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Comparative evaluation of microhardness of residual dentin in primary molars following caries removal with chemomechanical agent (BRIX 3000) and polymer burs (ss white): In vitro study

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***Abstract*---**Aim: To evaluate and compare microhardness of residual dentin in primary molars following caries removal with chemomechanical agent (BRIX 3000) and polymer burs (SS white). Materials and Method: Extracted maxillary or mandibular primary molars with proximal carious lesion, were selected with active carious cavities extending in to 2/3rd of dentin. The selected teeth were preserved in phosphate buffer saline solution no longer than 30 days.

The selected teeth were separated into two experimental groups: group A- chemomechanical method – Brix3000 and Group B- slow speed polymer bur. After caries excavation the microhardness test was carried out on treated dentin using a Knoop indenter. Results: The results suggest a significant difference between among the groups Brix 3000® showed superior results compared to group B (Polymer burs) i.e., The results showed that the microhardness of the remaining dentine after caries excavation with Brix 3000 was found to be greater than the microhardness of the remaining dentine after caries excavation with Polymer bur. Conclusion: In conclusion of the current study, it can be stated that Brix 3000 may be utilized as a successful agent in minimally invasive caries excavation since Polymer burs showed partial removal of carious dentine. Clinical significance: In primary teeth caries excavation with minimally invasive method that will prevent weakening of the remaining tooth structure will enhance the treatment outcome.

***Keywords*---**BRIX 3000, chemomechanical agent, enzymatic gel, minimal invasive dentistry, primary teeth, polymer bur, microhardness.

Introduction

To begin with, the most essential aspect of pediatric dentistry is the behaviour management of children throughout treatment. Treating children with minimally invasive treatments will transform their perception of pain and anxiety about dental treatment. Dental caries is a diet-modulated, multifactorial, biofilm-mediated noncommunicable, disease that causes mineral loss in dental hard tissues [Fejerskov 1997; Pitts et al., 2017]. The mixed dentition has the highest overall frequency (58 percent). Western India has a higher prevalence (72 percent).[1] Untreated early childhood caries (ECC) has a considerably worse dental health-related quality of life in children than in children who do not have ECC. Furthermore, treatment of carious teeth results in faster weight gain and development in the treated youngster.[2]

The management of dental caries has evolved over the last few decades with a change from 'extension for prevention' to 'construction with conservation'.[3] Caries removal by traditional method using rotary burs & sharp instruments have certain drawbacks like difficulty in removing the exact amount of infected dentin, pain, discomfort, generation of heat, vibration & noise and the possibility of over-extension with consequent weakening of the `remaining tooth and causing pulp injuries.[4] However, the use of conventional burs has the advantages of being less time-consuming and has decreased residual microorganisms present at the site after the removal of caries.[5]

Minimal invasive dentistry (MID) is the modern medical approach to the management of caries.[6] The success of MID is determined by elements such as the demineralizati5on – remineralization cycle, restorative material adherence, and biomimetic restorative materials. Various approaches of MID for carious

lesion are available, including Atraumatic restorative treatment (ART), Air abrasion, chemomechanical caries removal, lasers.[7] Amongst all the techniques the chemomechanical method for removing caries is known to be less painful. The CMCR agents are either enzyme- or sodium hypochlorite-based. Sodium hypochlorite-based agents were the first to be introduced CMCR is a minimally invasive procedure that eliminates infected dentin with damaged collagen while preserving good tooth structure that may be remineralized and restored.[4] However, NaOCl based agents led to the acquisition of specific instruments that raised their market value, thus preventing their implementations on a large scale. Furthermore, the NaOCl-based agent was unstable and lacked selectivity, removing both diseased and damaged dentin as well as sound dentine.[8] To address this issue, amino acids were added to succeeding versions, and enzyme-based agents, such as papain-based agents, are currently in use. Papacarie gel, the first papain enzyme-based CMCR agent was introduced in 2003, subsequently Biosolv, Cari-Care were introduced. These papain-based agents though provided selectivity in the removal of infected dentin, had less viscosity thus making them flow when used on the cavity to overcome this disadvantage newer papain-based agent Brix3000 with encapsulating buffer emulsion technology (EBE) is introduced, raising its efficiency. Brix Medical Science, Argentina, released it in 2012 as a proprietary papain-based gel formulation. The high papain content (3000 U/mg) and Encapsulating buffer emulsion (EBE) technology, inducing gel with optimal pH to encapsulate the enzyme at the point of exerting proteolysis in collagen, thereby boosting its activity and specificity, are distinctive properties of this product.[8]

Another minimal invasive method is the use of polymer burs for the excavation of caries. Conventional burs with high-speed airotor are been used and can effortlessly remove the decayed tooth structure; however, they readily won't differentiate between normal and carious dentin and thus have a less conservative approach, and this excess removal of dentin occurs as conventional burs have a greater Knoop hardness of 7,000 KHN (KHN- Knoop Hardness Number) which also increased risk of pulp exposure in the deep carious lesion.[9] Traditional burs normally have a negative rake angle, resulting in excessive dentin removal.[10] Also, other drawbacks such as high-pitched noise, increase in the friction induced heat at the surface, which can cause thermal injury is experienced with the use of conventional burs. However, the use of conventional burs has the advantages of being less time-consuming and has decreased residual microorganisms present at the site after the removal of caries. Thus, the use of such bur that have more conventional approach and will prevent removal of affected dentin along with convenience for use in pediatric age group is required.[11] It is another rotating device constructed of specifically formulated polymer material that, according to the manufacturer, selectively removes infected dentin while leaving healthy dentin.[12] The polymer cutting instrument's design is based on the varying hardness of the tooth tissues. Enamel has a knop hardness of 380-400 KHN, while dentin has a knop hardness of 66-80 KHN. Carious dentin has a Knoop Hardness of 30 KHN. In order to achieve an effective removal of carious dentin and to save sound dentin polymer burs have KHN 50.[13]

When comparing permanent and primary teeth there is a significant difference between dentine of primary and permanent teeth. The dentine of primary teeth is

less dense and less thick, whereas dentine of permanent teeth is denser and thicker. [14] Which creates a great possibility in primary teeth of pulp exposure during caries excavation when both the infected as well as affected dentine is removed. Thus, the objective of preserving the dentine by various MID techniques is to enliven the tissue that has hope to repair. Preservation of only affected dentine should be done and not infected dentine. Carious dentin is made up of two layers: an outside infected layer that has been permanently denatured, and an inner affected layer that can be remineralized. There is strong evidence suggesting leaving behind infected dentin when there is a danger of pulp exposure. Several other investigations have shown that cariogenic bacteria either die or remain dormant after removing their source of sustenance and placing restoration with adequate integrity, posing no harm.[15]

Microhardness analysis of residual dentin following caries removal has been utilized as a tool to measure mineral loss and reincorporation in tooth tissue. The decrease in numerical hardness has a linear relationship with mineral loss from the tooth structure and is an appropriate criterion for measuring demineralization of the afflicted dentin.[4] Demineralization of the intertubular dentine, crystal deposition inside the tubule lumen, no degradation of the collagen matrix, and no bacterial penetration indicate 'caries affected dentine. The 'caries-infected' dentine, on the other hand, exhibited deformation of the architecture of the dentinal tubules, permanent denaturation of the collagen fibers, and significant bacterial infiltration.[16]

Though the method of chemomechanical caries removal is a minimally invasive technique, there are contradictory results about the microhardness of residual dentin after its use. There are insufficient data available in the literature regarding the hardness of remaining dentine after caries excavation with CMCR agent Brix 3000 and hardness of remaining dentine after caries excavation with polymer burs. As a result of this comparison of the most recent chemomechanical caries removal agent (BRIX3000) and polymer burs (SS white), both of which are minimally invasive caries removal procedures, will help in a better understanding of residual dentin in primary teeth and can help clinicians choose the least invasive technique.

Thus, the purpose of this in vitro study is to assess the microhardness of remaining dentin in primary molars following caries treatment with a chemomechanical agent (BRIX 3000) and polymer burs (SS white).

Methodology

The current in vitro study was conducted in the Department of Pediatric and Preventive Dentistry, D.Y. Patil Dental College and Hospital, D.Y.Patil Vidyapeeth, in collaboration with Phonex metallurgy lab, to assess the microhardness of the remaining dentinal surface after carious tooth tissue removal with a polymer bur attached to slow speed handpice and a CMCR agent (Brix 3000) using the Knoop microhardness tester.

Collection of the specimen tooth was done by extraction of over retained tooth having proximal carious lesion. Fourteen extracted maxillary or mandibular

primary molars with proximal carious lesion, were selected according to inclusion criteria i.e. With active carious cavities extending in to 2/3rd of dentin, and the extent of carious lesion was confirmed after radiographic evaluation. Radiographic examination of tooth showing pulpal involvement, teeth with any pathology other than dentinal caries, such as developmental anomalies, fracture, filling material were excluded from the study. The selected teeth were preserved in phosphate buffer saline solution no longer than 30 days. [17]

The selected teeth were separated in accordance with the carious tissue removal technique into two experimental groups with seven teeth in each group: group A- chemomechanical method – Brix3000 and Group B- slow speed polymer bur. Before performing caries excavation, scaling of the tooth was performed to remove the debris.

Carious tissue removal using chemomechanical method

For the Brix 3000 group, material was applied using a blunt spoon excavator according to the manufacturer's directions and left on the carious lesion for 2 minutes. Decayed dentin which becomes softened was scraped away with blunt spoon excavator in pendulum motion without pressure. The gel was reapplied until it displayed a light coloration, indicating the absence of softened infected tissue, and was validated using dental explorer to examine the hardness of residual dentin.[18]

Carious tissue removal using the polymer bur

A single operator removed carious tissue using a polymer bur of a size determined by the cavity size, the bur was attached to micromotor handpice and used at low speed. Caries were excavated in a circular motion from the center of the lesion to the edge, as indicated by the manufacturer. Excavation was halted when the instruments were abraded macroscopically and dull, and were no longer capable of removing tissue. A dental explorer was used to check for carious tissue removal until firm dentin was attained.[19]

Preparing test specimens for microhardness test

Following the removal of carious tissue, the teeth were longitudinally sectioned – under water cooling along the mesiodistal direction of the crown, at the center of the cavity – until workpieces were acquired. One of the parts was implanted in acrylic resin, exposing the region to be studied. Followed by polishing with abrasive sheets of 220,320,600, and 1500 grit.[20] The microhardness test was carried out on treated dentin using a Knoop indenter and a static force of 10 g applied for 30 seconds. Three indentations were made, one at a distance of 50,250,500 m from the cavity's base, and the average of the three readings was used as the mean KHN of residual dentin. The KHN values were acquired and analyzed using an unpaired t test.[20] (figure-1)

Figure. 1 : microscopic image of indentations obtained at 50 µm, 250 µm and 500 µms from the deepest point of the cavity.

Results

In this study the microhardness of the remaining dentine is evaluated after caries excavation in Group A- chemomechanical agent (BRIX 3000) and Group B- Polymer burs (SS white). The Knoop hardness number (KHN) was obtained for prepared samples for both the groups by using microhardness tester machine and the indentations were made on the remaining dentine using the Knoop indenter. To obtain the KHN values the indentation's longest diagonal was measured.

The gathered data were evaluated using the Post hoc Tukey test, and the statistical values were summarized to arrive at the proposed study's conclusion. The statistical analysis of the data revealed that the mean dentin microhardness at 50 m for Group A was 52.8900 kgf/mm^2 and 21.5871 kgf/mm^2 for Group B. At 250 µm, the mean value for Group A was 59.8257 kgf/mm^2 and that for Group B was 28.5843 kgf/mm^2. The mean microhardness value for Group A at 500 m was 62.4943 kgf/mm^2 and 32.8671 kgf/mm^2 for Group B. All of the comparisons had strong statistical significance (P 0.05), indicating that the microhardness at all depths differed considerably between treatment groups. The values obtained indicated increase in hardness with increase in depth. Also, the microhardness of group A was higher than group B at every depth.(Table no:-1,2)

This revealed P 0.05, indicating statistical significance The microhardness of dentine towards the cavity margin was substantially lower than that farther away from the margin. Graph 1 depicts the difference in mean KHN of dentin at each depth interval between Group A and Group B. The difference between Group A and Group B at 50um, 250um, 500um is shown in Table.3 showing $P < 0.05$ suggesting statistically significant difference between the microhardness of remaining dentine between both the groups.

Table no.1- Difference in microhardness between 50 µm, 250 µm, 500 µm in Group A

µm	Mean	F	Significance (p)
50µm	52.8900	11.993	<0.0001*
250 µm	59.8257		
500 µm	62.4943		

*Significance at p<0.05
Significant difference present

Table no.2- Difference in microhardness between 50 µm, 250 µm, 500 µm in Group B

um	Mean	F	Significance (p)
50µm	21.5871	4.983	0.019*
250 µm	28.5843		
500 µm	32.8671		

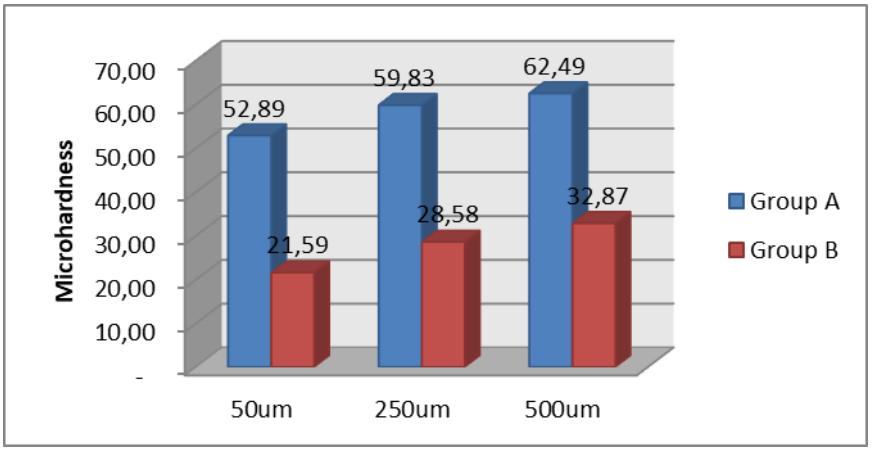
*Significance at p<0.05

Table no.3- Difference between Group A and Group B for 50 µm, 250 µm, 500 µm

µm	Groups	Mean	t	Mean Difference	Significance (p)
50µm	Group A	52.8900	15.059	31.30286	<.0001*
	Group B	21.5871			
250µm	Group A	59.8257	8.635	31.24143	<.0001*
	Group B	28.5843			
500 µm	Group A	62.4943	10.310	29.62714	<.0001*
	Group B	32.8671			

*Significance at p<0.05
Significant difference present between Group A and B for 50um, 250um and 500um

Graph no.1- Mean microhardness in Group A and B



Discussion

There are various factors in consideration during caries excavation. Since the advancement in technology, there have been evolutions in cavity preparation and adhesive restorative materials, which has led us towards minimally invasive dentistry, allowing maximum preservation of natural tooth structure. In pediatric dentistry, it plays a major role by providing compliance to the child with painless experience. Also, treatment time affects the response of the child, as children of different age groups have different attention spans, making it difficult for them to co-operate for longer period. Different minimally invasive techniques have been introduced in order to make it a more efficient and effective treatment option.

When comparing permanent and primary teeth, the dentine of primary teeth is less dense and less thick, wheir as dentine of permanent teeth is denser and thicker which creates a great possibility in primary teeth of pulp exposure during caries excavation when both the infected as well as affected dentine is removed.[14] Carious dentin is made up of two layers: an outside infected layer that is irreversibly denatured and cannot be remineralized; and an inner affected layer that can be remineralized. When there is a possibility of pulp exposure, there is substantial evidence that diseased dentin should be left intact. Several other investigations have shown that cariogenic bacteria either die or remain dormant after being removed from their source of sustenance by restoring adequate integrity, posing no harm.[21]

Thus, various minimally invasive techniques have been introduced, including atraumatic restorative treatment (ART), the chemo-mechanical method of caries removal, air abrasion, and lasers.[7] However, numerous pitfalls, including adverse heat effects on pulp, the necessity of anaesthetic agents, the unneeded excavation of sound affected dentin, and discomfort produced, have been identified.[20] Silver diamine fluoride (SDF) can be used in the least invasive way possible. The blackish discoloration of the carious lesion and the restoration is one of the disadvantages when compared to the conventional treatment process, the chemomechanical method of removing caries is known to be less painful[5] and also micro tensile binding strength of adhesive materials to caries-affected dentin is good when compared to lasers and conventional burs.[22] Conversely when Polymer bur was compared to chemomechanical agents by Aswathi et.al. (2017) in his study, to assess and compare the clinical and microbiological efficacy of Polymer burs and chemomechanical caries removal agents for selective removal of carious dentin were tested clinically and microbiologically, when tested clinically both Polymer bur and Carie-Care were effective caries removal agents and when tested microbiologically, Polymer burs were proven to be more effective than Carie-Care.[13]

Papacarie gel, the first papain enzyme based CMCR agent, was introduced in 2003. Subsequently, Biosolv and Cari-Care were introduced. While these papain-based agents provided selectivity in the removal of infected dentin, they had less viscosity, thus making them flow when used on cavities. To overcome this disadvantage, the newer papain-based agent Brix3000 with encapsulating buffer emulsion technology (EBE) was introduced, raising its efficiency. [23] There are various studies comparing different parameters of chemomechanical agents,

highlighting its advantages such as minimizing pain during caries excavation, eliminating the exposure to administration of local anesthesia, obtaining the co-operation of the child, especially in very young children who are afraid of loud noise of airotor and pooling of water in oral cavity. Reduction of bacterial load after caries excavation using CMCR agent (BRIX3000 and Carie Care) and smart burs studied by Mahenaz Salam Inamdar et.al. stated that the BRIX3000 (156.93 104) achieved the greatest decrease in bacterial count, Smart Burs (139.07 104) and Carie-Care (135.80104) were second and third, respectively, with p>0.5. The mean working time for excavation was: BRIX3000(13.66), Carie Care(18.30), and Smart Burs(20.60) with p 0.5.[9] Somani R et al. (2019) examine the efficacy in terms of bacteriology and efficiency in terms of time spent by traditional and smart burst, and find that Polymer burs are just as successful as conventional burs in terms of microbial presence following caries eradication, but Polymer burs take longer time.[24]

Different chemomechanical agents were compared with newly emerging CMCR agents in which Carisolv treated teeth had somewhat higher mean shear bond strength than Papacarie, although Papacarie was clinically more effective in caries eradication than Carisolv, it had much greater marginal leakage.[25] When Papacarie Duo and Carie Care were compared to examine the leftover dentinal surfaces, the surface morphology of remaining dentin was better on the Carie Care-treated surface.[26]

Aswathi et al. (2017) evaluate and compare the clinical and microbiologic effectiveness of Polymer burs and chemomechanical caries removal agents for selective removal of infected dentin. When tested clinically and microbiologically, both Polymer bur and Carie-Care were effective caries removal agents, whereas microbiologically Polymer bur was proven to be more effective than Carie-Care.[13] Conventional burs are designed to remove decalcified enamel and dentin effectively; unfortunately, they cannot distinguish between carious and normal dentin, which also increased risk of pulp exposure in the deep carious lesion. However, use of conventional burs has advantage of being less time-consuming and have decreased residual microorganisms present at the site after removal of caries. Thus, use of such bur that have more conventional approach will prevent removal of affected dentin and convenient for use in pediatric age group.

Polymer burs are a unique rotary instrument made of specifically developed polymer material (medical grade glass bead reinforced polymer) according to the manufacturer it is a self-limiting device, it selectively eliminates damaged dentin while leaving affected dentin alone.[4] The use of airotor produces sound and also there is accumulation of water in oral cavity which may produce gag, conversely Polymer bur are used with slow speed micromotor handpice without water coolant, which will prevent exposure to stimulus of sound and gag.[13] Smart Burs are Polymer burs are paddle-shaped burs constructed of polyether-ketone. The hardness of Smart Bur (50KHN) is more than that of diseased dentin is (15-20KHN) but less than that of healthy dentin which is (68KHN), allowing it to selectively removing infected dentin while leaving healthy dentin intact in the cavity.[27] While using Polymer bur for caries excavation, after removal of desired infected dentine when smart bur comes into frequent contact with healthy

calcified tooth structure or restoration, it dulls and vibrates, this helps to know when to stop the excavation of caries.[13]

There are studies highlighting certain drawbacks when Polymer burs were compared to conventional burs in which conventional burs showed superior results in terms of time consumed and efficacy. A study done by Kittur et.al. (2021) analyse and compare the effectiveness and fracture resistance of composite-restored teeth using two minimally invasive caries eradication procedures using a scanning electron microscope. Results showed that the diamond bur group took less time to excavate caries (86.13 s), retained more smear layer, and had a higher median score for staining of diseased dentin than the V-Carisolv gel group. The diamond bur group had the highest fracture resistance (1.53) (P 0.001). Concluding that the diamond bur group outperformed the Polymer bur group and V-Carisolv gel in terms of effectiveness of caries removal and high fracture resistance of composite restoration.[28] Similar results were obtained by Lohmann et.al , concluding conventional burs surpassed Polymer bur in removing curiously altered collagen during dentin caries excavation.[29]

While selection of the tool for measuring the microhardness of tooth material there are various consideration to be monitored. Several earlier microhardness experiments have revealed findings of both KHN and VHN at various indentation loads and periods. There are several reasons to conduct testing under various settings. A high load is selected because it creates a large imprint, making the indentation diagonal simple to measure. A large force applied to a soft surface, on the other hand, results in an enormous imprint with diagonals that are longer than the micrometer scale connected to the tester's eyepiece. As a result, when comparing the baseline and eroded surfaces with the same indentation stress in a pre-post experimental evaluation of, say, enamel erosion, a little load must be added. Gutiérrez-Salazar and Reyes-Gasga proposed that in tooth hardness studies, the Vickers indenter is more useful than the Knoop indenter because a square shape must always be preserved and the indentation produced on a non-flat surface, or by the difference in hardness of enamel and dentin is easily detectable.[30] According to Meredith et al., the Knoop is the most prevalent approach Knoop indentation is longer and shallower than Vickers indentation, allowing fragile materials to be loaded without cracking. Furthermore, the larger diagonal is simpler to read than the Vickers small diagonal. However, in this investigation, the longer diagonal of the Knoop was compensated by the difficulty in determining where the tapered tip finishes on the surface of the dentin.[31] Without taking into account changes in indentation loads and time, the results obtained in this investigation for the KHN and VHN values of enamel and dentin are consistent with previously reported values: for example, the hardness of enamel has been reported in the range of 314 to 361 KHN [32] or 322 to 353 VHN[33] and for dentin, the hardness has been reported in the range of 52 to 64 KHN or 46 to 53 VHN.[33] Loading time differences (10, 20, and 30 seconds) were not significant for either enamel or dentin evaluated at the same test load, this implies that a 10-second indentation duration is adequate to create a lasting indentation on the tooth surface.[33] Thus in our study we have measured the microhardness in Knoop hardness number.

Although there is limited data available on microhardness of remaining dentine after caries excavation with CMCR agent Brix 3000 and Smart burs. In our study we have compared microhardness of the remaining dentine after caries excavation with chemomechanical agent (BRIX 3000) and Polymer burs (SS white). In line with the carious tissue removal approach, fourteen extracted primary molars with active carious cavities extending into 2/3rds of dentin were separated into two experimental groups as follows: group A- chemomechanical method – Brix3000 and Group B- slow speed Polymer bur. After the carious tissue was removed the teeth were longitudinally sectioned with dimond disk attached to micromotor handpice and sectioned in mesiodistal direction of the crown, at the center of the cavity, until two pieces were obtained, out of which one of the parts was immersed in acrylic resin, leaving the region to be examined exposed. Polishing of this section was done with abrasive sheets of 220,320,600, and 1500 grit polishing paper.

The microhardness test was carried out on treated dentin using a Knoop indenter and a static force of 10 g was applied for 30 seconds and three indentations were made, each at distance 50,250,500 μm from base of cavity and the average of three readings were taken as the average KHN of the remaining dentin. The KHN values were obtained and analyzed using unpaired t test. The statistical analysis of the mean microhardness of dentin at 50 m for Group A was 52.8900 kgf/mm^2 and 21.5871 kgf/mm^2 for Group B. At 250 μm, the mean value for Group A was 59.8257 kgf/mm^2 and that for Group B was 28.5843 kgf/mm^2. At 500 μm, the mean microhardness value for Group A was 62.4943 kgf/mm^2 and for Group B was 32.8671 kgf/mm^2. All the comparisons had a high level of statistical significance (P 0.05), indicating that the microhardness values at all depths were significant and the microhardness of the remaining dentine in Group A was higher than Group B. The probable reason for less microhardness in Group B is due to remnant of the carious dentine indicating incomplete removal of carious infected dentine. As the knop hardness of dentin is approximately 66-80 KHN and the Knoop Hardness for carious dentin is 30 KHN.[15] when comparing the microhardness of the remaining dentine at 50 um in Polymer group the mean value is about 21.5871 kgf/mm^2 which is less than hardness of carious dentin that is 30 KHN, were as the mean hardness of the remaining dentine after caries excavation with brix3000 was 52.8900 kgf/mm^2 which is higher than the microhardness of carious dentine.

Similar results were obtained by Camila Ferraz et.al. (2014), in this study the efficiency of several mechanical procedures for the removal of demineralized dentin was evaluated. In this study they found that in both mineralized and demineralized dentin the steel bur created the deepest cavities and in demineralized dentin the Polymer bur created the shallowest cavities. The microhardness measurements of the deepest surfaces of the cavities formed in demineralized dentin revealed that the steel bur and hand tool generated equal values, however Polymer burs produced lower values.[34] Conversely Fernanda et.al concluded the microhardness of the residual dentin following rotary cutting tool removal and chemomechanical removal was comparable.[4] In study done by Surendar R et al. (2013) when effect of two different chemomechanical caries removal (CMCR) agents on dentin microhardness was compared, it was found to

be negligible, with neither CMCR technique creating a significant change in the microhardness of normal dentin or treated carious dentin.[35]

Shihab A. et al. (2017) studied the Knoop hardness of the remaining dentinal surface after caries removal using a slow speed conventional bur and a chemomechanical caries removal agent (Carie-care). According to the results of the experiment, the rotating instrument group exhibited a consistent microhardness value with little change dependent on depth and in chemomechanical group the microhardness value was lower closer to the cavity than further away. Kumar KS et al. (2016) investigate the efficacy of numerous caries removal techniques in mandibular primary molars in clinical and community-based settings among primary school pupils, including Smart Burs, ART (mechanical caries removal), and Carie-care. Carie-care was more time-consuming but more efficient with greater acceptance in clinical settings than Smart Burs, and the difference was statistically significant (P 0.05). Carie care was more efficient, less time consuming, and had better acceptance in community-based settings as compared to atraumatic restorative treatment.[36] The microhardness values were considerably different for each treatment group at all depths, with the rotary group having a greater value.[20]

In spite of advantages of using Polymer bur it is noted that in small cavities the Polymer bur easily touched the enamel and the bur went blunt and during excavation of large cavities, more than one bur was required.[37] Both were consuming more time compared to conventional technique and required preparation of enamel with high-speed airotor and burs whenever there is no direct access to the carious dentine.[38],[39]

Subjective analysis of caries excavation was the limitation of our study. A *Scanning electron microscope* assessment needs to be carried out along with microhardness of remaining dentine. Additional research needs to be done on Polymer bur and brix 3000 comparing different parameters with other minimally invasive techniques for caries excavation to understand in detail about the best minimally invasive treatment option for caries excavation, providing long term success of restorations and preserving vitality of pulp by performing MID which effectively removes infected dentine.

Conclusion

1. Microhardness of the remaining dentine after caries excavation with Brix 3000 showed less microhardness of the surface which was closer to the cavity margin and the hardness increased in the dentine surface that was away from the cavity margin treated with brix3000.
2. In polymer bur group the microhardness of the remaining dentine closer to the cavity margin was less and higher in the dentine away from the cavity margin.
3. However, microhardness of the remaining dentine after caries excavation with Brix 3000 was found to be greater than the microhardness of the remaining dentine after caries excavation with polymer bur.

4. Thus, Brix 3000 may be utilized as a successful agent in minimally invasive caries excavation since Polymer burs showed partial removal of carious dentine.

Clinical significance

In primary teeth caries excavation with minimally invasive method that prevent exposure of pulp in deep carious lesions, thereby prevent weakening of the remaining tooth structure and enhancing the treatment outcome.

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