ORIGINAL RESEARCH

Comparative Evaluation of Efficiency, Efficacy, and Patient Perception of Caries Excavation Burs in Pediatric Patients: A Randomized Clinical Trial

Arundhati Goyal[1], Manvi Srivastava[2], Ritu Khanduja[3], Kusum Bharti[4]

Abstract

Aim: This *in vivo* study was aimed to investigate and compare the cutting efficiency, removal of carious dentin (efficacy), and patient comfort while removing caries between newer caries excavation bur (ceramic bur and smart bur) with conventional bur (diamond point).

Material and methods: A total number of 75 carious primary molars were selected in pediatric patients and three different types of burs were used for caries excavation which were evaluated and compared for total time taken (efficiency), remaining infected dentin (efficacy), and patient acceptance clinically.

Result: Significant difference ($p = 0.000$) was obtained in terms of efficiency with least time consumed by ceramic bur and highest by smart bur. For efficacy, a significant difference was obtained ($p = 0.002$), ceramic bur being the most effective in carious dentin removal. For patient acceptance, a significant difference was obtained ($p = 0.000$), diamond point and ceramic bur were equally acceptable to the patient and the least accepted was smart bur.

Conclusion: Ceramic bur proved to be suitable for minimally invasive caries excavation in primary molars as well as comfortable to the pediatric patients because of high cutting efficiency and lesser time consumption.

Keywords: Caries excavation burs, Clinical trial, Efficacy, Efficiency.

Journal of South Asian Association of Pediatric Dentistry (2022): 10.5005/jp-journals-10077-3214

Introduction

In the earlier days, caries removal was done by hand instruments which is time-consuming and unpleasant.[1] With the advent of time, the removal of caries shifted from hand instruments to rotary instruments like diamond burs, carbide burs, and stainless steel burs.[2] The disadvantage of these burs is that they are nonselectively leading to over-preparation compromising the remaining tooth structure and increasing the potential for iatrogenic damage of the primary teeth due to less dentin thickness. Above all, the amount of pain and discomfort with them is the greatest concern in the pediatric population.[3]

To overcome these problems, there has been a shift from the philosophy of "drill and fill" to a minimally invasive approach in restorative dentistry. The idea behind minimally invasive dentistry is maximum conservation of healthy dentin with new means of dentinal caries excavation as the affected dentin has the ability to remineralize.[4]

Recently, Boston introduced a new polymer bur to substitute conventional burs. Smart Burs™ (SS White, Lakewood, NJ, USA) is made up of a polymer with reinforced blades for selective carious dentin removal.[4] These burs remove only infected dentin as soft infected dentin has KHN of 0–30 and polymer material has KHN of 50 while healthy dentin has KHN of 70–90.[5]

Another recently introduced bur is alumina based ceramic bur with stabilized zirconia (ZrO_2: 76%; Al_2O_3: 20%; Y_2O_3: 4%) (CeraBur, K1SM, Komet). Listed advantages of ceramic bur over conventional burs are corrosion resistant, smooth in operation, and excellent cutting efficiency.[6]

Therefore, the present study was conducted to investigate and compare the cutting efficiency, carious dentin removal (efficacy), and patient comfort while removing caries between newer caries excavation burs (ceramic bur and smart bur) with the conventional method (diamond point).

[1-3]Department of Pedodontics and Preventive Dentistry, KD Dental College & Hospital, Mathura, Uttar Pradesh, India

[4]KD Dental College And Hospital, Mathura B.R Ambedkar University, Agra, Uttar Pradesh India

Corresponding Author: Arundhati Goyal, Department of Pedodontics and Preventive Dentistry, KD Dental College & Hospital, Mathura, Uttar Pradesh, India, Phone: +91 7454947843, e-mail: drarundhatigoyal@gmail.com

How to cite this article: Goyal A, Srivastava M, Khanduja R, *et al.* Comparative Evaluation of Efficiency, Efficacy, and Patient Perception of Caries Excavation Burs in Pediatric Patients: A Randomized Clinical Trial. J South Asian Assoc Pediatr Dent 2022;5(1):11–16.

Source of support: Nil

Conflict of interest: None

Material and Methods

This research protocol was examined and accepted by the institutional ethical committee before conducting the study. Patients who participated in the study were selected from the outpatient Department of Pediatrics and Preventive Dentistry after obtaining written informed consent from the parents.

Sample Size Calculation

The sample size was evaluated in a 95% confidence interval and 85% statistical power with a standard deviation of 25, effect size of 20,

Z value of 1.96, type I error of 5% at 80% power. Thus, total sample of 75 was calculated and equally randomized and divided into three groups of twenty-five samples in each group as shown in the consort flowchart (Fig. 1).

Group 1: Smart bur II (SS WHITE® RA-4, RA-6, RA-8) (Fig. 2)
Group 2: Ceramic bur (CeraBur® Komet USA K1SM.204.016) (Fig. 2)
Group 3: Diamond point (API® BR-46 ISO 001/012) (Fig. 2)

This research study was a randomized clinical trial with an allocation ratio of 1:1:1, randomization was done using the lottery method. To prevent bias, two blinded examiners contributed, one for assigning the participants to the groups and the other one for evaluating cavity and to check whether the prepared cavities are caries free.

Inclusion measures:

- Healthy children of age 3–9 years who were willing to take part in the study were selected from both sexes.
- Children with positive or definitely positive behavior according to Frankel's behavior rating scale.
- Right and/or left maxillary and mandibular primary molars with occurrence of carious lesion into dentin on occlusal surface.
- Asymptomatic carious lesions with distinct dentin involvement verified by radiograph.
- Carious tooth without any clinical symptom with clear dentin involvement confirmed radiographically.

Exclusion measures:

- Noncooperative child.
- Grossly decayed teeth.
- Presence of any clinical/radiographic sign and symptom.
- Presence of developmental defects in primary molar.
- Children with underlying systemic disease.

Clinical Procedure

A total of 75 primary molars either in the deciduous or mixed dentition of healthy children of both sex from 3–9 years of age were selected. The surrounding gingiva of the selected tooth was first anesthetized by topical anesthesia (Lidocaine Topical aerosol USP 15% w/w). Rubber dam (Coltene Rubber Dam Kit Hygenic) isolation was done for better visibility and to improve the efficiency of the operator (Figs 3A, 4A, and 5A). To expose the carious dentin, unsupported enamel was first removed from each tooth using a high-speed handpiece under water cooling. The carious dentin was then removed with smart bur (group 1), ceramic bur (group 2), and diamond point (API) (group 3) heat generation under water irrigation to prevent and prevent pulp damage using a slow-speed contra-angle handpiece (API) with light, discrete strokes that were directed from the center of the lesion outward (Figs 3B, 4B, and 5B). Cutting was performed until no flakes of softened dentin stopped coming out and the bur discontinued to progress into the healthy dentin. Caries excavation was verified with the visual and tactile method and was further verified by caries detector dye (MAARC Find Fast Caries indicator) as suggested by the manufacturer. The caries detector dye was dropped onto an applicator tip and then placed into the cavity. After 10 seconds, the dye was rinsed off with water, and scoring was done by a coinvestigator without knowledge of assignment (Figs 3C, 4C, and 5C). The restoration was done with glass ionomer cement (Figs 3D, 4D, and 5D).

Evaluation of time (Efficiency):

The time taken for caries removal was recorded using a stopwatch by an assistant from the beginning of the cavity preparation until the infected dentin excavation was complete.

Evaluation of caries excavation (Efficacy):

The cavity was assessed for remaining carious dentin first by visual and tactile criteria and then by caries detecting dye. The visual criterion was the absence of any dentin discoloration and the tactile criterion was the smooth passage of an explorer over the surface of the affected area of the dentin without a catch or a "tug back" sensation. Efficacy was further confirmed by the dye and was numerically scored using the standard suggested by Munshi et al.[7] as shown in Table 1. Scoring was done by the 2nd blinded investigator assessing this study.

Evaluation of Pain and Patient Discomfort

This was assessed using Face, Legs, Activity, Cry, Consolability (FLACC) scale proposed by Merkel et al.[8] as shown in Table 2. This tool includes five categories of pain behaviors, including facial expression, leg movement, activity, cry, and consolability. These behaviors are to be reliably associated with pain in young children. The examiner was provided with the guide to use this scale. Scoring of the patient's behavior was done during the procedure.

Score 1: Relaxed and comfortable
Score 1–3: Mild discomfort
Score 4–6: Moderate pain

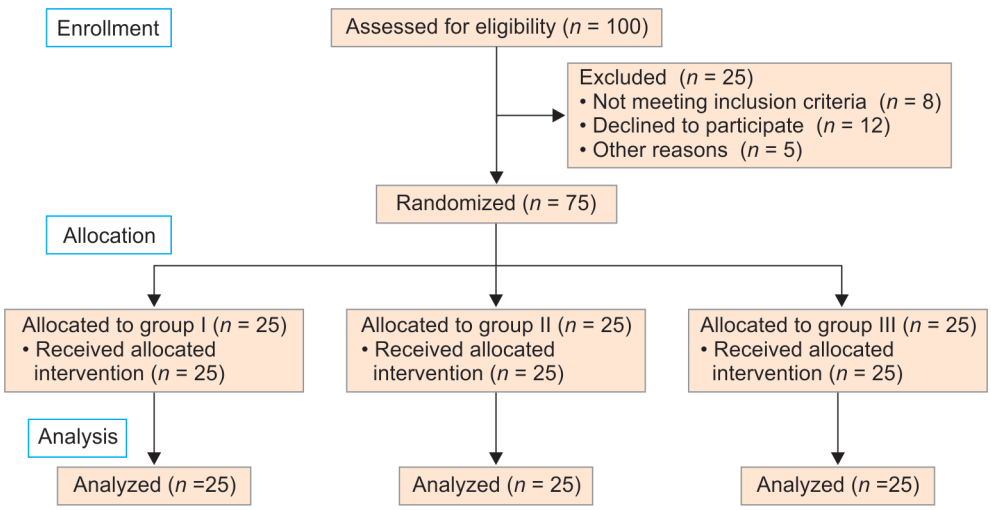


Fig. 1: Consort flowchart for randomized controlled trial

Score 7–10: Severe pain or discomfort or both

After completion of the clinical trial, the obtained data was subjected to statistical analysis using statistical package for social sciences version (SPSS) 17.0. The test used to analyze the data in this study were one-way ANOVA, post hoc Tukey's test (HSD), Chi-square test, Mann–Whitney *U* test. The level of statistical significance was set at 95% ($p = 0.05$), p-value < 0.05 was considered to be significant.

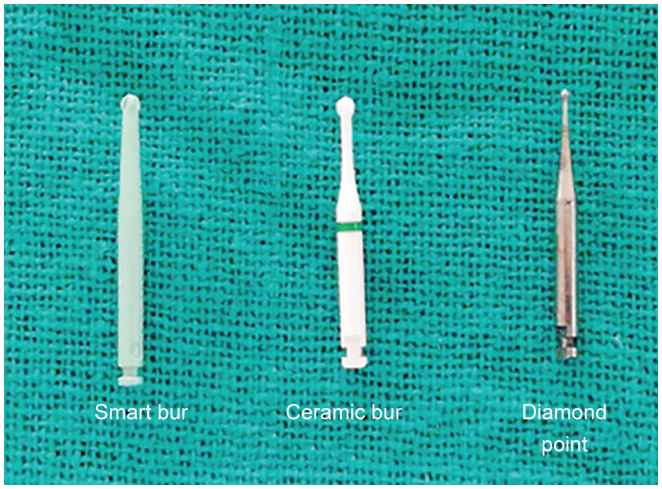
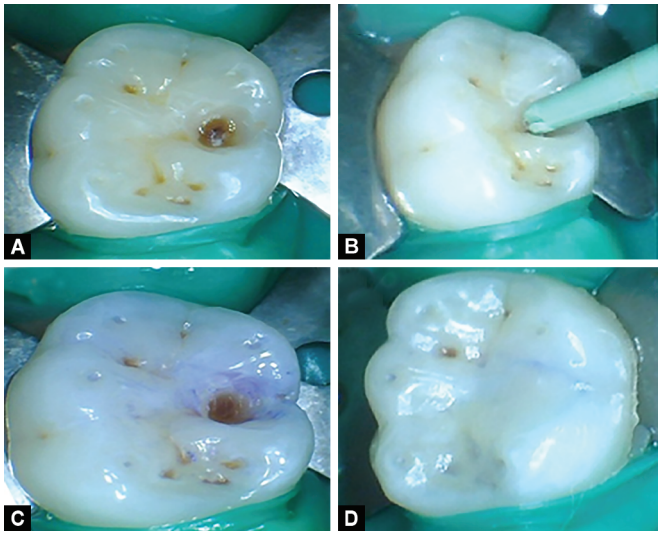


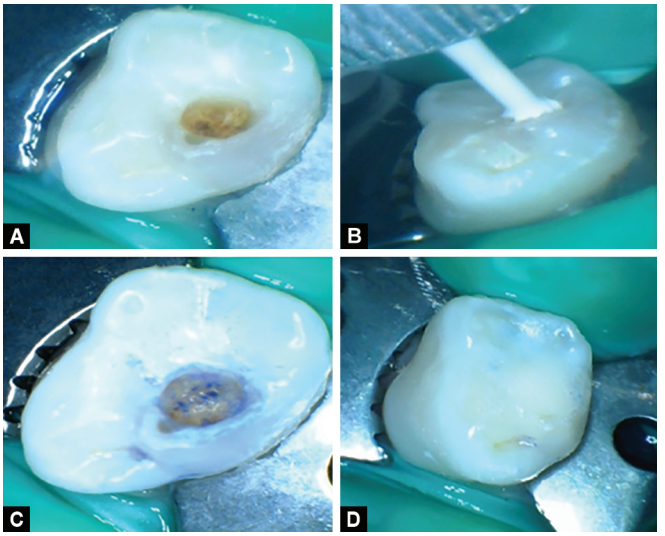
Fig. 2: Different types of burs used in the study



Figs 3A to D: Procedure of caries excavation using smart bur: (A) Preoperative photo of 85, (B) During cavity preparation, (C) Evaluation of stained dentine, (D) Cavity restored with GIC

Results

Total number of primary molars examined were 75 out of which 21 were maxillary molars (28%) and 54 were mandibular molars (72%). The mean age of children who participated in this trial was 6.39 ± 1.50.



Figs 4A to D: Procedure of caries excavation using ceramic bur: (A) Preoperative photo of 84, (B) During cavity preparation, (C) Evaluation of stained dentine, (D) Cavity restored with GIC

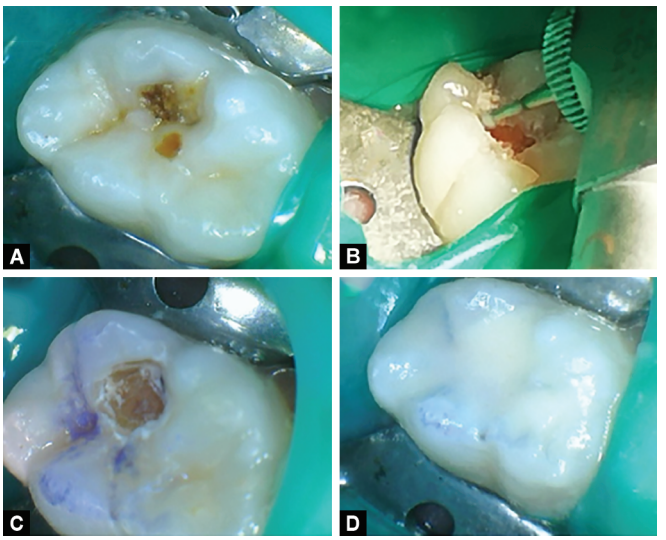
Table 1: Scoring criteria for the assessment of the efficacy of caries removal

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

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	Normal position or relaxed	Uneasy restless sense	Kicking or legs drawn up
Activity	Lying quietly normal position moves easily	Squirming, shifting back and forth tense	Arched rigid or jerking
Cry	No cry awake or sleep	Moans or whimpers occasional complaint	Crying steadily screams or sobs frequent complaints
Consolability	Content, relaxed	Reassured by occasional touching, hugging or taking to distractible	Difficult to console or comfort

Table 3 describes the mean value of efficiency, efficacy, and patient acceptance among three different groups. Mean time obtained by group 2 was least, followed by group 3, and the highest time was consumed by group 1. Maximum efficacy was seen with group 2, followed by group 1, and group 3. Minimum mean value of FLACC score was obtained with group 3 followed by group 2 and maximum mean value was obtained in group 1.



Figs 5A to D: Procedure of caries excavation using diamond point: (A) Preoperative photo of 75, (B) During cavity preparation, (C) Evaluation of stained dentine, (D) Cavity restored with GIC

Table 4 describes the intergroup comparison of efficiency among three groups using post hoc Tukey's test. Significant differences were obtained among the three groups when one-way ANOVA was applied. To confirm the data, post hoc Tukey's test was done which gave significant differences between all the groups.

Statistically significant difference was obtained when comparison was done among the three groups using the Chi-square test for the efficacy of the burs. Hence, the data was further evaluated by Mann–Whitney *U* test as shown in Table 5. A significant difference was obtained when the comparison of group 1 with group 2 and group 2 with group 3 was done, whereas nonsignificant *p* value was obtained on comparison between group 1 with group 3.

The value of FLACC score among the three groups was compared by using Chi square test. For multiple comparisons, Mann–Whitney *U* test was applied (Table 6), and significant difference was obtained on comparison between group 1 with group 2 and between group 1 with group 3. Nonsignificant *p* value was obtained on comparison between group 2 and group 3.

Discussion

Minimally invasive dentistry is conceptually based on methods that remove caries with minimal loss of sound tooth structure henceforth maintaining the vitality of the pulp.[9] In this study, slow-speed burs were selected over the widely used method of caries removal (high-speed air-rotor) because its high speed and sound produce aversive behavior in pediatric patients. Diamond

Table 3: Mean value of efficiency (seconds), efficacy, and patient acceptance among three groups

Variable	*Groups*	*N*	*Mean±SD*	*Min.*	*Max.*
Efficiency	Group 1	25	750.00±275.73	260.00	1320.00
	Group 2	25	290.88±108.09	120.00	495.00
	Group 3	25	519.60±236.52	250.00	1150.00
Efficacy	Group 1	25	1.20±0.71	0	2
	Group 2	25	0.44±0.58	0	2
	Group 3	25	1.20±1.12	0	4
FLACC score	Group 1	25	0.96±0.73	0	2
	Group 2	25	0.32±0.69	0	2
	Group 3	25	0.08±0.28	0	1

Table 4: Intergroup comparison of efficiency among three groups using *post hoc* Tukey's test

Variable	*Group vs group*	*Mean difference (I –J)*	*p-value (post hoc Tukey HSD)*
Efficiency	Group 1 vs group 2	459.12	0.000*
	Group 1 vs group 3	230.4	0.001*
	Group 2 vs group 3	–228.72	0.001*

**p*-value < 0.05 which means significant difference

Table 5: Intergroup comparison of efficacy among three groups using Mann–Whitney *U* test

Variable	*Group vs group*	*Mean difference (I –J)*	*p-value (Mann–Whitney test)*
Efficacy	Group 1 vs group 2	3.592	0.000*
	Group 1 vs group 3	0.379	0.704
	Group 2 vs group 3	2.624	0.009*

**p*-value < 0.05 which means significant difference

Table 6: Intergroup comparison of patient acceptance among three groups using Mann–Whitney *U* Test

Variable	*Group vs group*	*Mean difference (I–J)*	*p-value (Mann–Whitney test)*
FLACC score	Group 1 vs group 2	3.234	0.001*
	Group 1 vs group 3	4.583	0.000*
	Group 2 vs group 3	1.304	0.920

*p-value < 0.05 which means significant difference

point was taken as a control group for this study as it is the most widely and routinely used bur for caries removal in dentistry but inefficient in differentiating between carious and healthy dentin.

Smart burs II are a relatively recent and novel introduction for selective dentin caries removal. Unlike the conventional burs, they are "self-limiting" as their cutting edges are shovel-like straight and not spiral. Smart bur II is preferred over first-generation (SMARTPREP) because the plastic used was not durable when run at rotary speeds above 1000 rpm.[10] The introduction of Smart bur II provides significant changes in design and materials used in the fabrication of the bur allowing its use at 4000 rpm without damage to the bur's integrity.[10] Carious tissue is removed with a light pressure in circular movements starting from the center to the periphery to avoid contact with the harder enamel. The bur gets dull and vibrates when it comes in contact with highly calcified caries-affected dentin.[12]

Another bur taken as test group was ceramic bur (CeraBur K1SM). These burs are used in a slow-running handpiece at a speed of 1000–1500 per minute. According to the highly efficient description by the manufacturers, these burs have excavating ability on soft, carious dentin with minimal reduction of the sound, hard tooth structure. Hence, ceramic burs were suitable for minimal caries excavation and were thus included in the study. To the best of our knowledge, no scientific study on the efficiency of ceramic bur in comparison to smart bur and diamond point has been published to date.

As the present study was *in vivo*, the selected teeth were healthy and could not be compromised when subjected to more effective methods like confocal laser scanning microscopy to maintain the integrity of caries removal. Therefore, the visual and tactile criterion was acquired because it is the most widely used clinical criterion to evaluate complete caries removal. The caries detector dye was additionally used in order to overcome the implicit problem of visual and tactile techniques.

Efficiency

Efficiency is the total time taken by the bur for complete caries removal. Hence, lesser the time consumed, more will be the efficiency of the bur. In the present study, ceramic bur proved to be most efficient among the three groups while polymer bur turned out to be least efficient in removing carious dentin. Time reported by smart bur was between 260 seconds and 1320 seconds.

Dammashke et al. in 2008[5] in an *in vitro* study found that the efficiency of ceramic bur on average was 159.12 (± 68.17) seconds but no statistically significant difference was obtained when efficiency of ceramic bur was compared with conventional bur, whereas in our study, mean time taken by ceramic bur was 290.88 ± 108.09 seconds and statistically significant difference was obtained when the value was compared with smart bur and conventional bur. Ceramic bur is composed of alumina–yttria ceramic which in general has excellent wear resistance and cutting ability and good hardness which makes it fast.[6] Disadvantage with diamond point is that they were difficult to control because of its high cutting efficiency of dentin with little tactile feedback.

The reason for longer duration of time taken by smart bur can be attributed to the fact that polymer bur gets abraded quickly and loses its cutting efficiency when contact sound dentin and new bur is attached to the handpiece for complete caries excavation. Such abrasion does not occur with ceramic bur. Therefore, repeated change of bur was required until complete caries removal was achieved. The result of this study corresponds to study by Wahba et al.[11] and Shakya et al.,[12] where they compared the efficacy of polymer bur (SmartPrep) with conventional burs (carbide bur & diamond points) and concluded that SmartPrep bur was less efficient than conventional burs.

Efficacy

Efficacy is the removal of infected dentin preserving the integrity of healthy dentin. Therefore, visual and tactile criteria were acquired as it is the most widely used criteria to check complete caries removal and confirmed with caries detecting dye for remaining carious lesion. According to Divya et al.,[13] polymer bur was more conservative with the least amount of dentinal tubule destruction when compared to conventional bur. In the present study, ceramic bur proved to be most effective in the removal of infected carious dentin as compared to smart bur and diamond point while smart bur and diamond point showed nonsignificant difference. Score 2 was found in nine subjects of smart bur group (carious dentin on floor and wall) indicating that polymer bur tends to leave behind infected dentin. Wahba et al. also had similar observation when they used smart bur II and reported complete removal of caries only in 36.6% and incomplete caries removal in 63.4%. According to Prabhakar et al.,[14] the polymer bur was found to be self-limiting, moreover ability to cut the dentin also decreased on contact with healthy dentin and did not cut sound dentin. Until now, no data has been examined on ceramic burs effectiveness in caries removal.

Out of 25 subjects in group 2, 15 got a score of 1 indicating complete caries removal which clearly points towards minimally invasive caries excavation with CeraBur that has the advantage of fewer dentinal tubules being removed. For more details on whether ceramic burs are able to remove a sufficient amount of carious dentin without affecting healthy tooth structure, a further study should be conducted using SEM to check the remaining dentin thickness. If ceramic burs are able to selectively and solely remove only the carious dentin, then this would be a considerable benefit, because the major disadvantage of conventional burs is that they remove healthy noncarious dentin.

Patient Acceptance

FLACC scale was used to record behavior pattern of the patients while caries excavation procedure. Because of its elaborate nature, it is proven to be the best.[15] Allen et al.[6] in their study stated that polymer bur without local anesthesia was accepted by the patient over conventional bur without local anesthesia. But in our study,

smart bur was least accepted whereas diamond point and ceramic bur were equally acceptable to the patient. The possible reasons for least acceptance of polymer bur in the present study could be the time consumption factor and greater vibration and sound in these polymer bur when they contact healthy tooth structure. The findings of our study were similar to Rajkumar et al.[16] where they compared polymer bur to hand excavation and concluded that pain perception was not minimized by polymer bur.

Since ceramic bur had shown that the patient acceptance was better than smart bur, it points out that there was minimal healthy tooth structure loss as affected dentin is sensitive to mechanical alterations. Least to mention that all the subjects were restored with Fuji IX following application of calcium hydroxide base wherever needed, of total 75 teeth only, one restorative failure was reported to the department from smart bur group. To date, none of the patient reported complaint of sensitivity or pulpal involvement symptoms in any of the three groups.[17]

Limitations

The present study lacks microbial count assessment, brief research with longevity of restoration, and secondary caries development evaluation.

Conclusion

Ceramic burs would be acceptable for minimally invasive caries excavation as they proved to be more efficient. Polymer burs although selective in carious dentin removal has the disadvantage of incomplete caries removal that led to the repeated change of burs and lesser patient acceptance due to vibration and more time consumption. Further studies would be needed to authenticate our findings since there has been no scientific examination published in dentin cutting excavation using ceramic bur until now to the best of our knowledge.

References

1. Hassan AF, Yadav G, Tripathi AM, et al. A comparative evaluation of the efficacy of different caries excavation techniques in reducing the cariogenic flora. An in vivo study. Int J Clin Pediatr Dent 2016;9(3):214–217. DOI: 10.5005/jp-journals-10005-1366
2. Isik EE, Olmez A, Akca G, et al. A microbiological assessment of polymer and conventional carbide burs in caries removal. Pediatr Dent 2010;32(4):316–323.
3. Maarouf R, Badr S, Ragab H. Clinical efficiency of polymer burs in caries removal in primary molars and relevant pain perception: a randomized controlled trial. Int Arab J Dent 2018;9(1):9–14.
4. Dammaschke T, Rodenberg TN, Schafer E, et al. Efficiency of the polymer bur SmartPrep compared with conventional tungsten carbide bud bur in dentin caries excavation. Oper Dent 2006;31(2):256–260. DOI: 10.2341/05-24
5. Dammaschke T, Vesnic A, Schafer E. In vitro comparison of ceramic burs and conventional tungsten carbide bud burs in dentin caries excavation. Quintessence Int 2008;39(6):495–499.
6. Allen KL, Salgado TL, Janal M, et al. Removing carious dentin using a polymer instrument without anesthesia versus a carbide bur with anesthesia. J Am Dent Assoc 2005;136(5):643–651. DOI: 10.14219/jada.archive.2005.0237
7. Munshi AK, Hegde AM, Shetty PK. Clinical evaluation of Carisolv in the chemico-mechanical removal of carious dentin. J Clin Pediatr Dent 2001;26(1):49–54. DOI: 10.17796/jcpd.26.1.lr48727276478461
8. Merkel SI, Voepel-Lewis T, Shayevitz JR, et al. The FLACC: a behavioral scale for scoring postoperative pain in young children. Pediatr Nurs 1997;23(3):293–297.
9. Zakirulla M, Uloopi K, Subba Reddy V. In vivo comparison of reduction in bacterial count after caries excavation with 3 different techniques. J Dent Child 2011;78(1):31–35.
10. Strassler HE. Dentin-safe, self-limiting, medical-grade burs can help preserve caries excavation. Inside Dent 2011;7(7).
11. Wahba W, Sharaf A, Bakery N, et al. Evaluation of polymer bur for carious dentin removal in primary teeth. Alexandria Dent J 2015;40(1):107–112. DOI: 10.21608/ADJALEXU.2015.58744
12. Shakya VK, Chandra A, Tikku AP, et al. A comparative evaluation of dentin caries removal with polymer bur and conventional burs—an in vitro study. Open J Stomatol 2012;2(1):12–15. DOI: 10.4236/ojst.2012.21002
13. Divya G, Prasad MG, Vasa AAK, et al. Evaluation of the efficacy of caries removal using polymer bur, stainless steel bur, carisolv, papacarie – an invitro comparative study. J Clin Diagn Res 2015;9(7):ZC42–ZC46. DOI: 10.7860/JCDR/2015/12705.6202
14. Prabhakar A, Kiran NK. Clinical evaluation of polyamide polymer burs for selective carious dentin removal. J Contemp Dent Pract 2009;4(10):26–34.
15. Bohari MR, Chunawalla YK, Ahmed BMN. Clinical evaluation of caries removal in primary teeth using conventional, chemomechanical and laser technique: an in vivo study. J Contemp Dent Pract 2012;13(1):40–47. DOI: 10.5005/jp-journals-10024-1093
16. Rajakumar S, Mungara J, Joseph E, et al. Evaluation of three different caries removal techniques in children: a comparative clinical study. J Clin Pediatr Dent 2013;38(1):23–26. DOI: 10.17796/jcpd.38.1.p3324121m66n1737
17. Ardeshana A, Bargale S, Karri A, et al. Evaluation of caries excavation efficacy with ceramic bur and hand excavation in primary teeth: an experimental study. J South Asian Assoc Pediatr Dent 2020;3(2):60–64