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Effect of Chemo-Mechanical Caries Removal Agents on Dentin Microhardness and Morphology: An in vitro study

[1]Dr Geetanjali Jadhav, Assistant Professor, D Y Patil Dental School, Lohegaon, Pune, Research Scholar, Bharati Vidyapeeth deemed to be University, Pune.

[2]Dr Rahul Lodaya, Associate Professor, Bharati Vidyapeeth Dental College and Hospital, Bharati Vidyapeeth deemed to be University, Pune.

[3]Dr Rohan Shah, Assistant Professor, Bharati Vidyapeeth Dental College and Hospital, Bharati Vidyapeeth deemed to be University, Pune.

[4]Dr Alok Patel, Professor and H.O.D, Bharati Vidyapeeth Dental College and Hospital, Bharati Vidyapeeth deemed to be University, Pune.

[5]Dr Preetam Shah, Professor, Bharati Vidyapeeth Dental College and Hospital, Bharati Vidyapeeth deemed to be University, Pune.

Corresponding Author: Dr Geetanjali Jadhav, Assistant Professor, D Y Patil Dental School, Lohegaon, Pune, Research Scholar, Bharati Vidyapeeth deemed to be University, Pune.

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Abstract

Aim: The aim of this in vitro study was to assess the effect of two different chemo-mechanical caries removal (CMCR) agents on dentin micro hardness and morphological characteristics.

Materials and Methods: In this study, the crown portion 60 carious and 5 non carious teeth were selected. In the samples, the teeth were decoronated at the level of cement-enamel junction, and it's divided into four groups, fifteen teeth in each group. Then, they were further divided longitudinally through the centre. In one group, no agent was applied on one half, and Carisolv is applied on other half. In another group, no agent was applied on one-half and Papacarie was applied on the other half till they were caries free. After using CMCR agents, a surface hardness of dentin was examined using Vickers hardness number (VHN).

Statistical Analysis and Results: The data were analyzed using *t*-test and one-way analysis of variance (ANOVA). There were no significant difference among normal dentin (51.70), Carisolv-treated normal dentin (50.66), and papacarie-treated normal dentin (49.90). In carious samples, the results of Carisolv-treated dentin (50.66) was

not statistically significantly different from those of the papacarie-treated dentin (49.90). While teeth treated using rotary (55.68) showed a significant difference compared to CMCR.

The SEM study revealed an extremely rough or irregular surface, with minimal smear layer; and open dentinal tubules.

Conclusion: The outcome, neither of the CMCR methods caused a significant change in the morphology and microhardness of normal dentin and the treated carious dentin.

Keywords: Chemomechanical caries removal, carisolv, papacarie, dentin microhardness and morphology.

Introduction

Rotary methods cause some detrimental biological reactions to the dentino-pulpal complex, mainly from heat generation, pressure and non-selective removal of both infected and sound tooth tissue. One major disadvantage of rotary technique in caries removal is the vibration caused by the rotation frequency of the bur, which is particularly unpleasant for patients. In the case of dental-phobic and child patients, the slow speed bur cannot be used due to the increased anxiety that it can create in this patient group.

An alternative method to conventional caries removal by means of rotary instruments, is the use of Chemo-mechanical caries removal agents(CMCR). This new method of treatment has gained high acceptance especially among children as it involves chemical friability of carious dentin, followed by its removal with gentle excavation. The main objective of chemo-mechanical caries removal is to eliminate the outermost portion (infected layer), leaving behind the affected demineralized dentin that can be remineralized and repaired.

Chemo-mechanical caries removal, which attempts to reduce pain, sound tissue removal, as well as eliminate other disadvantages of conventional techniques such as fear, noise, discomfort, and use of anesthesia.

AIM

The aim of this study was to determine the efficacy of two chemo-mechanical caries removal agents Carisolv and Papacarie for caries removal on infected and healthy dentin.

Objectives

The objectives were classified into

1. To determine the effect of Carisolv – Chemo-mechanical caries removal agent on chemical, morphological and microhardness changes in dentin.
2. To determine the effect of Papacarie – Chemo-mechanical caries removal agent on chemical, morphological and microhardness changes in dentin.
3. To determine the effect of rotary methods on chemical, morphological and microhardness changes in dentin.
4. To compare the effect of two chemo-mechanical caries removal agents (Carisolv and Papacarie) and rotary (conventional method) on chemical, morphological and microhardness changes in dentin.

Materials And Method

Sixty teeth indicated for extraction are taken and split into 5 groups.

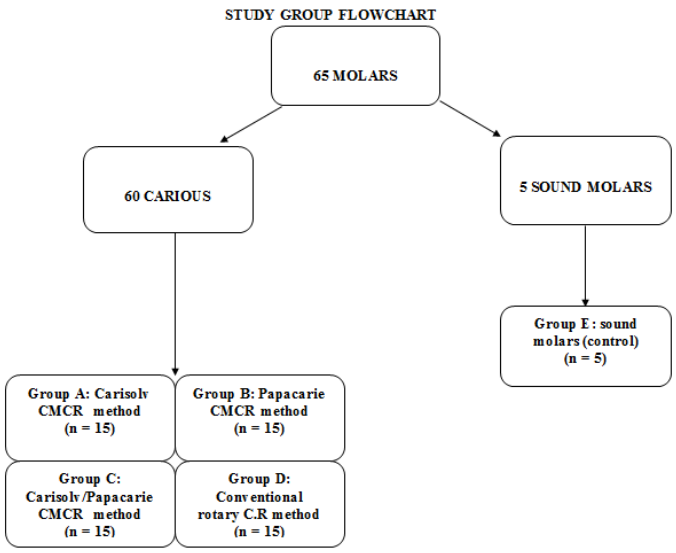
Group A: fifteen molars: (carious) Carisolv applied on one half, and no agent applied on the other half.

Group B: fifteen molars (carious) Papacarie applied on one half and no agent applied on the other half.

Group C: fifteen molars (carious) Papacarie applied on one half and Carisolv on the other half.

Group D: fifteen molars (carious) rotary (conventional method) is used.

Group E: five molars (non carious) as control.



In this study, the crown portions of caries-free and caries-affected teeth were selected. In caries-free samples, the teeth were decoronated at the level of cementoenamel junction using a diamond disc and it's divided into four groups, fifteen teeth in each group. Then, they were further divided longitudinally through the centre. In one group, no agent was applied on one half, and Carisolv was applied on the other half, In another group, no agent was applied on one-half, and Papacarie was applied on the other half.

Study was done to compare Carisolv and papacarie with the conventional drilling technique. Sixty - five patients of age 3-12 years. In carious samples, the crowns were divided through the centre of a carious lesion. Carisolv was applied on one-half and Papacarie was applied on the other half. After using CMCR agents, the morphological assessment and surface hardness of dentin was examined.

Measurement of hardness:

The sections were then embedded in a chemically cured acrylic resin and the occlusal surfaces were exposed to the external surface. The blocks were soaked in saline instantly at the dough stage of polymerization of the resin. At the doughy stage, the temperature rise as a result of auto-curing was very low, and it did not alter the tooth tissues. [1]

After polymerization, each block was smoothed with sandpaper. The blocks were covered with a wet napkin to prevent dehydration at room temperature until hardness measurement was completed within 24 h.

Microhardness was measured with a Vickers hardness tester. The test was determined using a load of 0.49 Newton (50 g) applied to the specimens for 15 s. [1]

The Vickers hardness numbers (VHNs) were measured at five points in dentin with a minimum distance of 40 µm. In the carious samples, VHNs were measured at 25 µm next to the cavity floor, which was considered as Carisolv/papacarie-treated dentin.

Tables

Machine specifications: Microhardness Tester, Reichert Austria Make, Sr.No.363798 Load: 50 mg time 15 sec

Group D : Rotary			**Group B : Papacarie Vs Normal**			
Sn.	Sample ID	Hardness in HV	Sr. No.	Sample ID	Hardness in HV	
					Papacarie	Normal
1	No.1	55.16	1	No.1	46.20	51.57
2	No.2	57.82	2	No.2	49.22	54.30
3	No.3	40.24	3	No.3	52.06	52.88
4	No.4	57.37	4	No.4	49.10	50.31
5	No.5	62.88	5	No.5	48.31	49.71

6	No.6	61.90	6	No.6	50.31	52.44
7	No.7	58.66	7	No.7	51.21	52.00
8	No.8	57.59	8	No.8	53.18	50.33
9	No.9	60.22	9	No.9	48.31	50.11
10	No.10	53.12	10	No.10	52.36	52.98
11	No.11	53.88	11	No.11	53.22	54.00
12	No.12	55.13	12	No.12	49.81	50.22
13	No.13	49.89	13	No.13	48.77	49.38
14	No.14	57.30	14	No.14	52.00	53.18
15	No.15	54.11	15	No.15	49.31	51.21
Average		55.68	Average		50.22	51.64

Table 1: Vickers Hardness of Group D&B

Group C : Papacarie Vs Carisolv					**Group A : Carisolv Vs Normal**			
Sn.	Sample ID	Hardness in HV			Sn.	Sample ID	Hardness in HV	
		Papacarie	Cariesolv				Cariesolv	Normal
1	No.1	64.89	63.38		1	No.1	41.20	39.44
2	No.2	45.92	46.32		2	No.2	51.09	53.21
3	No.3	39.80	41.39		3	No.3	50.22	51.82
4	No.4	51.22	49.88		4	No.4	47.90	48.33
5	No.5	47.22	45.81		5	No.5	49.22	53.18
6	No.6	52.18	50.33		6	No.6	56.22	56.81
7	No.7	46.18	45.22		7	No.7	54.30	55.18
8	No.8	50.18	48.99		8	No.8	52.18	53.31
9	No.9	51.20	47.19		9	No.9	51.10	52.40
10	No.10	49.22	48.91		10	No.10	50.11	51.38
11	No.11	50.11	49.88		11	No.11	51.08	53.31
12	No.12	49.00	49.88		12	No.12	55.18	55.50
13	No.13	50.22	78.18		13	No.13	49.00	50.22
14	No.14	46.99	47.89		14	No.14	48.31	51.03
15	No.15	49.27	48.98		15	No.15	50.31	51.20
Average		49.57	50.81		Average		50.49	51.75

Table 2: Vickers Hardness in Group C&A

Group E : Non Carious		
Sn.	Sample ID	Hardness in HV
1	No.1	55.80
2	No.2	50.70
3	No.3	49.89
4	No.4	53.21
5	No.5	50.18
Average		51.95

Table 3: Vicker Hardness in Group E

ANOVA Test

	Rotary	Papacarie	Normal	Cariesolv	Non Carious	F-Value	P-Value
N	15.00	30.00	30.00	30.00	5.00		
Mean	55.68	49.90	51.70	50.66	51.96		
S.D.	5.47	2.22	2.24	4.08	2.52	5.49	0.001**
Std. Error	1.41	0.57	0.58	1.05	1.13		

Table 4: Using Anova test, since p-value is less than 0.05, we conclude that there is significant difference between the effects of different agents.

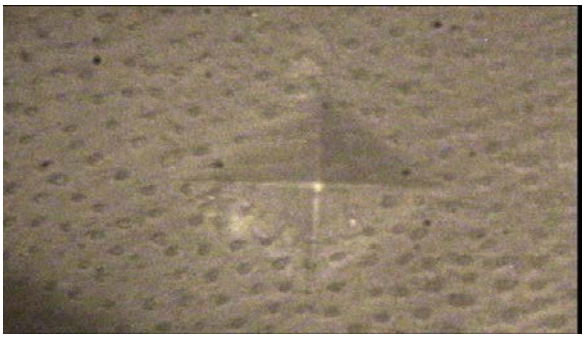


Fig.1: microhardness on non carious sample

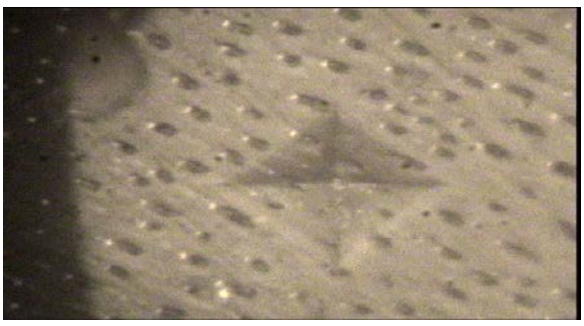


Fig.2: microhardness test on tooth treated with carisolv

Fig.3: microhardness on a tooth treated using rotary

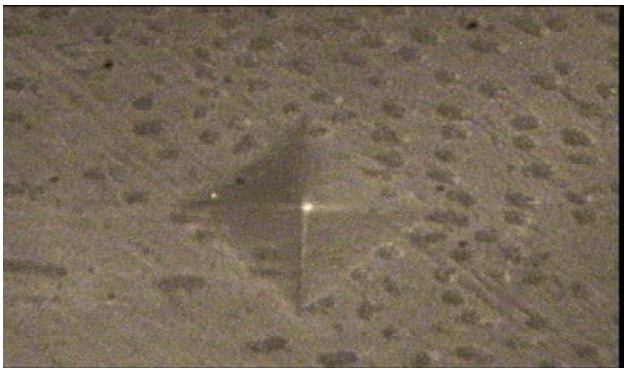


Fig.4: microhardness on a tooth treated with papacarie

Sem Study

Surface characteristics were scrutinized by the scanning electron microscope (SEM).

SEM analysis revealed an extremely rough or uneven surface, with minimal smear layer; and open dentinal tubules. The results indicated that Carisolv does not produce any adverse side effects on dentinal compositions of the treated cavities.The residual dentine of the Carisolv group exhibited two patterns; the first showed the presence of a smear layer that covered the dentinal tubules, while the other pattern showed patent dentinal tubules and the partial absence of a smear layer.

The SEM of the dentine surface following the rotary caries excavation constantly showed the presence of a smear layer and occlusion of most of the dentinal tubules with smear plugs.

The most characteristic finding was seen with the Papacarie group, in which there was nearly a total absence of a smear layer on all specimens and most of the dentinal tubules were patent. The residual dentine surfaces following chemo-mechanical caries removal methods by either Carisolv or Papacarie were irregular in comparison to the rotary.

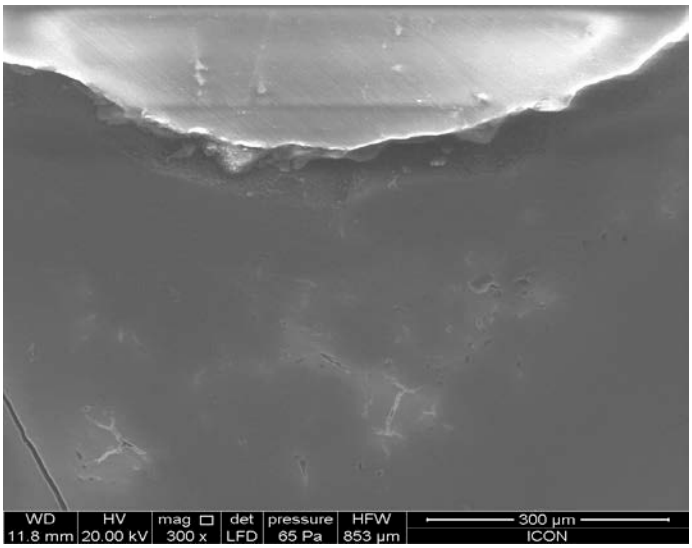


Fig 5: Tooth section treated with rotary. Inference: smear layer not seen on the tooth sample. (300 x)

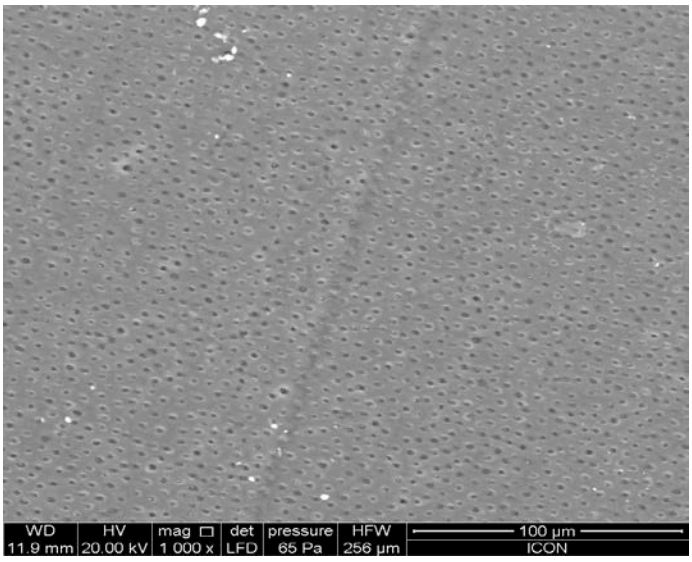


Fig.6: Normal Tooth Section

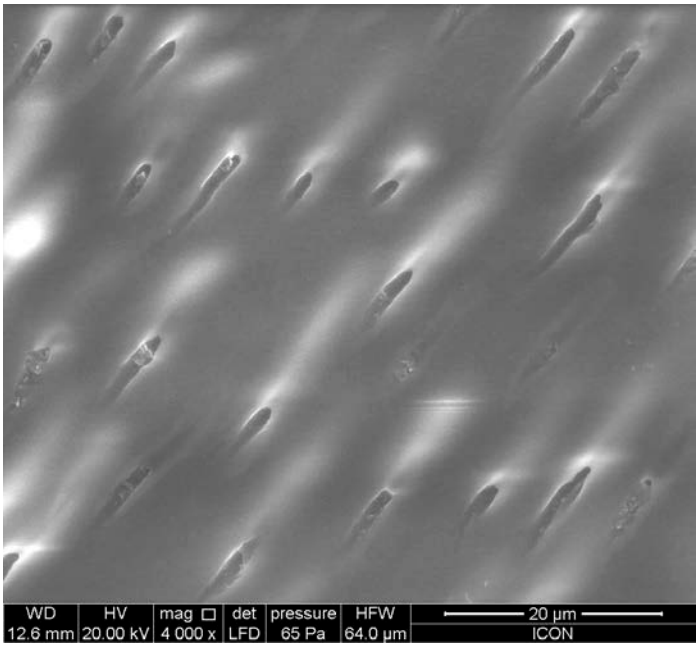


Fig.7: Dentinal tubules seen in 2000 x on the side treated with papacarie

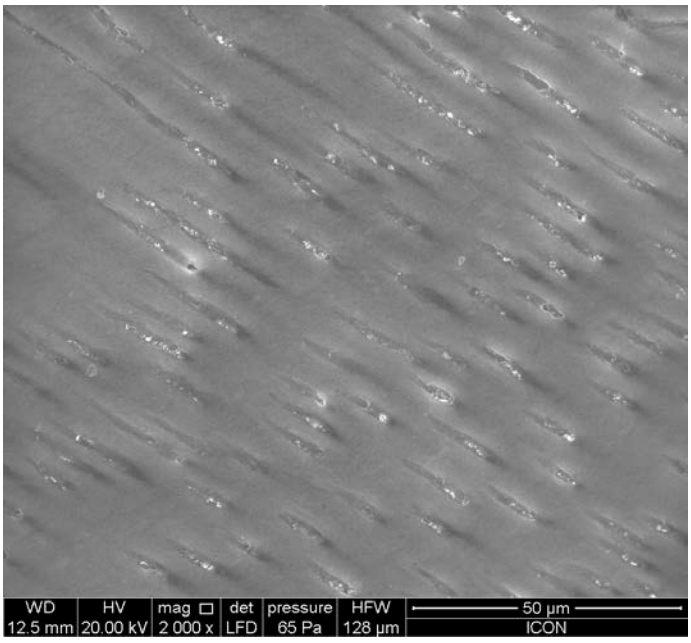


Fig.8: Dentinal tubules seen in 2000 x on the side treated with carisolv

Discussion

Microhardness Test: The purpose of this study was to evaluate the caries dissolving capacity of carisolv and papacarie in vitro. After excavation with the chemo-mechanical agents, dentin surface were caries free.

However, eight cavities showed caries in the dentinoenamel junction. Results have concluded that there may be a possibility of leaving caries in the dentinoenamel junction. Hence apt case selection appears to be important to ensure a successful outcome.

The conclusions regarding the difference in hardness from one section of a tooth to another are at times in variance with each other. This study of dentin was undertaken in an attempt to establish any trends in hardness existing from one area of a tooth to another or between differently treated dentin. With this purpose in mind, this research did not attempt to relate the hardness values to the histologic tooth structure, but a sufficiently large number of hardness measurements were made so that the data could be treated on a statistical basis.

Caries excavation has routinely been performed according to the mechanical principles using drills and sharp-edged hand instruments. These methods, although often efficient, have some major disadvantages that can result in pressure, heat dentin desiccation, pain, and vibration. First, due to apparent lack of objective clinical markers, the amount of dentin to be removed is often difficult to establish. Second, it often induces pain and discomfort.

This study evaluated the dentinal composition using the caries detecting dye and Vickers hardness measurements of the cavity floor following the removal of carious dentin by the Carisolv and Papacarie. The carious dentin of extracted human teeth was removed and the Vickers hardness number (VHN) of the cavity floor was determined.

Examination was done in vitro to determine the time necessary for removal of carious dentin (efficiency) and the Vickers hardness number (V.H.N) of remaining dentin (effectiveness) using Carisolv / Papacarie or hand excavation. Results exhibited that hand excavation

presented higher efficiency and effectiveness than chemo-mechanical excavation.

Microhardness of tooth can be analyzed by three ways, namely, Knoop's Hardness number (KHN), VHN, and Brennel's hardness number (BHN). In this study, VHN test was used in preference to KHN test as it was proposed that the Vickers indenter should always be used in tooth hardness test [2] and square shape of indent obtained in VHN was easy and more accurate to measure the tooth hardness.[3]

Collys et al., [4] suggested a load of 50 g and more for studies of hardness in teeth, because they found that lower loads influence the indentation size.

Qasim et al., [5] recommended a load of 100 g, because it gave a clear indentation to be observed under the microscope.

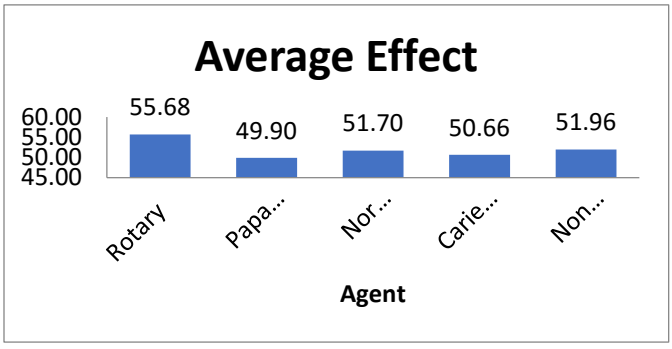
In our study, we have used 50gm (0.49N) load for 15 seconds as it gave a clearer indentation. Hence, in our study, we have used the Vickers microhardness test. Results from our concluded that the microhardness of remaining dentin after removal with rotary cutting instruments and chemo mechanical method was similar with the presence of a significant difference (p > o.o5). In our study – the average mean response was as follows:

Rotary – 55.68 VHN

Papacarie - 49.57- 50.22 VHN

Carisolv – 50.49 – 50.81 VHN

Non-carious - 51.95 VHN



Graph 1: Result

Summary

The study was conducted on 60 teeth stored in 0.1 percent thymol solution used within two weeks after extraction from the patients who came to the OPD at the department of Pediatric dentistry and preventive health, Pune.

60 extracted teeth were collected from the patients were advised extraction, department of oral surgery and pedodontics and preventive dentistry, Bharati vidyapeeth dental college and was stored in 0.1 pc thymol solution. The data obtained from the study was compiled, tabulated and analyzed statistically using ANOVA test and T- test.

Results

- Results determined that the microhardness of remaining dentin after removal with rotary cutting instruments and chemo mechanical method was similar with presence of a significant difference (p > o.o5)
- The SEM of the dentine surface following the rotary caries excavation consistently exhibited the presence of a smear layer and occlusion of most of the dentinal tubules with smear plugs.

The residual dentine of the Carisolv group exhibited two patterns; the first showed the presence of a smear layer that covered the dentinal tubules, while the other pattern showed patent dentinal tubules and the partial absence of a smear layer.

The most unique finding was observed in the Papacarie group, in which there was nearly a total absence of a smear layer on all specimens and most of the dentinal tubules were patent. The residual dentine surfaces following chemomechanical caries removal methods by either Carisolv or Papacarie were uneven when compared to the rotary.

Conclusions

Wherever possible, tissue should be conserved; invasive treatment should be kept to a minimum, and natural tissue should be replaced with artificial substitutes only when it is absolutely unavoidable.

CMCR combines traumatic, conservative, and selective properties for removal of carious dentin, has antibacterial properties that reduce that reduce the number of cariogenic bacteria, and does not cause dentinal mud on the surface of a prepared cavity, thus facilitating the bonding of the restorative material.

Papacarie and Carisolv has been found to be easy to manipulate, simple. A cheaper version of Papacarie has been developed in India known as Carie-care and BRIX – 3000 in the United Kingdom is as effective in removing infected tissues. Moreover its use can be afforded by unprivileged people which otherwise would have no other option.

The conclusion of the present study showed the papain based (Papacarie) chemo-mechanical caries removal method to be a suitable and conservative alternative to conventional rotary excavation of carious tissue[6]. This enzymatic chemo-mechanical caries removal

method provided briefer excavation time and potentially enhanced morphological features of residual dentine for consequent bonding in comparison to the sodium hypochlorite chemomechanical caries removal technique.[7]

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