

# Clinical Evaluation of a Papain-Based Gel for the Chemo-Mechanical Removal of Caries in Children

Lumbini Pathivada\*, Munagala Karthik Krishna, Mehak Kalra, Gopinath Vivekanandan, Jaspal Singh, Saumya Navit

Department of Paedodontics and Preventive Dentistry, Teerthanker Mahaveer Dental College and Research Centre, Moradabad, India

## Abstract

**Aim:** To evaluate and compare the efficacy and acceptability of a papain based chemomechanical caries removal gel, Carie-care, against Carisolv gel and conventional air-rotor cavity preparation.

**Study design:** This study was designed as a split-mouth, randomized controlled trial with three treatments being compared in the same subject.

**Materials and Methods:** The study was conducted on 30 children in the age group of 8-15yrs, each having at least three permanent molar teeth with non-pulpally involved carious lesions. Each of the three teeth was randomly assigned to be treated with either Carie-care, Carisolv or high-speed cavity excavation with air-rotor. The following assessments were made for each tooth: efficacy of caries removal, cavity entrance size, cavity preparation time, pain during treatment, requirement for local anesthesia and degree of patient co-operation.

**Statistical Analysis:** Within group and between group variances amongst the study groups were analyzed with parametric (ANOVA) and non-parametric (Kruskal WallisH test) methods. Students 't' test was used to test the significance of two means.

**Results:** The rate of complete caries removal was highest in airrotor group (86.7%) and least in Carisolv group (66.7%). No changes in cavity entrance size pre- and posttreatment were observed in the CMCR groups whereas a significant increase in cavity entrance size was observed ( $0.65 \pm 0.55$ ) in airrotor treated teeth. Mean values of time taken for procedure were  $5:38 \pm 0:30$ (SD) mm:ss and  $5:50 \pm 0:27$ (SD) mm:ss  $0:58 \pm 0:09$ (SD) mm:ss for Carie-care, Carisolv and airrotor, respectively. None of the patients treated with Carie-care had reported pain. In Carisolv and airrotor groups, mean values of pain scores were  $0.2 \pm 0.41$  and  $1.33 \pm 0.55$ , respectively. Patients treated with CMCR gels did not request for local anesthesia but 8 (26.7%) of airrotor treated patients had required LA. The mean value for Frankl behavior rating scale was higher for CMCR groups ( $3.53 \pm 0.51$ ) as compared to that for the traditional method ( $2.43 \pm 0.50$ ).

**Conclusion:** Based on the results of this study, the CMCR methods were less invasive and painful and more acceptable for patients as compared to the conventional method. The only observed drawback with these methods was the lengthy procedure time. Between the two CMCR gels, Carie-care was observed to be less painful and marginally less time-consuming.

*Key Words: Caries, Chemomechanical caries removal, Papain gel, Carisolv*

## Introduction

Recent paradigm shift in restorative dentistry emphasizes the need of minimal intervention and maximum conservation of tooth structure while treating carious lesions [1]. Chemomechanical caries removal (CMCR) is one of the developing treatment modalities in the field of minimally invasive dentistry involving the application of a chemical solution to the carious dentine thus enabling the exclusive removal of carious tissue in the demineralized zone and preserving the underlying sound dentin [2].

A plethora of CMCR methods have been experimented and developed over the years. Early studies involved using a solution, GK-101, containing the active ingredient, N-monochloroglycine (NMG) [3,4]. Later, the GK101 system was modified by replacing the glycine with aminobutyric acid (N monochloro- D-2 aminobutyrate) for the purpose of enhancing its efficacy (GK101E), commercially introduced in the early eighties as a two-bottle system, called Caridex [5,6]. Several clinical trials showed a high rate acceptability and preference of Caridex [7]. Continuous attempts to improve the

product resulted in the development of Carisolv™ (MediTeam, Sweden), a gel-based system that can be applied with specially designed hand instruments [2].

Recently, Papacarie™ (Formula Eacao, Brazil) was introduced which owes its proteolytic action to papain, a unique endoprotein extracted from the papaya fruit [8]. One of the recent entrants in CMCR is Carie-care™, developed by Uni BioTech Pharma and the Vittal Mallya Scientific Research Foundation, India (Figure 1). Similar to Papacarie, this blue coloured gel consists of papain as its main ingredient. In addition, the preparation contains clove oil, an anti-inflammatory and analgesic essential oil, chloramines and dye. Till-date, limited research has been performed for determining the suitability of this product for the purpose of CMCR [9]. The aim of the present study was to evaluate the efficacy and acceptability of Carie-care in comparison with another gel formulation and conventional high-speed cavity preparation.

## Materials and Methods

Prior approval for this study was obtained and parents/



Figure 1. Carie-care™ gel.

guardians of each child were fully informed regarding the study design, objectives and probable advantages of the study before their written consent was procured.

Children in the age group of eight to fifteen years, each with at least three permanent molar teeth with non-pulpally involved carious lesions of similar size were included in the study. Teeth with developmental disorders, extensive carious lesions, pulpal or periodontal pathology, abscess, sinus or fistula, internal/external resorption and patients with history of allergies to any drugs or medications and any congenital/medical disorders were not considered. A total of thirty children satisfying the study criteria were shortlisted.

This study was designed as a split-mouth, randomized controlled trial with three treatments being compared in the same subject. A thorough dental and medical history and pre-treatment intra-oral examination of each child were performed. In each subject, the three selected carious permanent molars were randomly assigned to one of treatment procedures; CMCR with Carie-Care gel, CMCR with Carisolv gel or high-speed cavity excavation. Sequentially numbered envelopes containing the allocation details including the names of the operators and treatment procedure were prepared and were opened in successive order during the trial to maintain allocation concealment. Randomization was performed by an independent investigator utilizing pre-prepared randomization envelopes of the treatment procedures. Patients were asked if they require local anesthesia prior to each procedure. All three treatments were carried out in the same session under rubber dam isolation.

## Method of Chemomechanical Caries

### Removal

In teeth treated with Carie-care and Carisolv, the carious lesion was covered with the gel and left undisturbed for sixty and thirty seconds, respectively. After removing the gel with a moistened cotton pellet, carious dentin was excavated gently with a spoon excavator without applying pressure. This method was repeated until the gel became clear and the surface was adequately hard when checked with hand instruments. After satisfactory caries removal was achieved, the remaining gel was rinsed away with water (Figure 2). In the third site, the teeth were drilled with high-speed airrotor hand-piece (Pana Air ETM, NSK, Japan) and no. 2 and 4 round diamond

burs until the cavity was caries free. Use of slow speed steel burs was avoided as they have been shown to result in excess removal of tooth structure, thermal damage, pulpal pressure and needless requirement for frequent anesthesia. Further, the creation of microcracks and enamel chipping is minimal with use of high speed burs and they are more efficient over a range of speeds [10].

The following assessments were made for each of the teeth operated in:

#### **Cavity entrance size**

The greatest diameter of the entrance size of each cavity was measured with a metallic structured caliper before and after removing the caries. Measurements were recorded in millimeters.

#### **Cavity preparation time**

The cavity preparation time for each technique was recorded using a stopwatch in minutes: seconds format. For the CMCR methods, the time taken from the beginning of gel application until the cavity was considered to be caries free was recorded. Time taken for local anesthesia administration was not included.

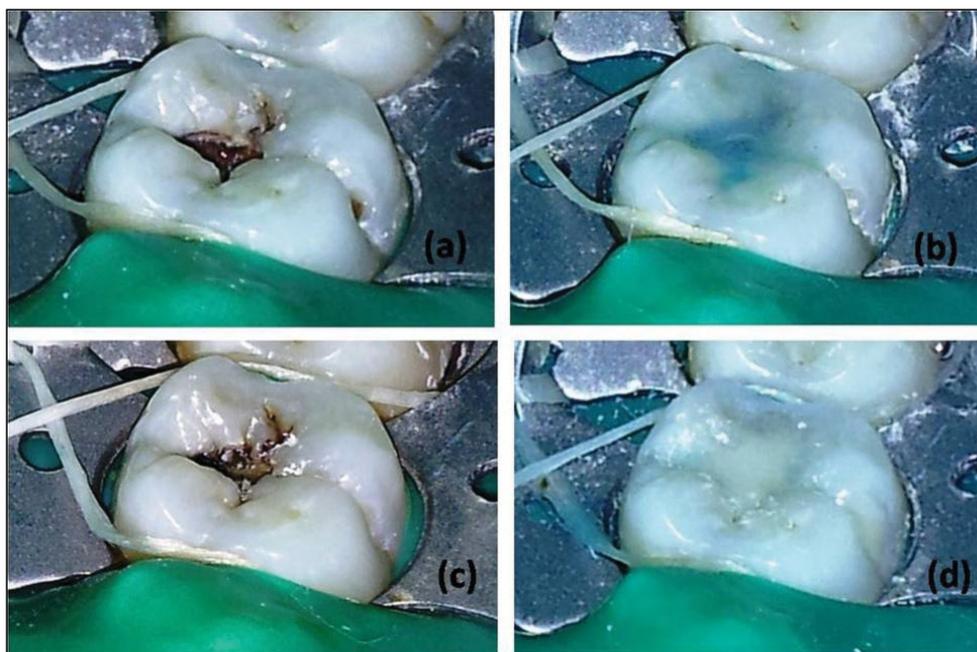
#### **Pain during treatment**

After the completion of each procedure, the severity of pain was assessed using the Wong Baker's faces pain rating scale [11]. The scale shows a series of faces ranging from a happy face at 0 to a crying face at 10, indicating feelings from "no hurt" to "hurts worst". Each subject was asked to choose a face that best described their sensation.

#### **Degree of patient co-operation**

The degree of cooperation by the patient during each caries removal procedure was evaluated based on the Frankl behavior rating scale [12]. This four-point scale has ratings ranging from definitely negative (--) to definitely positive (++) . Each subject was asked to choose a rating based on their experience.

The prepared cavities were filled with light-cured composite to restore the teeth as well support any remaining undermined enamel. Each cavity was conditioned with 37.5% phosphoric acid (Scotchbond™ Etchant, 3M ESPE, USA). The next step included application and curing of a bonding agent (Adper™ Single Bond 2 Adhesive, 3M ESPE, USA) for a period of 15 seconds. Composite material (Filtek™ Z350 XT, 3M ESPE, USA) of requisite thickness was then applied in layers and cured for approximately 40 seconds.



**Figure 2.** Steps of CMCR with the tested gel: a) pre-operative view of carious lesion in tooth # 36. b) application of the gel. c) post-operative view after CMCR. d) cavity restored with light-cured composite.

### Statistical Analysis

Within group and between group variances amongst the study groups were analyzed with parametric (ANOVA) and non-parametric (Kruskall Wallis H test) methods. Students 't' test was used to test the significance of two means and paired 't' test was used to compare changes in cavity entrance size before and after treatment. The statistical analysis was done using SPSS (v 15.0) software.

### Results

Age of study subjects ranged from eight to fifteen years (mean age=9.80 ± 2.89 years). Study population included 16 (53.3%) males and 14 females (46.6%) (M:F ratio=1.14:1). Number of sites with complete caries removal were 24 (80%), 20 (66.7%) and 26 (86.7%) for Carie-care, Carisolv and airrotor, respectively. Statistically there was no significant difference among the groups with respect to caries removal rate ( $p>0.05$ ).

No statistically significant intergroup difference for pre-treatment mean cavity entrance sizes among three groups was observed. No change was observed in the post-treatment cavity entrance sizes of CMCR groups whereas a statistically significant increase was observed in the airrotor group ( $p<0.001$ ). ANOVA revealed a statistically significant intergroup difference for mean time taken for procedure among three groups ( $p<0.001$ ) (Table 1).

None of the patients treated with Carie-care reported pain, whereas mean pain scores were 0.20 ± 0.41 and 1.33 ± 0.55 for Carisolv and airrotor groups, respectively. Intergroup comparison of pain scores revealed a statistically significant intergroup difference ( $p<0.001$ ) (Table 2). Mean values of Frankl behavior rating scale in the both CMCR groups were the same whereas a lower value was observed in the airrotor group. Intergroup comparison of scores revealed a statistically significant intergroup difference ( $p<0.001$ ) (Table 3).

### Discussion

Although, CMCR agents have been predominantly based

**Table 1.** Cavity preparation time in the treated groups.

Group	Time in min:sec (Mean+SD)
Carie-care	5:38+0:30
Carisolv	5:50+0:27
Airrotor	0:58+0:09

$p<0.001$

**Table 2.** Mean pain scores (based on Wong-Bakers rating scale) in the treated groups.

Group	Pain Score (Mean+SD)
Carie-care	0.00+0.00
Carisolv	0.20+0.41
Airrotor	1.33+0.55

$p<0.001$

**Table 3.** Frankl behaviour rating scale scores in the treated groups.

Group	Behaviour Score (Mean+SD)
Carie-care	3.53+0.51
Carisolv	3.53+0.51
Airrotor	2.43+0.50

on inorganic compounds as their active ingredient, recent attempts involved developing products with natural and organic substances with caries dissolving properties. Papacarie and the more recently introduced Carie-care, are both based on papain, a papaya based extract, which acts as an endoprotein and is capable of breaking peptide bonds by a process of deprotonation, thus enabling the dissolution of infected dentin.

In the present study, efficacy of caries removal with Carie-care was similar to that of Carisolv. Previous studies comparing Papacarie with Carisolv [13,14] and airrotor [8,15-17] have found no significant differences in their capacity for complete caries removal. The results of this study suggested smaller post-treatment mean cavity sizes for both chemomechanical methods as compared to that of the traditional method. Similar findings were observed in a previous study in which the clinical efficacy of Carisolv was

evaluated [18]. The basis for smaller cavity sizes in CMCR methods may be the minimally invasive excavation protocol.

No significant differences were observed in the caries removal times between the Carie-care and Carisolv groups, although Carisolv treatment times were slightly on the higher side. Studies comparing Carisolv and Papacarie in this aspect have found similar results [13,14,19]. Cavity preparation times by means of airrotor were significantly lower than those of chemomechanical methods, in accordance with previous studies evaluating Carisolv [1,16,20-23] and Papacarie [13,14]. The reason for significantly higher caries removal times in the CMCR methods as compared to traditional method maybe explained by the time consuming step-by-step procedure involved in the former.

No pain was sensed by any of the children treated with Carie-care. Similar results were observed in a recent study that compared Carie-care with traditional method in treating carious lesions in five to seven years old children [9]. Most of the earlier CMCR studies had reported minimal or no pain during cavity preparation [1,13-15,24,25]. Probably one of the main reasons for the painless nature of CMCR treatment is that the amount of tooth structure removed is better controlled

by the operator as compared to airrotor. High speed caries excavation frequently results in excess removal of sound tooth structure and proximity of the bur to the pulpal tissues may result in pain.

Patients in the present study exhibited more negative behavior when undergoing high-speed rotary caries excavation as compared to the chemo-mechanical methods. Similar observations were recorded in previous studies in which patient behavior in response to Carisolv treatment was recorded based on Frankl behavior rating scale [18] or other methods [22,26]. The reasons for the positive behavior of patients to CMCR as compared to the conventional method of drilling maybe manifold. Findings reveal the patients' concern about several aspects of rotary cavity excavation including pain/discomfort, requirement of local anaesthesia, noise and vibrations of the drill, etc.

Based on the findings of this study, Carie-care gel can be considered as similar, if not superior, to Carisolv gel in efficacy and acceptability as a CMCR agent in the pediatric population. Long-term studies are the need of the hour to further evaluate this product prior to recommending it for routine use in clinical practice.

## References

- Ericson D, Kidd E, McComb D, Mjör I, Noack MJ. Minimally invasive dentistry-concepts and techniques in cariology. *Oral Health and Preventive Dentistry*. 2003; **1**: 59-72.
- Beeley JA, Yip HK, Stevenson AG. Chemochemical caries removal: a review of the techniques and latest developments. *British Dental Journal* 2000; **188**: 427-430.
- Schutzbank SG, Marchwinski M, Kronman JG, Goldman M, Clark RE. In vitro study of the effect of GK-101 on the removal of carious material. *Journal of Dental Research* 1975; **54**: 907.
- Goldman M, Kronman JH. A preliminary report on a chemomechanical means of removing caries. *Journal of American Dental Association*. 1976; **93**: 1149-1153.
- Schutzbank SG, Galaini J, Kronman JH, Goldman M, Clark RE. A comparative in vitro study of GK-101 and GK-101E in caries removal. *Journal of Dental Research*. 1978; **57**: 861-864.
- Smales RJ, Yip HK. The atraumatic restorative treatment (ART) approach for the management of dental caries. *Quintessence International*. 2002; **33**: 427-432.
- Anusavice KJ, Kincheloe JE. Comparison of pain associated with mechanical and chemomechanical removal of caries. *Journal of Dental Research*. 1987; **66**: 1680-1683.
- Bussadori SK, Guedes CC, Bachiega JC, Santis TO, Motta LJ. Clinical and radiographic study of chemical-mechanical removal of caries using Papacarie: 24-month follow up. *Journal of Clinical Pediatric Dentistry*. 2011; **35**: 251-254.
- Venkatraghavan K, Kush A, Lakshminarayana CS, Diwakar L, Ravikumar P, et al. Chemomechanical caries removal: a review & study of an indigenously developed agent (Carie Care™ gel) in children. *Journal of International Oral Health*. 2013; **5**: 84-90.
- Cortes M, Pecorari VGA, Basting RT, Franca FMG, et al. Effect of rotary instrument speed on its capacity to remove demineralized and sound dentin. *European Journal of Dentistry*. 2013; **7**: 429-435.
- Wong D, Baker C. Pain in children: comparison of assessment scales. *Journal of Pediatric Nursing*. 1988; **14**: 9-17.
- Frankl SN, Shiere FR, Fogels HR. Should the parent remain with the child in the dental operator? *Journal of Dentistry for Children*. 1962; **29**: 150-163.
- Kochhar GK, Srivastava N, Pandit IK, Gugnani N, Gupta M. An evaluation of different caries removal techniques in primary

teeth: a comparative clinical study. *Journal of Pediatric Dentistry*. 2011; **36**: 5-9.

14. Bohari MR, Chunawalla YK, Ahmed BM. Clinical evaluation of caries removal in primary teeth using conventional, chemomechanical and laser technique: an in vivo study. *The Journal of Contemporary Dental Practice*. 2012; **13**: 40-47.

15. Kotb RM, Abdella AA, El Kateb MA, Ahmed AM. Clinical evaluation of Papacarie in primary teeth. *Journal of Pediatric Dentistry*. 2009; **34**: 117-23.

16. Motta LJ, Bussadori SK, Campanelli AP, Silva AL, Alfaya TA, et al. Randomized controlled clinical trial of longterm chemomechanical caries removal using Papacarie (cent) gel. *Journal of Applied Oral Science*. 2014. **22**: 307-313.

17. Matsumoto SF, Motta LJ, Alfaya TA, Guedes CC, Fernandes KP, Bussadori SK. Assessment of chemomechanical removal of carious lesions using Papacarie Duo(cent): randomized longitudinal clinical trial. *Indian Journal of Dental Research*. 2013. **24**: 488-492.

18. Lozano-Chourio MA, Zambrano O, González H, Quero M. Clinical randomized controlled trial of chemomechanical caries removal (Carisolv). *International Journal of Paediatric Dentistry*. 2006; **16**: 161-167.

19. Kumar J, Nayak M, Prasad KL, Gupta N. A comparative study of the clinical efficiency of chemomechanical caries removal using Carisolv and Papacarie - a papain gel. *Indian Journal of Dental Research*. 2012; **23**: 697.

20. Maragakis GM, Hahn P, Hellwig E. Chemomechanical caries removal: a comprehensive review of the literature. *International Dental Journal*. 2001; **51**: 291-299.

21. Chaussain-Miller C, Decup F, Domejean-Orliaguet S, Gillet D, Guigand M, et al. Clinical evaluation of the Carisolv chemomechanical caries removal technique according to the site/stage concept, a revised caries classification system. *Clinical Oral Investigations*. 2003; **7**: 32-37.

22. Kakaboura A, Masouras C, Staikou O, Vougiouklakis G. A comparative clinical study on the Carisolv caries removal method. *Quintessence International*. 2003; **34**: 269-271.

23. Kavvadia K, Karagianni V, Polychronopoulou A, Papagiannouli L. Primary teeth caries removal using the Carisolv chemomechanical method: a clinical trial. *Journal of Pediatric Dentistry*. 2004 ; **26**: 23-28.

24. Fure S, Lingström P, Birkhed D. Evaluation of Carisolv

for the chemo-mechanical removal of primary root caries in vivo. *Caries Research*. 2000; **34**: 275-280.

25. Carrillo CM, Tanaka MH, Cesar MF, Camargo MA, Juliano Y, Novo NF. Use of papain gel in disabled patients. *Journal of*

*Dentistry for Children (Chicago)*. 2008; **75**: 222-228.

26. Rafique S, Fiske J, Banerjee A. Clinical trial of an air-abrasion/chemomechanical operative procedure for the restorative treatment of dental patients. *Caries Research*. 2003; **37**: 360-364.