excavation. However, this aggressive action may increase the risk of unnecessary removal of healthy dentin, especially in primary teeth with limited dentinal thickness. Ceramic burs demonstrated moderate excavation time with improved conservation of tooth structure, as their cutting design allows gradual removal of softened dentin while providing tactile feedback on reaching harder dentin.[5]

In contrast, Smart Burs II exhibited the lowest cutting efficiency due to their self-limiting polymer composition. Since the hardness of the bur lies between infected and sound dentin, it loses cutting ability upon contact with harder dentin, thereby prolonging excavation time. Although time-consuming, this selective action may help preserve healthy dentin and reduce the risk of accidental pulpal exposure.[6]

Regarding caries removal efficacy, diamond burs achieved the highest rate of complete caries removal, followed by ceramic burs, whereas Smart Burs II showed comparatively greater residual dentin. The superior efficacy of diamond burs may be attributed to their continuous aggressive cutting action, which enables thorough removal of softened dentin but may also increase unnecessary dentin loss. Ceramic burs demonstrated efficacy comparable to conventional burs while maintaining a more conservative approach.[4]

In contrast, the lower efficacy observed with Smart Burs II may reflect their selective self-limiting cutting behavior, designed to remove only infected dentin while preserving affected remineralizable dentin.[7] Therefore, the residual dentin observed with Smart Burs II may represent conservative excavation rather than inadequate caries removal, consistent with the principles of minimally invasive dentistry. Similar findings were reported by Somkuwar et al. (2025)[8], who observed superior complete caries removal with conventional rotary burs (96.7%) compared with BRIX3000 (93.3%) and Smart Burs (90.0%).

Patient comfort and behavioral response are important considerations in pediatric dentistry, as unpleasant dental experiences may contribute to fear, anxiety, and poor cooperation during future visits. In the present study, patient discomfort was assessed using the FLACC scale, a validated behavioral pain assessment tool commonly used in children. Smart Burs II and ceramic burs demonstrated significantly lower FLACC scores compared with conventional diamond burs, indicating superior patient comfort during caries excavation.

These findings are consistent with studies by Dammaschke et al. (2006)[9], who reported significantly lower pain perception with polymer burs, with nearly 70–80% of patients experiencing minimal discomfort during excavation. Similarly, El-Baz (2024)[10] observed significantly lower pain and anxiety scores in children treated with Smart Burs II compared with conventional burs.

The increased discomfort associated with diamond burs may be attributed to their high rotational speed, vibration, pressure, and noise. In contrast, Smart Burs II operate with a gentle scraping action at lower speeds, reducing vibration and sensory stimulation. Ceramic burs also produce less vibration and noise, which may explain their favorable patient acceptance.[11]

The findings highlight the clinical relevance of minimally invasive excavation systems in pediatric restorative dentistry. While diamond burs may reduce chairside time, their aggressive cutting action may compromise healthy dentin preservation. Smart Burs II may be beneficial in deep carious lesions where preservation of dentin and prevention of pulpal exposure are critical. Ceramic burs demonstrated a balance between excavation efficiency and patient comfort, suggesting their usefulness as an alternative minimally invasive excavation instrument in pediatric patients.

Limitations of the study

The present study had certain limitations. The relatively small sample size may limit generalizability of the findings. immediate clinical outcomes were assessed, whereas long-term outcomes such as restoration longevity, pulpal response, and postoperative sensitivity were not evaluated. Behavioral responses recorded using the FLACC scale may also reflect anxiety or discomfort rather than pain alone. Future studies with larger sample sizes and longer follow-up are recommended to validate these findings and assess long-term clinical outcomes.

CONCLUSION

Within the limitations of the present randomized clinical study, conventional diamond burs demonstrated the highest cutting efficiency and fastest caries excavation in primary molars. However, minimally invasive systems such as Smart Burs II and ceramic burs provided significantly better patient comfort and a more conservative approach to dentin removal.

Smart Burs II promoted selective caries removal with greater preservation of healthy dentin, whereas ceramic burs demonstrated a balance between excavation efficiency, caries removal efficacy, and patient acceptance. These findings suggest that minimally invasive excavation systems are effective alternatives to conventional rotary burs in pediatric restorative dentistry, particularly when dentin preservation and patient comfort are important clinical considerations.

REFERENCES:

[1] Uribe, S. E., Innes, N., & Maldupa, I. (2021). The global prevalence of early childhood caries: a systematic review with meta-analysis using the WHO diagnostic criteria. *International journal of paediatric dentistry*, *31*(6), 817-830.

[2] Schwendicke, F., Dörfer, C. E., & Paris, S. (2013). Incomplete caries removal: a systematic review and meta-analysis. *Journal of dental research*, *92*(4), 306-314.

[3] Neves, A. D. A., Coutinho, E., De Munck, J., & Van Meerbeek, B. (2011). Caries-removal effectiveness and minimal-invasiveness potential of caries-excavation techniques: a micro-CT investigation. *Journal of Dentistry*, *39*(2), 154-162.

[4] Banerjee, A., Kidd, E. A. M., & Watson, T. F. (2000). In vitro evaluation of five alternative methods of carious dentine excavation. *Caries research*, *34*(2), 144-150.

[5] CHAVHAN, P. D., KHOLE, M. D., SHAH, S. S., CHANDAK, S. A., PATIL, G. R., MUJARIYA, P. P., ... & KULKARNI, B. A. (2024). Comparative Efficacy of Smart Burs vs Conventional Burs in Removing Infected Dentin and Preserving Affected Dentin in Primary Teeth: A Randomised Control Study. *Journal of Clinical & Diagnostic Research*, *18*(10).

[6] Thomas, S., Duraisamy, V., Selvarajan, N. B., Gainneos, R. P. D., Joybell, C. C., & Gopalan, T. (2024). Comparative evaluation of the efficiency of polymer bur, cera bur, and tungsten carbide bur in dentin caries excavation of mandibular primary molars: An in vivo study. *Journal of Pharmacy and Bioallied Sciences*, *16*(Suppl 2), S1442-S1446.

[7] Abdul-Kareem Mahmood, M., Khairi Al-Hadithi, H., & Mueen Hussein, H. (2024). Evaluation of dentin features in teeth after caries removal by three techniques (chemomechanical, mechanical with a smart bur, and air-abrasion): an in vitro study. *PeerJ*.

[8] Somkuwar, J. K., Ansari, A. A., Singh, R. K., & Bahal, R. (2025). Comparative Evaluation of BRIX3000 Smart Burs and Conventional Technique of Caries Excavation among 5–9-year-old Children: A Randomized Clinical Trial. *Journal of South Asian Association of Pediatric Dentistry*, *7*(3), 143-150.

[9] 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.

[10] El-Baz, G. (2024). Comparative study between SmartBurs II and conventional carbide burs in the evaluation of pain and anxiety in children. *Dental Science Updates*, *5*(1), 197-203.

[11] Okamoto, K. I., Aoki, S., & Tamura, Y. (2014). Comparisons of discomfort among cutting instruments for removal of carious dentine in children. *Pediatric Dental Journal*, *24*(1), 46-52.