

# Evaluation of the Efficacy of Caries Removal Using Papain Gel (Brix 3000) and Smart Preparation Bur(*in vivo* Comparative Study)

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## Abstract

**Background:** New approaches for caries removal by chemomechanical methods require effective materials with antibacterial and anti-inflammatory properties for the removal of infected dentin. Brix3000 is a recently-developed material that comprised papain based gel.

**The aim of this study:** This study was performed to evaluate and assess the clinical efficiency of carious tissue removal using a new chemomechanical agent (Brix3000) compared to the ceramic bur regarding the efficacy in bacterial removal, pain reaction and duration of the treatment.

**Materials and Methods:** Split mouth design was performed on 30 bilateral cavitated permanent molars where caries excavation was done using brix 3000 on one side and ceramic burs on the other side. The parameters assessed were: total bacterial count, pain reaction and mean time required for the treatment

**Results:** There was a statistically significant difference concerning the reduction in the total bacterial count for each of the methods; however, it was slightly more in the chemomechanical group compared with that of the conventional group but this difference did not achieve a statistical significant. A statistical significant difference was found between the two methods concerning pain reaction while the time taken for caries removal using brix 3000 was significantly more than that required for the ceramic bur

**Conclusion:** Papain gel is an excellent alternative treatment for caries removal with the same effectiveness of the traditional method, even it requires longer time.

**Keywords:** Bacterial count, Brix 3000, ceramic bur, chemomechanical caries removal, pain reaction.

## INTRODUCTION

Dental caries is an incessant public health problem worldwide that still deemed the most chronic disease with high spread affecting numerous children in different countries. It is a multifactorial disease including several preventive and risks factors. (Al Agili, 2013; Al-Ansari, 2014)

In the permanent dentition, the first permanent molars (FPM) exhibits an exceeded tendency to caries in the occlusal pits and fissures within reasons; the early time of its eruption ,morphological properties and its position in the oral cavity.( Batchelor and Sheiham,2004; Beauchamp,2008)

Treatment with rotary instruments has progressively amended in accuracy and efficiency for enamel and dentin excavation (Chaussain et al., 2003), however, it is unpleasant to many patients. Moreover, drilling can cause over heating on the pulp, vibration, noise and pain stimulation (require local anesthesia to be reduced) (Mhatre et al., 2011), in addition it may involve the removal of excessive sound tissues that lowering the degree of regenerative potential of the pulp-dentin complex (Heyeraas et al., 2001).

Today, the concept of "Prevention of Extension" replaces the old one of G. V. Black in 1891, which was "Extension for prevention" in the treatment of dental caries. A new philosophy of "Minimal Intervention Dentistry" was found that minimize the removal of the healthy tooth structure and its fundamental importance to use conservative procedures (Beeley et al., 2000), which including manual

excavators, air abrasion, sonoabrasion, ultrasonicationlasers, and chemomechanical methods. (Corrêa et al., 2007)

Chemomechanical methods for elimination of carious dentin have so far proved to be promising methods, particularly in pediatric dentistry, medically compromised or anxious patients. They have the ability to identify the superficial and highly infected tissue (infected dentin) from the internal carious tissue (affected dentin), by which they provide pulp protection, which can give a chance for the remineralization of the affected dentin (Banerjee et al., 2000; Lima et al., 2005). Their action take place by the chemical softening of the carious dentinal tissue, which will be removed by a gentle excavation; mean that there is a selective removal of the degraded soft collagen fibrils in the carious infected dentin lesion while preserving the affected demineralized dentin layer. Consequently, since 1970s many chemical compositions had been used for chemomechanical caries removal. These include GK-101(which contain N-monochloroglycine (NMG) as the active ingredient), Caridex, then Carisolv and enzymes (Beeley et al., 2000). In 2003, a research project in Brazil procure to the evolution of Papacarie which was intrinsically created from papain gel, toluidine blue ,chloramines, thickening agent and salts, which all together idiosyncrasies to its act as anti-inflammatory and antibacterial features( Kholi and Surbhi ,2015). In India, Carie-care was used as a chemomechanical agent for caries removal, which was a gel-based comprise a purified enzyme, which was derived from Carica papaya (papaya)

with the benefits of Clove oil that had antiseptic and analgesic effects (Hegde et al., 2014). Recently, a new material had been found in Argentina in 2016. It was named as Brix 3000 (Brix SRL Argentina), which was a dental product for non-traumatic caries treatment involving an enzymatic activity 3000 U/mg (U/mg: can be defined as the International units to measure a specific enzymatic activity or the concentration of enzymatic activity) in which papain was a bio-encapsulated using EBE Technology (Encapsulating Buffer Emulsion). It is an exclusive technology, immobilizes and confers stability that increases the enzymatic activity of the final product exponentially with respect to current technology. Thus, the followings are achieved: higher proteolysis effectiveness to remove the collagen fibrils in its decayed tissue, less dissolution of active principle by the oral fluids, greater resistance to storage even in unfavorable conditions, does not requiring cold-chain preservation, greater antibacterial and antifungal potency with an increase in its antiseptic effect on the tissue. Brix 3000 holds a dermatological certificates attesting to the non-toxicity of the product to mouth, skin or eyes demonstrating that it does not provoke any type of reactions when it comes into contact with the healthy tissue (Torresi and Besereni, 2017; Romero et al., 2018).

Another self-limiting concept in the mechanical removal of caries had been brought into practice by a bud bur that made of a special alumina-based ceramic with stabilized zirconia (CeraBur, K1SM, Komet). Ceramic burs have the ability of being highly efficient concerning the excavating ability on the carious (soft) dentin with minimal reduction of the hard (sound) tooth structure. For this reason, ceramic burs are fit for minimally invasive caries removal by which a minimal amount of dentinal tubules are cut off and thereby decreasing the sensation of pain that are stimulated compared to the use of the traditional burs (Dammaschke et al., 2008; Aline et al., 2011).

The purpose of this study was to evaluate the clinical efficiency of brix 3000 in caries removal (through its microbiological effects) compared to the conventional method using smart preparation bur. Time factor and pain reaction were also evaluated during the present study.

#### MATERIALS AND METHODS

A randomized, controlled clinical trial (split mouth) was designed and the children were allocated to the two methods of caries removal in the ratio 1:1. After the submission of the study protocol, which was reviewed, by the Scientific and Ethical Committee of the Pedodontics and Preventive Dentistry Department in College of Dentistry / University of Baghdad; Iraq, approval was gained. This study followed the guidelines of the Helsinki declaration, where the parents/ guardians of each child were informed completely regarding the study design, purposes and probable benefits of the study before their involvement ensuring them for the right to withdraw (if they wanted) from this study at any time by a written consent. This study was performed among 30 healthy children aged 8-12 years old attending the Pedodontics clinic in the Pedodontics and Preventive Dentistry Department at Baghdad dental teaching hospital.

#### Participants

Each child had the following criteria would be eligible for the present study (Shivasharan, et al., 2016):

1. Presence of two contralateral open occlusal carious lesion with dentin involvement (they should be similar in size for standardization by using Diagnodent device). The opening should be large enough to be accessible with the small excavator.
2. Presence of asymptomatic permanent molars without clinical evidence of pulp involvement.
3. No proximal caries is evidence.
4. Adequate child behavior in the first dental visit without history of previous dental treatment or a history of any systemic diseases.
5. The selected permanent teeth should have normal structure and morphology.

Sixty permanent molar teeth had been included in this study divided into two groups in which each group consisted of 30 teeth.

Group A (test group): Caries was removed by chemomechanical method using papain based gel (Brix 3000).

Group B (control group): Caries was removed by conventional method (ceramic bur).

#### The Clinical Procedure

Treatment was performed according to the following steps:

- Local anesthesia was not given, unless the patient required.
- Each tooth was partially isolated using saliva ejector and cotton rolls (Bussadori et al., 2005).
- The isolated tooth was cleaned using a wet cotton pellets to remove any debris and plaque before starting the procedure of caries removal (Abdul Khalek et al., 2017).
- A sample from the selected tooth was taken, from the floor of the cavity (microbiological swab), by sharp spoon excavator and placed into a transport media for the laboratory investigation (Lager et al., 2003).
- The time was calculated by pressing on the stopwatch to start when the method of caries removal begin until the end of the procedure after the complete removal of the carious lesion.
- Caries removal was carried out using either of the two following techniques:

#### Group A: (Brix 3000 group)

Brix 3000 (Brix S.R.L. of Argentina) was used as a chemomechanical caries removal agent for one side of the bilateral carious teeth (selected randomly). Application of the material was done according to the manufacturer's instructions by which the material was applied with a blunt spoon excavator and left for 2 minutes (allowing the chemistry to work). At first, Brix gel was clear, but later on, due to its effect (decomposition of the carious lesion) it turned darker (turbid). The decayed dentin, which became softened (due to the action of the material), then scraped away using a blunt excavator in a pendulum movement without pressure. If necessary, the procedure would be repeated to get healthy dentin until the gel remain clear

(without any evidence of darkish colour) indicating that the infected carious lesion was completely removed. Then the cavity was examined by tactile sensation and visual inspection (Banerjee et al., 2000) to assess the complete removal of the carious lesion.

#### Group B: (Using conventional drilling method)

In this group, caries removal was done using a low speed hand piece with a ceramic bur (Cera Bur, Komet – Brasseler; Lemgo, Germany). The cavities then were checked using the same criteria that used with group A to check for the remaining caries .

After the completion of caries removal, by either method, cavities were restored using light cured composite filling material (GC Corporation, Hongo, Bunkyo-ku; Tokyo, Japan) following the manufacturer's instructions.

#### Assessment parameters

For each patient, the same investigator recorded the followings:

- A total bacterial count before and after each technique by a microbiological investigation to evaluate the colony forming bacteria.
- Pain reaction using Sound, Eye and Motor scale (SEM) according to Wright et al. in 1991, Table (1), which is an objective scale used for the assessment of pain where the patient's comfort was measured according to the three observational type of reactions :sound (S),eye (E) and motor (M).
- The total working time required for caries removal using either method was recorded in minutes using a stopwatch. In case that local anesthesia was required, the operative time for caries removal recorded including the time for the administration of anesthesia.

**Table 1: Sound, Eye and Motor (SEM) Scale, (Wright et al., 1991).**

Parameters	Comfort (Score 1)	Mild discomfort (Score 2)	Moderate discomfort (Score 3)	Painful (Score 4)
Sound	No sound	Non-specific sound	Verbal complaint, louder sound	Verbal complaint shouting, crying
Eye	No sign	Dilated eye without tears (anxiety sign)	Tears, sudden eye movements	Crying, tars all over the face
Motor	Relaxed body and hand status	Muscular contraction, contraction of hands	Sudden body and hand movements	Hand movements for defense, turning the head the opposite site

**Table 2: Distribution of the sample according to age.**

Age	No. of children (%)	Cumulative percent
8	1 (3.3)	3.3
9	3 (10.0)	13.3
10	5 (16.7)	36.6
11	7 (23.3)	53.3
12	14 (46.7)	100.0
Total	30 (100)	

**Table 3: Evaluation of the reduction in mean of the bacterial count with each of the methods (before and after)**

Method	BCBT	BCAT	t- test	p-value
Brix 3000	124000	1700	6.98	0.000*
Ceramic bur	113000	5200	6.7	0.000*

BCBT; bacterial count before treatment, BCAT; bacterial count after treatment

\*Significant difference

#### Microbiological investigation

The samples collected from the patient's teeth (before and after each method) were transported to the laboratory in a transport media, within 2 hours. In the laboratory, each sample was placed in 2 ml of normal saline to be serially diluted. Then they were placed on Blood agar plates and incubated aerobically for 48 hours at 37 °C. After that ,calculation to the total number of the colonies was done which was exprested as CFU (colony forming units) per sample in which each tooth had two readings ,before and after the treatment, (Hassan et al.,2016).

#### Statistical analysis

Statistical package for social sciences (SPSS) version 25 had been used to analyze the main indicators, and to test the hypotheses of the study, mainly;

- Descriptive statistics (mean, standard deviation and standard error of the mean).
- T-test to compare the effects of the Brix 3000 and the Smart bur on the bacterial count.
- Chi-square to test the differences concerning the time and pain reaction between the two methods.

#### RESULTS

In this in vivo study, a total number of 60 permanent molars with occlusal carious cavitation were selected from 30 patients. Distribution of the sample by age was shown in Table (2). Among the selected 30 children, seven were boys and thirty-two were girls. Their age ranged from 8 to 12 years with the mean age of 10 years.

Concerning the microbiological analysis, in the two groups before and after the removal of the carious dentinal tissue, a statistical significant reduction in the total bacterial count was found for each method (Table 3).

**Table 4: comparison of the reduction in mean bacterial count between the two methods.**

Treatment	No. of children	Mean difference	SD	SE(M)	t-test	p-value
Brix 3000	30	111000	87000	16000	0.325	0.746
Ceramic bur	30	119000	98000	18000		

SD: standard deviation, SEM: standard errors of the means, Mean difference= bacterial count after treatment – bacterial count before treatment.

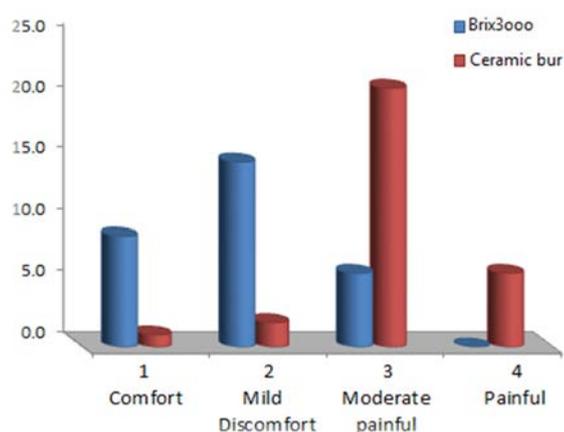
**Table 5: Distribution of the study observations according to the SEM scale of the two methods.**

Method	Scores of pain reaction				t-test	p-value
	Comfort(1)	Mild discomfort(2)	Moderately painful(3)	Painful(4)		
Brix 3000	9	15	6	0	30.4	0.000
Ceramic bur	1	2	21	6		

\*Statistical significance at  $p \leq 0.05$

The reduction in the total bacterial count for the chemomechanical group was slightly more compared with that of the conventional group; however, this difference did not achieve a statistical significance, (Table 4).

Assessment of pain level (comfort of patient), using (SEM) scale, between the two groups is presented in Table (5). The observations during caries excavation procedure in the chemomechanical group were; 30% of the cases demonstrated comfort (Score 1), 50% demonstrated mild discomfort (Score 2), 20% had a moderate painful reaction (score 3) while none of the cases showed a painful reaction (Score 4). Whereas in the conventional group: only 3.3% of the cases demonstrated comfort level (Score 1), 6.6% showed a mild discomfort (Score 2), while 70% of cases exhibited moderately painful reaction (Score 3) and the remaining 20% complained of a painful sensation (Score 4). This finding was found to be statistically highly significant when analyzed using chi-square ( $P = 0.000$ ), as shown in Table (5) and Fig. (1).

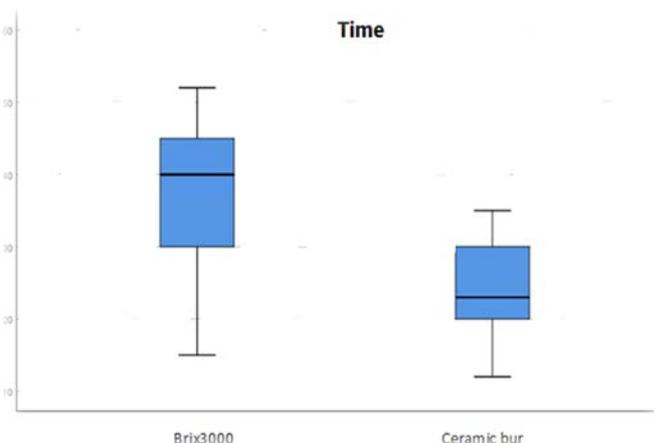
**Fig. 1: Bar chart of mean score values concerning (pain) parameter for studied groups.**

The mean time required for complete caries removal for the Brix 3000 group was (37.67min) which was longer when compared to the smart preparation bur ,ceramic bur, (23.53min) that implies highly significant difference in terms of the time for caries removal,(Table 6 and Figure 2).

**Table 6: Comparison between the two groups for time taken for caries removal.**

Method	No. of patients	Mean	SD	SEM	t-test	P-value
Brix 3000	30	37.67	10.209	1.864	6.525	0.000*
Ceramic bur	30	23.53	6.044	1.104		

\* Significant difference.

**Fig.2: Mean time in minutes for caries removal for the two groups.**

## DISCUSSION

Today, operative dentistry focuses on cavity design, out lines and selecting filling materials. Less effort had been developed on incorporating what was known about the progression pattern of caries and how it was related to its removal or excavation (Bjørndal and Buonocore, 2002). Hence, based on these concepts, minimal intervention dentistry was introduced which require the removal of only the infected dentin and preservation of the affected dentine which was also necessary for supporting the future restoration. Brix 3000, a recently introduced CMCR agent, was preferred in this study as it provide maximum preservation of the healthy tooth structure aiding in the removal of the infected dentin only while the removal of the sound dentine, which is painful, will be avoided. Hence, the use of local anesthesia would be minimized and this was in accordance with the findings of Beeley et al. in 2000. On the other hand, traditional caries removal involves the use of a drill with high-speed hand piece to

gain an access to the carious lesions and a low speed hand piece to remove the carious tissue. Quick and efficient caries removal can be achieved by this method; however, it may result in unnecessary removal of the healthy (sound) or even the affected dentin that affects the ability of remineralization. This was detected as unpleasant and painful sensation by many patients and so local anesthesia was routinely needed to control pain (Elkholany et al., 2009). In 2008, Ceramic Burs was marketed (Komet-Brasseler; Lemgo, Germany). They were able to distinguish between the infected and the affected dentin and had the advantage of being minimally invasive method that selectively remove the infected dentine. The present in vivo study was aimed to evaluate and compare the efficacy of these two methods (Brix 3000 and the use of Ceramic burs) clinically and microbiologically.

The results of this study showed that a statistical significant reductions in the total bacterial count was found in both of the methods for caries removal (Table 3), however, no statistical significant difference was found between the two groups as shown in Table (4). The reduction in the bacterial count with the use of the papain-based gel (Brix 3000) may be related to its microbiological effects, bactericidal and bacteriostatic action, (Dawkins et al., 2003) and the reduction of the microorganisms in both groups indicated their efficacy in caries removal. Based on the findings of the present study, Brix 3000 was an excellent option as a minimally invasive method for caries removal since it achieved a significant reduction in the total bacterial count with the same effectiveness as that found in the conventional caries removal method offering the advantage of being with less devastating effects on the sound dentinal tissue. This result was in agreement with that found by previous studies (El-Tekeya et al., 2012; Motta et al., 2014; Aswathi et al., 2017).

It is difficult to quantify and assess pain in young children (Kotb et al., 2009). So, SEM scale was used in the present study to assess pain by measuring the sound, eye and motor observation components of the child's reaction to the pain stimuli (Wright et al., 1991). Brix 3000 group experienced significantly more comfort compared to the ceramic bur drill group (Table 5). This result could be probably due to the absence of vibration, sound and pain as well as to the minimum pressure required to remove the softened caries tissue in addition to the characteristics of heat insulation of Brix 3000. This finding was supported by the results of several studies (Bedi et al., 1992; Locker et al., 1996; Kotb et al., 2009; Venkataraghavan et al., 2013). Meanwhile, patients might also satisfy the absence of injection and drilling which are the most stressful factors in stimulating pain and anxiety in young children (Venkataraghavan et al., 2013).

In the current study, the time required for the removal of dental caries in the Brix 3000 group was longer than that taken in the ceramic bur group with highly significant difference (Table 6, Fig. 2). This might be attributed to the lesion consistency (soft, medium or hard) in which hard caries lesion required multiple application of Brix 3000 gel to decompose the infected dentine (Habib et al., 1975; Bussadori et al., 2005). This result was in harmony with

that found by many other studies evaluating the working time required for caries removal (Ericson et al., 1999; Maragakis et al., 2001; Jawa et al., 2010; Venkataraghavan et al., 2013). While Kotb et al. in 2009 found no significant difference in the operating time between the papain gel and the conventional method.

### CONCLUSION

Chemomechanical caries removal may not be able to replace the use of rotary instruments (drill) for caries removal, but can be used as an alternative treatment in many cases especially in children (who required multiple restorations, very young children and those who have difficult behavior) especially that it is simple and does not need any effort or training.

The results of the present study concluded that:

1. Brix 3000, a new chemomechanical gel, is an effective alternative to the traditional drilling method in caries removal with promising results.
2. Brix 3000 is a prime option for the minimally invasive removal of dental carious tissue, obtaining significant reductions in total bacterial count with the same effectiveness as the conventional caries removal method by the ceramic bur.
3. Although Brix 3000 took longer working time than the conventional method, it appears to be more comfortable than the conventional drilling method as it removes only the carious dentine so that the painful removal of the sound dentine will be avoided so as the need for local anesthesia.

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### REFERENCES

- 1) Abdul Khalek AMG, El Kateb MA, Abdel Aziz WE, El Tantawi M. Effect of papacarie and alternative restorative treatment on pain reaction during caries removal among children: A randomized controlled clinical trial. *Journal of clinical pediatric dentistry* 2017; 41(3):219-224
- 2) Al Agili DE. A systematic review of population-based dental caries studies among children in Saudi Arabia. *Saudi Dent J.* 2013; 25:3-11.
- 3) Aline de Almeida Neves, Eduardo Coutinho, Marcio Vivan Cardoso, Paul Lambrechts, Bart Van Meerbeek. Current concepts and techniques for caries excavation and adhesion to residual dentin. *The Journal of Adhesive Dentistry* 2011; 13(1): 7-22.
- 4) Al-Ansari AA. Prevalence, severity, and secular trends of dental caries among various Saudi populations: A literature review. *Saudi J Med Med Sci.* 2014; 2:142-50.
- 5) Anil Kohli, Surbhi Sahani. Chemicomechanical caries removal; a promising revolution: say no to dental drills. *Int J Dent Med Res* 2015; 1 (5): 158-161.
- 6) Aswathi K K, Rani S P, Athimuthu A, Prasanna P, Patil P, Deepali K J. Comparison of efficacy of caries removal using polymer bur and chemomechanical caries removal agent: A clinical and microbiological assessment - An in vivo study. *J Indian Soc Pedod Prev Dent* 2017; 35:6-13.

- 7) Banerjee A, Watson TF, Kidd EAM. Dentin caries excavation: a review of current clinical techniques. *Br Dent J* 2000; 188:476-482.
- 8) Banerjee A, Kidd EA, Watson TF. In vitro evaluation of five alternative methods of carious dentine excavation. *Caries Res* 2000;34:144-150
- 9) Batchelor PA, Sheiham A. Grouping of tooth surfaces by susceptibility to caries: A study in 5-16 year-old children. *BMC Oral Health*. 2004; 4:2.
- 10) Beauchamp J, Caufield PW, Crall JJ, Donly K, Feigal R, Gooch B, et al. Evidence-based clinical recommendations for the use of pit-and-fissure sealants: A report of the American Dental Association Council on Scientific Affairs. *J Am Dent Assoc*. 2008; 139:257-68.
- 11) Bedi R, Sutcliffe P, Donnan PT, McConnachie J. The prevalence of dental anxiety in a group of 13- and 14-year-old Scottish children. *Int J Paediatr Dent* 1992;2:17-24
- 12) Beeley JA, Yip HK, Stevenson AG. Chemochemical caries removal: A review of the techniques and latest developments. *Br Dent J* 2000; 188:427-30.
- 13) Bjørndal L. Buonocore memorial lecture. Dentin caries: Progression and clinical management. *Oper Dent* 2002; 27:211-7.
- 14) Bussadori SK, Castro LC, Galvao AC. Papain gel: A new chemomechanical caries removal agent. *J Clin Pediatr Dent* 2005;30:115-9
- 15) Cecchin D, Farina AP, Orlando F, Brusco EH, Carlini-Júnior B. Effect of carisolv and papacarie on the resin-dentin bond strength in sound and caries-affected primary molars. *Braz J Oral Sci* 2010; 9:25-9.
- 16) Chaussain-Miller, Decup, Domejean-Orliaguet, Gillet, Guigand, Kaleka, Laboux. Clinical evaluation of the Carisolv chemomechanical caries removal technique according to the site/stage concept, a revised caries classification system. *Clin Oral Invest* 2003; 7:32-37.
- 17) Corrêa FN, Rocha Rde O, Rodrigues Filho LE, Muench A, Rodrigues CR. Chemical versus conventional caries removal techniques in primary teeth: A microhardness study. *J Clin Pediatr Dent* 2007; 31:187-92.
- 18) Elkhoolany NR, Abdelaziz KM, Zaghoul NM, Aboulenine N. Chemo-Mechanical Method: A Valuable Alternative for Caries Removal. *Dent News* 2004;9(3):16-22
- 19) El-Tekeya M, El-Habashy L, Mokhles N, El-Kimary E. Effectiveness of 2 Chemomechanical Caries Removal Methods on Residual Bacteria in Dentin of Primary Teeth. *Pediatr dent*. 2012; 34(4):325-30.
- 20) Ericson D, Zimmerman M, Rober H, Gotrich B, Bornstein R, Thorell J. Clinical evaluation of efficacy and safety of a new method for chemo-mechanical removal of caries. A multi-centre study. *Caries research* 1999; 33(3): 171 -7.
- 21) Ganesh M, Dhaval Parikh. Chemomechanical caries removal (CMCR) agents: Review and clinical application in primary teeth. *Journal of Dentistry and Oral Hygiene* 2011; 3(3):34-45
- 22) Habib CM, Kronman J, Goldman M. A chemical evaluation of collagen and hydroxyproline after treatment with GK-101 (N-Chloroglycine). *Pharmacol Ther Dent* 1975; 2:209-15.
- 23) Hassan AF, Yadav G, Tripathi AM, Mehrotra M, Saha S, Garg N. 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.
- 24) Hegde AM, Preethi VC, Shetty A, Shetty S. Clinical evaluation of chemo-mechanical caries removal using Carie-care system among school children. *Nitte Univ J Health Sci* 2014; 4:80-4.
- 25) Heyeraas KJ, Sveen OB, Mjor IA. Pulp-dentin biology in restorative dentistry. Part 3: pulpal inflammation and its sequelae. *Quintessence Int* 2001; 32:611-625
- 26) Jawa D, Singh S, Somani R, Jaidka S, Sirkar K, Jaidka R. Comparative evaluation of the efficacy of chemomechanical caries removal agent (Papacarie) and conventional method of caries removal: An in vitro study. *J Indian Soc Pedod Prev Dent* 2010; 28:73-7.
- 27) Kotb RM, Abdella AA, El Kateb MA, Ahmed AM. Clinical evaluation of Papacarie in primary teeth. *J Clin Pediatr Dent* 2009;34:117-23
- 28) Kohli A, Sahani S. Chemicomechanical Caries Removal; A Promising Revolution: Say No to Dental Drills. *Int J Dent Med Res* 2015; 1(5):158-161.
- 29) Locker D, Shapiro D, Liddell A. Negative dental experiences and their relationship to dental anxiety. *Community Dent Health* 1996; 13:86-92.
- 30) Lager A., Thornqvist E., Ericson D. Cultivable bacteria in dentine after caries excavation using rose-bur or Carisolv. *Caries Res* 2003; 37:206-21.
- 31) Lima GQ, Oliveira EG, Souza JI, Monteiro Neto V. Comparison of the efficacy of chemomechanical and mechanical methods of caries removal in the reduction of *Streptococcus mutans* and *Lactobacillus* spp. in carious dentine of primary teeth. *J Appl Oral Sci* 2005; 13:399-405.
- 32) Maragakis GM, Hahn P, Hellwig E. Clinical evaluation of chemo-mechanical caries removal in primary molars and its acceptance by patients. *Caries research* 2001; 35(3): 205-10.
- 33) Mhatre S, Kumar SVK, Sinha S, Ahmed BMN, Thanawala EA. Chemo-Mechanical Method Of Caries Removal: A Brief Review. *Int J Clin Dent Sci* 2011; 2(2):52-57.
- 34) Motta LJ, Bussadori SK, Campanelli AP, Silva AL, Alfaya TA, Godoy CH, et al. Efficacy of PapacarieH in reduction of residual bacteria in deciduous teeth: a randomized, controlled clinical trial. *Clinics*. 2014;69(5):319-322.
- 35) Romero K., Priscila N., fernanda G., Conceicao FA., Baena M. Use of BRIX -3000 enzymatic gel in mechanical chemical removal of caries :clinical case report .*journal of health sciences*.2018; 20(2): 87-89.
- 36) Till Dammaschke, Aleksandra Vesni, Edgar Scafer. In vitro comparison of ceramic burs and conventional tungsten carbide bud burs in dentin caries excavation *Quintessence international* 2008, 39 (6):495-9.
- 37) Torresi FN., Besereni L. Effectiveness method of chemomechanical removal of dental caries as papain in adults. *J Rev Assoc Paul cir Dent* 2017;71(3):266-9
- 38) Venkataraghavan K, Kush A, Lakshminarayana C, Diwakar L, Ravikumar P, Patil S, et al. Chemomechanical caries removal: A review & study of an indigenously developed agent (Carie Care™ Gel) in children. *J Int Oral Health* 2013; 5:84-90.
- 39) Wright GZ, Weinberger SJ, Marti R, Plotzke O. The effectiveness of infiltration anesthesia in the mandibular primary molar region. *Pediatr Dent* 1991; 6:238-42.
- 40) Shivasharan PR, Farhin AK, Wakpanjar MM, Shetty A. Clinical Evaluation of caries removal in primary teeth using Carie-care and smart prep burs: An In vivo Study. *Indian J Oral Health Res* 2016; 2:27-31.