

ORIGINAL RESEARCH

Efficacy of Chemomechanical Caries Removal System as Compared to Conventional Rotary Method of Caries Removal - An *In Vitro* Comparative Study

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ABSTRACT

Introduction: Chemomechanical caries removal (CMCR) system has been the most intriguing development in minimal invasive dentistry. The fundamental drawback of the drilling approach has remained to be - unpleasantness to the patient, need for local anesthesia, and potential adverse effects to the pulp due to heat and pressure. The CMCR technique on the other hand introduced in 1970, provides the advantage of cooperation from the pediatric patients due to lack of sounds of the drill and flushing of water jet from air rotor.

Aims and Objective: This study was aimed to compare the efficacy of chemomechanical system and conventional rotary system in eliminating the bacteria from the prepared tooth specimen.

Materials and Methods: The study was done on 54 non-carious primary second molars, divided into 2 groups of 27 each. Class 1 cavities were prepared on the specimen and then subjected to a demineralizing agent. Bacterial cultures were introduced into the prepared cavities and incubated. The specimen in Group 1 was subjected to caries removal using low-speed conventional drilling method with spherical carbide bur under water cooling. The specimen in Group 2 was subjected to CMCR system using Carisolv and excavated with Hu Friedy Curette. After caries removal, the specimen in both the groups was inoculated with brain heart infusion incubated and the samples collected. The collected samples were cultured, and colony forming units were determined for total bacterial count.

Statistical Analysis: The data were statistically analyzed using SPSS version 16.0.

Results: Conventional rotary and CMCR yield 28.6% and 30.3% of clean surface, respectively, at 24 h and 29.4% and 33.8% at 48 h ($P < 0.001$).

Conclusion: The results show that the chemomechanical system is equally effective in bacterial elimination, compared to conventional rotary instruments.

Keywords: Cariogenic flora, Carisolv, Chemomechanical caries removal, Minimal invasive dentistry.

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INTRODUCTION

Most of the patients in dental practice show apprehension toward dental treatment, especially more so for the child patient, attributed to the use of air rotary due to its sound and flushing of water jet. There has been paradigm shift toward the concept of conserving healthy tooth structure after the gained popularity of adhesive resin bonding system. Moreover, the majority of rural population in India lacks access to elaborate dental treatments. Due to all these reasons, basic interventions in the form of minimally invasive modalities such as atraumatic restorative technique and chemomechanical caries removal (CMCR) have always captured the interest of dental practitioners. Carisolv as CMCR agent was introduced in 1998 as successors to Caridex.^[1] The key difference to Carisolv with other products which were already available in the market was the use of three amino acids: Lysine, leucine, and glutamic acid.^[2] These counteracted the aggressive behavior of sodium hypochlorite on the oral tissues. However, there have been conflicting reports on the efficacy of Carisolv as CMCR agents.^[3-8] Hence, this study was conducted to compare the efficacy of Carisolv as CMCR agent in reducing the bacterial load from the prepared cavities as compared to that of the conventional technique.

MATERIALS AND METHODS

This experimental study design was carried out on primary second molars. The samples were obtained from the patients visiting the Department of Pedodontics, New Horizon Dental College and research institute.

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Inclusion Criteria

The following criteria were included in the study:

1. Non-carious primary second molars
2. Teeth with pre-shedding mobility
3. Teeth with more than two-third root resorption radiographically
4. Over retained teeth.

Exclusion Criteria

The following criteria were excluded from the study:

1. Carious teeth
2. Teeth with swelling, pain, and sinus opening
3. Teeth with more than half of root length radiographically.

Informed written consent was taken from guardians/parents before the collection of samples.

In vitro caries model 54 freshly extracted molars were stored in 0.2 wt. /% thymol solution at 4°C. The specimen was fixed in acrylic resin with the labeled bearing the no. of each sample. Conventional G. V. Black Class I cavities were prepared using high-speed bur #8 carbide bur. Specimen was ultrasonically cleaned in distilled water for 5 min. Samples were then immersed in demineralizing solution (1.5 mM CaCl_2 , 0.9 mM KH_2PO_4 , 150 mM KCl, and 0.1 mM Sodium acetate at pH 4.5) [Figures 1-4] and incubated at 37°C for 360 h. Cotton pellets were invaded with brain heart infusion (BHI) containing 10^5 bacterial suspensions of *Streptococcus mutans* and setting cavities. Molars were filled out with zinc oxide eugenol and incubated at 37°C by partial anaerobiosis for 48 h.^[8]

Caries Removal

Molars were randomly divided into two groups ($n = 27$) Gp 1 consisted of low-speed conventional rotary bur, and Gp 2 consisted of chemomechanical Carisolv system [Figure 5]. Zinc oxide eugenol was taken out of the molars. Carious tissue was removed with spherical no. 8 carbide bur under cooling by a single operator. For Carisolv (single mix), solutions 1 and 2 were mixed; gel was applied and left in the cavity for 30 s. The carious dentin was afterward removed with Hu Friedy Curette [Figure 6]. The gel was reapplied until cavity presented the nonexistence of softened carious tissue. To gauge carious tissue removal for both conventional rotary bur and Carisolv an exploratory probe and caries detector dye [Figure 7] was used to check until the hard dentin was obtained.^[8]

Bacterial Culture

Immediately after caries removal, 100 ml BHI [Figure 8] was inoculated into the cavities. BHI was recollected with

a pipette containing the remaining tissue and stored in 5 ml of BHI. Each sample of both groups was incubated for 24 h at 37°C. The remaining bacteria suspended in the BHI of each sample were cultured in brain-heart agar [Figure 9] and incubated for 24 and 48 h. The colony forming units were determined for total bacterial counts. Bacterial culture experiment was carried out for triplicate of each sample to obtain reproducible data^[8] [Figures 5-6].



Figure 1: Calcium chloride



Figure 2: Potassium dihydrogen phosphate



Figure 3: Potassium chloride



Figure 4: Sodium acetate



Figure 7: Caries-detector dye



Figure 5: Carisolv



Figure 8: Brain heart infusion broth

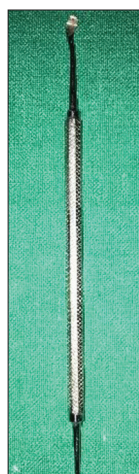


Figure 6: Hu Friedy Curette

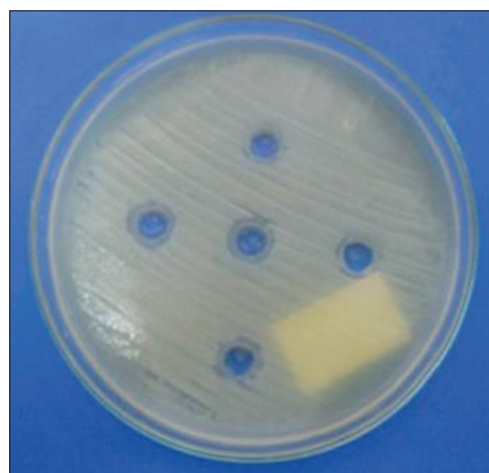


Figure 9: Brain heart infusion Agar plate

All experimental procedure was carried out by one blind investigator; the statistical analyses were performed for another author.

Statistical Analysis

The collected data were analyzed with SPSS (version 16.0).

RESULTS

Conventional rotary and CMCR yield 28.6% and 30.3% of clean surface, respectively. When cultured in BHI

agar for 24 h of incubation at 37°C, there was no statistically significant difference with continuity correction test. In terms of 48 h of incubation in BHI agar containing the remaining cavity bacteria, 29.4% and 33.8% were observed, respectively; continuity correction also showed no significant differences between groups. The values were represented in Number (%) and Mean \pm SD. There was no significant difference in the presence

of bacterial colonies in both the groups ($P < 0.001$). Table 1 shows the presence of *S. mutans* seen in both the groups 24 h and 48 h after incubation. No significant difference was observed between the two groups. Both CMCR and mechanical caries removal techniques showed a reduction in the bacterial growth rate.

DISCUSSION

Dental caries is an infectious disease caused by disequilibrium in the process of demineralization of hard tissues.^[8] Studies about carious dentine have indicated the presence of two layers, namely a more external, infected one, and necessarily removable, and another more internal, presenting as affected, softened, but capable of remaining, and being remineralized.^[9] It has been shown time and again that the use of rotary instruments in the conventional mechanical method most of the time involves the removal of healthy dental tissue. This is not considered satisfactory, because there is an over-reduction of the dentinal tissue softened by the demineralization that precedes the bacterial invasion which would be able to be mineralized. Thus, current knowledge about the process of caries disease development determines changes in its treatment, not only establishing a preventive approach but looking for less invasive methods to treat infected dentinal tissues.^[10] The clinical impact of bacterial persistence in caries-free dentine is not clear, but some authors agree that elevated bacterial counts remaining after a caries removal procedure can be considered clinically significant because they cause further disease progression.^[11] Furthermore, mechanical preparation using rotary or hand instruments result in smear layer covering the preparation surface. This layer has low bond strength and may reduce the strength of bond between the restorative material and dentin.^[12] The other challenges and disadvantages associated with high-speed drills are unpleasant perception due to noise and vibrations of drills, frequent requirement of local anesthesia, excessive tooth cutting and deleterious thermal, and pressure effects on the pulp.^[13,14] Hence, the CMCR methods stand out among all the alternative methods due to its tooth conservation and effective antibacterial properties.^[15] *In vivo* studies have reported that 17.5% of patients experience pain when Carisolv is used as compared to 40% when high-speed rotary instrument excavation is used.^[15] The rates of caries removal with the chemomechanical system have been reported to be about 88%–90.5%.^[16-19] The data reported here corroborated by the results of *S. mutans* culture in BHI agar after caries removal are 28.6% and 30.3% after 24 h incubation and 29.4% and 33.8% after 48 h of incubation. Histological studies after Carisolv excavation show the presence of bacteria into the dentinal tubules

Table 1: Conventional rotary instruments and chemomechanical caries removal; *S. mutans* BHI agar culture at 24 h and 48 h

Number of specimen	Presence of <i>S. Mutans</i>			
	Carisolv		Mechanical method	
	24 h	48 h	24 h	48 h
1	Yes	Yes	No	No
2.	No	No	No	No
3.	Yes	No	Yes	No
4.	No	No	No	No
5.	No	No	Yes	Yes
6.	Yes	Yes	Yes	Yes
7.	No	No	No	No
8.	No	No	No	No
9.	No	No	No	No
10.	No	Yes	No	No
11.	No	No	No	No
12.	No	No	No	No
13.	No	No	No	No
14.	No	No	Yes	No
15.	No	Yes	No	No
16.	Yes	No	No	No
17.	No	No	No	No
18.	No	Yes	Yes	Yes
19.	No	No	No	No
20.	Yes	Yes	No	No
21.	No	No	No	No
22.	No	No	No	No
23.	No	No	No	No
24.	Yes	Yes	Yes	No
25.	No	No	No	No
26.	Yes	No	No	Yes
27.	No	No	No	Yes

BHI: Brain heart infusion, *S. mutans*: *Streptococcus mutans*

when compared with conventional caries removal, high concentration of bacteria was shown with conventional drilling.^[17] Similar results were reported in this study after the agar culture of bacteria.

However, only the caries removal efficacy of Carisolv has been observed in this study. There are other parameters that need to be further studied like perception of pain which is crucial.

CONCLUSION

CMCR system instills a positive attitude toward dental treatment. Dental drill has always been the most stressful factor for the patients, especially children. The CMCR system using Carisolv has time and again proved to overcome the shortcomings of the traditional approach of caries management technique at the same time being minimally invasive and painless. In our study too, we found that Carisolv is as effective as a conventional rotary method of caries removal in terms of the efficacy in eliminating the cariogenic bacterial load. However, a more comprehensive and large-scale comparative study is needed.

REFERENCES

1. Fure S, Lingstrom P. Evaluation of the chemo-mechanical removal of dentin caries *in-vivo* with a new modified Carisolv gel. *Clin Oral Investig* 2004;8:139-44.
2. Maregakis GM, Hahn P, Hellwig E. Chemo-mechanical caries removal: A comprehensive review of the literature. *Int Dent J* 2001;51:291-9.
3. Bohari MR, Chunawalla YK, Ahmed BM. Clinical evaluation of caries removal in primary teeth using conventional, chemo-mechanical and laser technique: An *in-vivo* study. *J Contemp Dent Pract* 2012;13:40-7.
4. Rammooorthy S, Nivedita MS, Vanajassun PP. Effect of two different chemomechanical caries removal agents on dentin microhardness: An *in vitro* study. *J Conserv Dent* 2013;16:429-33.
5. Boob AR, Manjula M, Reddy ER, Srilaxmi N, Rani T. Evaluation of the efficiency and effectiveness of three minimally invasive methods of caries removal; An *in vitro* study. *Int J Clin Pediatr Dent* 2014;7:11-8.
6. Divya G, Prasad MG, Vavasa AA, Vasanthi D, Ramanarayana B, Mynampati P. Evaluation of the efficacy of caries removal using Polymer Bur, Stainless Steel Bur, Carisolv, Papacarie - An *in vitro* comparative study. *J Clin Diagn Res* 2015;9:42-6.
7. Subramaniyan P, Babu GK, Neeraja G. Comparison of the antimicrobial efficacy of chemomechanical caries removal (Carisolv) with that of conventional drilling in reducing cariogenic flora. *J Clin Pediatr Dent* 2008;32:215-9.
8. Garcia-Contreras R, Scougall-Vilchis RJ, Contreras-Bulnes R, Sakagami H, Morales-Luckie RA, Nakajima H, *et al.* A comparative *in vitro* efficacy of conventional rotatory and chemomechanical caries removal: Influence on cariogenic flora, microhardness, and residual composition. *J Conserv Dent* 2014;17:536-40.
9. Ohgushi K, Fusayama T. Electron microscopic structure of the two layers of carious dentine. *J Dent Res* 1995;54:1019-26.
10. Cederlund A, Lindskog S, Blomlöf J. Efficacy of carisolv-assisted caries excavation. *Int J Periodont Rest Dent* 1999;19:464-9.
11. Kidd EA, Joyston-Bechal S, Beighton D. Microbiological evaluation of caries activity during cavity preparation. *Caries Res* 1993;27:402-8.
12. Darle C, Bomstein R. *Chemomechanical Caries Removal*. 1st ed. Göteborg, Sweden: Medi Team, Savadelen; 2000. p. 5-7.
13. Bussadori SK, Castro LC, Galbao AC. Papain gel: A new chemomechanical caries removal agent. *J Clin Pediatr Dent* 2005;30:115-20.
14. Motta LJ, Martins MD, Torta KP, Bussadori SK. Esthetic restoration of deciduous anterior teeth after removal of carious tissue with Papacaire. *Indian J Dent Res* 2009;20:117-20.
15. Fusayama T. Two layers of carious dentin: Diagnosis and treatment. *Oper Dent* 1979;4:63-70.
16. Lozano-Chourio MA, Zambrano O, Gonzalez H, Quero M. Clinical randomized control trial of chemomechanical caries removal (Carisolv). *Int Dent J Pediatr Dent* 2004;16:161-7.
17. Azrak B, Callaway A, Grundheber A, Stender E, Willershausen B. Comparison of the efficacy of chemomechanical caries removal with (Carisolv) that of conventional excavation in reducing the cariogenic flora. *Int J Pediatr Dent* 2004;14:182-91.
18. Yazic AR, Atilla P, Ozgunalty G, Muftuoglu S. *In vitro* comparison of the efficacy of Carisolv and conventional rotary instrument in caries removal. *J Oral Rehabil* 2003;30:1177-82.
19. Cederlund A, Lindskog S, Blomlof J. Effect of a chemo-mechanical caries removal system (Carisolv) on dentin topography of non-carious dentin. *Acta Odontol Scand* 1999;57:185-9.