RESEARCH ARTICLE

Comparative Evaluation of Chemo-mechanical and Rotary-mechanical Methods in Removal of Caries with Respect to Time Consumption and Pain Perception in Pediatrc Dental Patients

Ashish Katiyar[1], Sukriti Gupta[2], Kirtija Gupta[3], Karuna Sharma[4], Bhoomika Tripathi[5], Nitin Sharma[6]

Abstract

Aim and objective:

- To compare the clinical efficiency in removal of caries by the two different methods of caries removal.
- To compare the treatment time between chemomechanical and rotary mechanical methods of caries removal.
- To compare the pain perception of the patient during the two different methods (chemomechanical and rotary mechanical) of dentin caries removal.

Materials and methods: The Carisolv system for caries removal, consisting of a solvent gel and a specially designed hand instrument, as compared to the conventional method of caries removal, i.e., Airotor. Sixty patients in the age-group of 6–14 years, having Black's class I dentinal caries with the cavity in the molars, were enrolled for the study.

Results: The time for caries removal with Carisolv and Airotor was, respectively, 7.17 ± 1.57 and 8.00 ± 1.56 minutes. Thus, the mean time taken was also significantly higher in group II as compared to group I ($t = 4.805$; $p < 0.001$).

Keywords: Chemomechanical caries removal, Early childhood caries, Facial pain rating scale.

International Journal of Clinical Pediatric Dentistry (2021): 10.5005/jp-journals-10005-1896

Introduction

The chemomechanical caries removal (CMCR) has been introduced as an alternative to the invasive method of caries removal which aims at the elimination of carious dentin with help of chemical agents. By this method only infected tissues are being removed, it helps in preserving healthy dental structures, avoiding pulp irritation and the patient does not have to go under any discomfort. Instead of using the conventional drilling method, using a chemical agent assisted by an atraumatic mechanical force to remove soft carious tooth structure has been an affable option. This work intends to perform a comprehensive study of old and most recently available methods for CMCR.

According to WHO, caries is defined as a "localized post eruptive, pathological process of external origin involving softening of hard tissue and proceed to the formation of a cavity".[1]

During the invasive treatment of caries using high-speed instrument, the operator is forced to destroy the sound tooth structure. Heat, vibration, and bone-conducted noise; all contribute to patient discomfort and it has an adverse effect on pulp (thermal and pressure).[2] So, even though it can quickly and efficiently remove caries, it can result in pain or discomfort which is a common phenomenon often inducing fear and anxiety in pediatric patients.

Caries excavation has conventionally been performed according to the mechanical principles using drills and sharp-edged hand instruments. These methods, although often effective, have some major disadvantages that can result in heat, pressure, dentin desiccation, vibration, and pain.[3] First, due to the 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; therefore, local anesthesia is needed.[4] To prevent these drawbacks, alternative dentin caries-removal methods have been proposed, including chemomechanical techniques,[5,6] air abrasion with aluminum oxide or glass particles,[7] sono-abrasion,[8] ultrasonic instrumentation,[9] and lasers.[10] The advantages of CMCR agents increased patient's compliance, avoided usage of local anesthesia,[11] left the healthy dentin intact,[12] and facilitated ultimate tissue preservation.

[1,4]Department of Pedodontics and Preventive Dentistry, Rama Dental College, Kanpur, Uttar Pradesh, India

[2]Department of Pediatric and Preventive Dentistry, RR Dental College and Hospital, Udaipur, Rajasthan, India

[3]Department of Pedodontics and Preventive Dentistry, Maharana Pratap Education Center, Kanpur, Uttar Pradesh, India

[5]Department of Conservative Dentistry and Endodontics, Modern Dental College and Research Centre, Indore, Madhya Pradesh, India

[6]Department of Pedodontics, Rajasthan Dental College, Jaipur, Rajasthan, India

Corresponding Author: Ashish Katiyar, Department of Pedodontics and Preventive Dentistry, Rama Dental College, Kanpur, Uttar Pradesh, India, Phone: +91 9936434789, e-mail: drashish1981@gmail.com

How to cite this article: Katiyar A, Gupta S, Gupta K, *et al.* Comparative Evaluation of Chemo-mechanical and Rotary-mechanical Methods in Removal of Caries with Respect to Time Consumption and Pain Perception in Pediatrc Dental Patients. Int J Clin Pediatr Dent 2021;14(1):115–119.

Source of support: Nil

Conflict of interest: None

Inclusion Criteria

- Children between 6 years and 12 years of age-group were selected because the caries activity rate is high during this period. Patient response is also well developed which leads to easy communication between the child and the dentist. During the early period, the tooth should be restored as much as possible because the exfoliation time of primary molars is not reached.
- Based on the clinical examination, patients with moderate involvement of dentin were included in the study.
- Only the carious lesions on the proximal and occlusal surface of primary and permanent molars were taken for the excavation of caries.

Exclusion Criteria

- The teeth with a history of pain (pulp exposure), presence of sinus tract, and mobility were not included in the study.
- Patients with extensive carious lesions were not taken for the study.

Division of Sample

The patients selected had single or multiple primary carious teeth and from among these patients, a total no. of 60 teeth were selected for the study group. The carious teeth were called samples and were randomly divided into three groups as follows:

Group I: By Airotor

This group comprises 30 carious teeth in which the caries was removed using number 245 round bur along with adequate coolant (Figs 1 and 2).

Group II: Caries Removal by Chemomechanical Method

Thirty carious teeth were taken in this group and the caries was removed using Carisolv gel (chemical agent) (Figs 3 and 4).

Procedure for Application

Group I: Caries Removal—Mechanically; Using a Rotary Instrument

The selected carious tooth was isolated. Access was gained with a round bur and the caries was removed using a rotary instrument; diamond burs (d = 1 mm) (round bur, straight fissure, inverted cone). After the caries was removed, a visual and tactile method to inspect the cavity was used, repeated if any part of the caries left.

Group II: Caries Removal—Chemomechanically

The selected carious tooth was isolated and access to the lesion was gained. (*When required, access to the lesion was made using a*

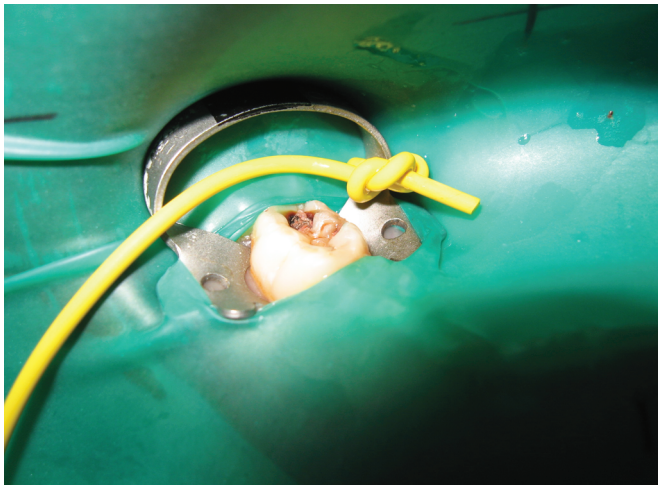

Fig. 1: Caries on occlusal surface of the tooth

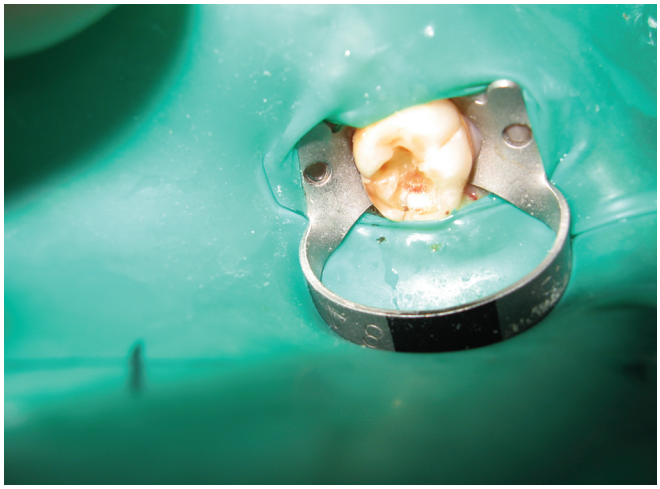

Fig. 2: Removal of caries done by using Airotor

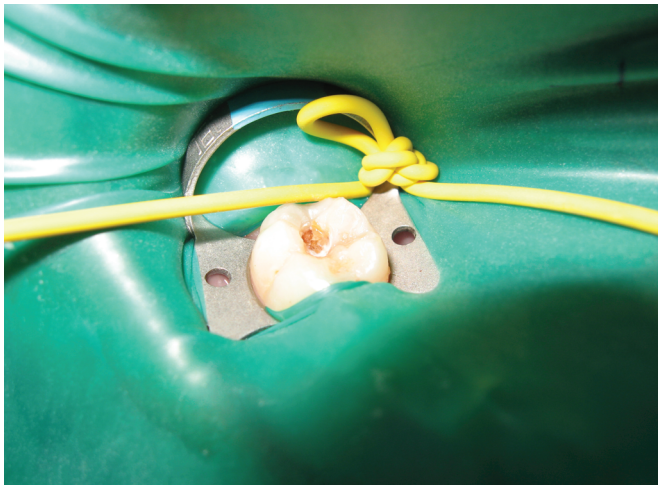

Fig. 3: Caries on occlusal surface of the tooth

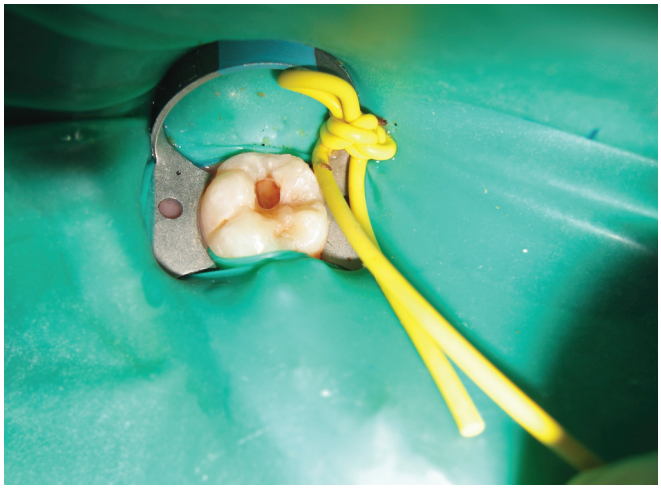

Fig. 4: Removal of caries done by using Carisolv

round diamond bur). Multi-mix syringe dispenser was used to mix the Carisolv gel. The mixed gel or the active gel was dispensed onto a mixing well. Using the hand instruments, the activated gel was then applied to the dentinal carious lesion. After 60 seconds, the cavity was gently scraped using a hand instrument to remove the softened carious tissue.

When the gel was applied on the cavitated lesion, it was clear but became cloudy with debris from the lesion, it was removed with gentle suction or with a cotton pellet when the gel was heavily contaminated with debris, and the fresh gel was applied.

It was done repeatedly until the gel was no longer contaminated with the debris and the surface of the cavity was felt hard. The cavity was checked using a probe (DG-16).

Results

The patients were randomly assigned to two different groups using the conventional rotary method and Carisolv. The distribution of patients in two groups is shown in Table 1 and the result is based on the following categories:

Age Distribution

The age of patients ranged between 6 years and 9 years. The age-wise distribution of patients is shown in Table 2. Overall, 28 (46.7%) patients were in the age-group 6–8 years while 32 (53.3%) were between 9 years and 12 years. In group I, 13 (43.3%) patients were between 6 years and 8 years of age while remaining 17 (56.7%) were in age-group 9–12 years. In group II, in both age-groups, i.e., 6–8 and 9–12 years, there were 15 (50%) patients each. Statistically, no significant difference was seen between two groups ($p = 0.605$). The mean age of study subjects was 8.90 ± 1.87 years. Group I patients had slightly higher mean age (9.03 ± 1.88 years) as compared to group II (8.77 ± 1.87 years), though the mean difference was not significant statistically ($t = 0.550$; $p = 0.584$). Thus, age-wise groups were matched (Table 2).

Table 1: Study groups

S. no.	*Group*	*Technique used*	*No. of patients*
1	Group I	Rotary	30
2	Group II	Carisolv	30

Tooth Involved

The distribution of patients according to the tooth involved is shown in Table 3:

In group I, 10 (33.33%) subjects had involvement of mandibular left deciduous second molar whereas, in group II, 8 (26.7%) subjects had involvement of the above-mentioned tooth number. Mandibular left deciduous second molar was the most commonly involved tooth in both the groups. Statistically, there was no significant difference between two groups ($p = 0.907$).

Time Taken

Time taken to carry out the procedures ranged from 3.5 to 10 minutes. In group I, in 24 (80%) patients, the time taken was up to 7 minutes whereas, in group II, in 25 (83.3%) patients, the time taken was above 7 minutes. Thus, in group II, the time taken was significantly higher statistically as compared to group I ($p < 0.001$). The mean time taken was 7.17 ± 1.57 minutes. In group I, this mean

Table 2: Age-wise distribution of patients

		Total		*Group I*		*Group II*	
S. no.	*Age-group (years)*	*No.*	*%*	*No.*	*%*	*No.*	*%*
1	6–9	60	100	30	50	30	50.0
2	9–12	32	53.3	17	56.7	15	50.0
	Mean ± SD		8.90 ± 1.87		9.03 ± 1.88		8.77 ± 1.87

Table 3: Distribution of patients according to tooth involved

		Total (n = 60)		*Group I (n = 30)*		*Group II (n = 30)*	
S. no.	*Tooth no.*	*No.*	*%*	*No. of patients*	*%*	*No. of patients*	*%*
1	16	4	3.3	2	3.3	2	3.3
2	26	3	1.7	2	3.3	1	0.0
3	36	4	20.0	2	16.7	2	23.3
4	46	4	16.7	3	20.0	1	13.3
5	74	6	6.7	3	6.7	3	6.7
6	75	18	30.0	10	33.3	8	26.7
7	84	4	5.0	1	3.3	3	6.7
8	85	16	15.0	6	13.3	10	16.7

Table 4: Distribution of patients according to time taken

		Total (n = 60)		*Group I (n = 30)*		*Group II (n = 30)*	
S. no.	*Time taken*	*No.*	*%*	*No.*	*%*	*No.*	*%*
1	<5 minutes	7	11.7	4	13.3	3	10.0
2	>5–7 minutes	22	36.7	20	66.7	2	6.7
3	>7–9 minutes	28	46.7	6	20.0	22	73.3
4	>9 minutes	3	5.0	0	0.0	3	10.0
	Mean ± SD		7.17 ± 1.57		6.33 ± 1.08		8.00 ± 1.56

Table 5: Efficacy

		Total (n = 60)		*Group I (n = 30)*		*Group II (n = 30)*	
S. no.	*Efficacy score*	*No.*	*%*	*No.*	*%*	*No.*	*%*
1	0	41	68.3	22	76.7	18	60.0
2	1	13	21.7	6	20.0	7	23.3
3	2	5	8.3	1	3.3	4	13.3
4	3	1	1.7	1	3.3	1	3.3

Table 6: Pain

		Total (n = 60)		*Group I (n = 30)*		*Group II (n = 30)*	
S. no.	*Verbal pain*	*No.*	*%*	*No.*	*%*	*No.*	*%*
1	0	25	41.7	1	3.3	24	80.0
2	1	9	15.0	5	16.7	4	13.3
3	2	18	30.0	16	53.3	2	6.7
4	3	7	11.7	7	23.3	0	0.0
5	4	1	1.7	1	3.3	0	0.0
	VAS (mean ± SD)		13.67 ± 13.89		24.33 ± 11.04		3.00 ± 5.96

was 6.33 ± 1.08 minutes whereas, in group II, it was 8.00 ± 1.56 minutes. Thus, the mean time taken was also significantly higher in group II as compared to group I ($t = 4.805$; $p < 0.001$) (Table 4).

Efficacy

Table 5 demonstrates that the efficacy score was 0 in the majority of cases (68.3%), in group I, 23 (76.7%) and in group II, 18 (60%) had efficacy score of 0. Efficacy score 3 was seen in 1 (1.7%) case only and this was a case in group II (3.3%). Statistically, there was no significant difference between the two groups ($p = 0.322$).

Pain

Table 6 shows verbal pain score ranged from 0–2 in all the patients of group II, whereas, in group I, 8 (26.7%) patients had pain score of 3 and 4. Statistically, there was a significant difference between two groups ($p < 0.001$). The mean VAS was 24.33 ± 11.04 among the group I patients and 3.00 ± 5.96 among group II patients, thus showing that the mean pain was significantly lower in group II as compared to group I ($t = 9.311$; $p < 0.001$).

Discussion

Carisolv gel (MediTeam, Sweden) was launched in 1998. Its effectiveness is based on the proteolytic action of sodium hypochlorite, which dissolves the infected dentin, and on the action of amino acids, which enhance the effect of sodium hypochlorite on denatured collagen and minimize damage to healthy tissue.[13]

So far the most promising method gaining a position as an alternative to the conventional method is chemomechanical elimination of the carious dentin, well suited in primary teeth in pediatric patients, especially those who are dental phobic and are mentally compromised. In the present study, the purpose of the chemomechanical caries excavation is to provide less invasive caries treatment by applying a solution to the outer infected, destroyed and, non-remineralizable carious dentin to soften this layer, thereby making it easier to remove using hand instruments.[14]

The gel comprises a clear fluid of high viscosity which contains three different amino acids (glutamic acid, leucine, and lysine), sodium chloride, water, and sodium hydroxide, and a transparent fluid consisting of 0.95 of sodium hypochlorite. When the gel and fluid are mixed, amino acids bind chlorine and form chloramines at a pH of 11.52. The formation of chloramines reduces the reactivity of chlorine without altering its chemical function. The result of this process is a breakdown of degraded collagen found in a demineralized portion of a caries lesion. The degraded collagen has an open structure and is, therefore, more susceptible to further breakdown by chloramines. The porous nature of demineralized dentin allows penetration of Carisolv. The unaffected collagen is more resistant to degradation but the framework of degraded collagen is broken down and can be easily scraped away.

The Carisolv is a gel-based system and in this study, it was used with specially designed hand instruments to abrade the carious dentin surface. At room temperature, the gel supplied in a twin syringe was mixed before use and then applied onto the exposed carious dentine using hand instruments and left for 60 seconds before excavation. While using Carisolv, the clouding of the applied gel is given as the caries indicator by the manufacturer. When the gel no longer turns cloudy, the cavity is indicated to be caries free.[15] The purpose of the excavation with Carisolv is to remove the soft irreversibly damaged, highly infected dentinal tissue, while conserving the reversely affected dentin. Caries-affected dentin is useful because of its low permeability compared to healthy dentin, which protects the pulp from any remaining bacteria. According to Pashley, in response to the carious process, the odontoblast precipitates calcium phosphate to form plugs in the dentinal tubules, creating the odontoblastic reaction zone. When this effect is combined with isolation of bacteria from the external sources of nutrients, caries progress has been shown to be arrested over periods up to 10 years.[16]

In the present study, it was noticed that the actual dimensions of the cavity were larger than was apparent clinically on the occlusal surface. Hence, to record all the details of the cavity, including undercuts, an addition of silicone impression material was used. Johnson and Craig showed addition silicone to demonstrate the best recovery from undercuts and extremely high accuracy with superior tear resistance plus less polymerization shrinkage, increased dimensional stability, and neutral odor and taste; besides,

it permits multiple accurate casts. Polyvinyl siloxane material shows 96.86% overall accuracy.[17]

With the help of CMCR selectively carious dentine is removed but avoids the painful and unnecessary removal of sound dentine. It facilitates delivery of atraumatic, bactericidal, and bacteriostatic activity and helps to remove the least amount of tooth structure, not leaving behind any infected and untreatable dentin.[18]

Conclusion

Within the limitations of this study comparing the clinical efficiency of CMCR using Carisolv and conventional airotor, the following conclusions could be drawn:

- Minimally-invasive, selective, and precise.
- Minimizes the need for anesthesia and enhances patient comfort.
- Makes it possible to avoid drilling close to the pulp and making treatment painless.

During the last 15 years, it has been used almost exclusively in pediatric dentistry; as the use of Carisolv in clinical practice might be limited because of the material cost.

Clinical Significance

Due to the shortcomings of the conventional drill method (noise and pressure) which leads to fear and anxiety among patients, alternative techniques like air abrasion, ultrasonic instrumentation, lasers, and chemomechanical approach to caries removal were developed. Reason being costly, air abrasion, sono-abrasion, ultrasonic instrumentation, and lasers are therefore less frequently used.

References

1. Fusayama T. Two layers of carious dentin: diagnosis and treatment. Oper Dent 1979;4(2):63–70.
2. Magalhaes CS, Moreira AN, Campos WD, et al. Effectiveness and efficiency of chemomechanical carious dentin removal. Braz Dent J 2006;17(1):63–67. DOI: 10.1590/s0103-64402006000100014.
3. Bulut G, Zekioglu O, Eronat C, et al. Effect of Carisolv™ on the human dental pulp: a histological study. J Dent 2004;32(4):309–314. DOI: 10.1016/j.jdent.2004.01.004.
4. Cederlund A, Lindskog S, Blomlöf J. Efficacy of Carisolv assisted caries excavation. Int J Periodontics Restorative Dent 1999;19(5):465–469.
5. Zinck JH, McInnes-Ledoux P, Capdeboscq C, et al. Chemomechanical caries removal: a clinical evaluation. J Oral Rehabil 1988;15(1):23–33. DOI: 10.1111/j.1365-2842.1988.tb00143.x.
6. Chaussain-Miller C, Decup F, Domejean-Orliaguet S, et al. Clinical evaluation of the Carisolv TM chemomechanical caries removal technique according to the site/stage concept, a revised caries classification system. Clin Oral Investig 2003;7(1):32–37. DOI: 10.1007/s00784-003-0196-5.
7. Horiguchi S, Yamada T, Inokoshi S, et al. Selective caries removal with air abrasion. Oper Dent 1998;23(5):236–243.
8. Banerjee A, Kidd EA, Watson TF. Scanning electron microscopic observations of human dentine after mechanical caries excavation. J Dent 2000;28(3):179–186. DOI: 10.1016/s0300-5712(99)00064-0.
9. Nielsen AG, Richards JR, Wolcott RB. Ultrasonic dental cutting instrument: I. J Am Dent Assoc 1955;50(4):392–399. DOI: 10.14219/jada.archive.1955.0077.
10. Bassi G, Chawla S, Patel M. The Nd:YAG laser in caries removal. Br Dent J 1994;177(7):248–250. DOI: 10.1038/sj.bdj.4808576.
11. Ericson D, Zimmerman M, Raber H, et al. Clinical evaluation of efficacy and safety of a new method for chemo-mechanical removal of caries. A multi-centre study. Caries Res 1999;33(3):171–177. DOI: 10.1159/000016513.
12. Baneerjee A, Kidd EA, Watson TF. In vitro evaluation of five alternative methods of carious dentin excavation. Caries Res 2000;34(2):144–150. DOI: 10.1159/000016582.
13. Mazumdar P, Das UK. Chemo-mechanical methods of caries removal-exploring new avenues in dental care. J Conserv Dent 2002;5:7–12.
14. Motta JL, Martins DM, Porta KP, et al. Aesthetic restoration of deciduous anterior teeth after removal of carious tissue with papacarie®. Indian J Dent Res 2009;20(1):117–120. DOI: 10.4103/0970-9290.49060.
15. Sudsangiam S, Van Noort R. Do dentin bond strength tests serve a useful purpose. J Adhes Dent 1999;1(1):57–67.
16. Pashley DH. Dynamics of the pulpodentin complex. Crit Rev Oral Biol Med 1996;7(2):104–133. DOI: 10.1177/10454411960070020101.
17. Johnson GH, Craig RG. Accuracy of addition silicones as a function of technique. J Prosthet Dent 1986;55(2):197–203. DOI: 10.1016/0022-3913(86)90342-2.
18. Sano H, Shono T, Sonoda H, et al. Relationship between surface area for adhesion andtensile bond strength: evaluation of a micro-tensile bond test. Dent Mater 1994;10(4):236–240. DOI: 10.1016/0109-5641(94)90067-1.