

Comparative Clinical Evaluation of Caries Removal Using Mechanical Method (AIR-ROTAR) and Chemo Mechanical Method (CARIE-CARE™) In Primary Teeth: An In Vivo Study

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Abstract

Introduction: This in vivo study was designed to clinically evaluate & compare chemomechanical caries removal using Carie-Care™ (papain gel based chemomechanical caries removal agent) with mechanical method of caries excavation using air rotor at high-speed in cavitated primary molars. This split mouth clinical study was carried out involving 30 children (60 teeth), aged 5 to 10 years, having minimum of 2 contra lateral occlusally carious (cavitated) primary molars. Each tooth was randomly allocated to either Group 1 (Mechanical method using air rotor at high-speed) or Group 2 (Chemomechanical caries removal method using Carie-Care™) depending upon the method of caries excavation. Following clinical parameters were evaluated in this study: Efficacy of caries removal, Efficiency of caries removal (time taken), Pain severity & Patient's preference.

Result: Higher caries removal efficacy was observed with mechanical method using air rotor (mean=0.17) than CMCR method using Carie-Care™ (mean=0.83). Time taken for caries removal was longer with CMCR method using Carie-Care™ (mean=9.744 minutes) than Mechanical method using air rotor (mean=3.535 minutes). Pain severity experienced was higher with mechanical method (mean=2.27) than CMCR method (mean=4.13). CMCR method was more preferred method than mechanical method by children.

Conclusion: Carie-Care™ can be used as a proficient minimal invasive treatment option in children for the removal of occlusal dentinal caries in primary molars as it appeared to be less painful and more preferred by children even though the time taken is longer than air rotor.

Keywords: Carie care, caries removal, efficacy, pain assessment

INTRODUCTION

In 1891, G. V. Black proposed his principle "extension for prevention" in the operative dental treatments of carious lesions¹. The principle insisted on the removal of the anatomical form and sound tooth structure at sites that might increase plaque

retention to help in an attempt to minimize the caries incidence. Conventional excavation techniques with low and high speed have been proven to cause noise, pressure, thermal and vibratory stimuli which are painful and in most of the cases, anesthesia has to be

used²⁻⁴. Other disadvantages include removal of both infected and non-infected dentin which may cause an unnecessary weakness of the tooth structure and also increase the possibilities of damaging pulp.

With development of the newer adhesive restorative materials and the alternative approaches of caries removal, the demand of removing sound tooth structure has been dramatically reduced⁶⁻⁷. Chemo mechanical removal of caries has emerged as an alternative to the conventional methods of removing caries which is based on the philosophy of Minimal Intervention Dentistry⁸. Chemo mechanical caries removal consists of application of a chemical to soften carious dentin followed by its removal with the use of hand instruments such as spoon excavators⁹. Chemo mechanical caries removal (CMCR) is a minimal invasive technique, which eliminates infected tissues, preserves healthy tooth structures and avoids pulp irritation and exposure, thus causing less discomfort and pain to patient¹⁰.

The idea of chemo-mechanical caries removal was developed in 1970s by Goldman while using sodium hypochlorite (NaOCl) for removal organic debris in the root canals¹¹. NaOCl was diluted and buffered forming a solution of 0.05% N-monochloroglycine (NMG) solution which was commercially available as GK101¹¹. According to Kurosaki et al (1977), GK 101 could soften only the first layer of carious dentin, and could not affect the second layer¹². GK101 system was further modified into N-monochloro-D-2 aminobutyrate (NMAB) and marketed as "Caridex"¹¹. CaridexTM had certain clinical limitations- (i) it was expensive, (ii) it required a large reservoir with pump, (iii) it required large quantities of solution (200-500ml), (iv) lengthy procedural time (10- 15min) and (v) it had a short shelf life⁹. CarisolvTM was introduced to the European market in 1997 as a successor to the CaridexTM system⁹. Carisolv contained three amino acids (glutamic acid, leucine and lysine), sodium hydroxide and sodium hypochlorite¹². Regardless of its effectiveness, CarisolvTM was not a popular and commonly used agent in dentistry mainly because it required (i) extensive training and registration of professionals for its use and (ii) requirement of customized instruments

which increased the total expenditure⁹. Other disadvantages were its slowness of action and the unpleasant taste¹². Recently since 2003, papacarie was introduced in the market as a chemo mechanical caries removal agent in Brazil. Its main components are papain, chloramine and toluidine blue¹². Papain is an enzyme which acts selectively on carious tissue which lacks the protease inhibitor alpha-1-antitrypsin¹³.

Carie-CareTM is a more recent, minimally invasive and papain gel based indigenous agent for chemo-mechanical caries removal. It is more economical than Papacarie and Carisolv^{14,15}. It contains most of the ingredients from natural sources. Carie-CareTM contains essential oil which gives extra benefit of anti-inflammatory, analgesic activity and aroma¹⁶. This warrants research to clinically compare the chemo mechanical caries removal using Carie-CareTM with mechanical method of caries excavation using air rotor at high-speed in cavitated primary molars.

MATERIAL AND METHODS:

This clinical comparative study was carried out in the Department of Pediatric and Preventive Dentistry. A total of 30 children, aged 5 to 10 years were included in this study.

The study protocol was approved by the local research and ethical committee. Patient's parents/guardians were explained in detail about the study procedure. Informed consent was obtained from each parent/guardian before including patient in the study. This split mouth clinical study was conducted in 30 children, aged 5 to 10 years, having minimum of 2 contralateral occlusally carious (cavitated) primary molars. The cavity was wiped with moistened cotton pellet to remove any debris. A pre- treatment clinical examination was done. The greatest diameter of the entrance size of the carious lesion was estimated with a caliper. Preoperative diagnostic intraoral periapical radiographs were taken (Bisecting angle technique). All the treatment was carried out by the same trained operator. Two independent investigators were present during this study. The first investigator performed randomization whenever it was necessary. The second

investigator evaluated efficacy of caries removal, efficiency of caries removal, pain severity and patient's preference.

Instruments and materials:-

1. Mouth Mirror, Explorer, Probe, Tweezer
2. Rubber dam kit (Hygenic Dental Dam-Coltene Whaledent)
3. Dental floss (Colgate)
4. Intra oral periapical films (Kodak INSIGHT Size 0) and X ray film holder
5. Topical local anesthetic gel (Precaine BTM containing benzocaine 20% in a flavored aqueous base)
6. Iwanson spring caliper (OracraftTM)
7. Carie-CareTM Gel (Papain Gel based Chemo mechanical caries removal agent)
8. Air rotor: high speed handpiece (NSK Pana Air Σ S)
9. Spoon excavator (Hu-friedyTM number 17)
10. Diamond bur (BR-45 MANITM, ISO no 001/010)
11. Digital stopwatch (Taksun)
12. Propylene glycol-based caries detector dye (SNOOPTM)

Inclusion criteria:

1. Clinical criteria
 - a. Children having minimum of two contralateral occlusally cavitated carious primary molars not involving pulp (Figure1) with having approximately equal-sized cavity openings (diameter $\geq 1.5\text{mm}$)
 - b. No clinical signs and symptoms of pulpal and periapical pathology associated with the teeth.
 - c. Patients exhibiting definitely positive and positive behavior as judged by the Frankl's behavior rating scale.
2. Radiographic criteria
 - a. Carious lesion involving $< 1/2$ of dentin thickness with approximately equal depth when compared with caries in contralateral molar.

- b. No pulpal involvement.
- c. Absence of periapical and inter-radicular pathology.
- d. Absence of pulpal pathology like internal resorption, pulp stones etc.

3. Exclusion criteria:
 4. Medically compromised, mentally challenged, systemically ill children
 5. Deep caries approaching pulp.
 6. Presence or history of swelling/draining sinus associated with the teeth.
 7. History of spontaneous or provoked pain associated with the teeth.
 8. Discoloration of tooth due to other reasons than caries
 9. Molars with extensive radicular resorption and mobility
 10. Tooth with proximal carious lesion
- Procedure methodology:

In case of a patient with more than 2 molars meeting the inclusion criteria, randomization was done to select only 2 molars. Each tooth was randomly allocated to either Group I (Mechanical caries removal method using air rotor at high-speed) or Group II (Chemo mechanical caries removal method using Carie-CareTM). Randomization was done to decide sequence of the procedure. Both the treatments were carried out in the same appointment. Both the treatments were carried out under rubber dam isolation after application of topical anesthesia (Precaine BTM gel) to the adjacent gingiva.

Procedure for Group I-

Air rotor (NSK) with diamond round bur (MANI INC Number 45) at high speed with water coolant was used to remove caries (Figure 2). The prepared cavity was verified as being caries-free on the basis of clinical criteria by another (second) independent co-investigator who was blinded to the method of caries removal. The cavity was checked using a dental explorer for normal hardness feeling of dentin. It should not stick in dentin. It should not give a "tug back" sensation. It must be stain free. If carious dentin remained, the procedure was repeated till the cavity was caries free based on the clinical criteria.

Procedure for Group II-

Access to the carious lesion was improved by removing unsupported and carious enamel using air rotor with diamond round bur (MANI INC Number 45). Carie-Care™ gel was applied directly on the carious lesion (Figure 3) and it was left undisturbed for about 60 seconds. The gel was removed with a moistened cotton pellet and softened caries was removed gently using a spoon excavator (Figure 4).

The prepared cavity was verified as being caries-free on the basis of clinical criteria by an independent co-investigator who was blinded to the method of caries removal. If carious dentin remained, additional gel was applied and the procedure was repeated till the cavity was caries free based on the clinical criteria. Finally, the margin of the lesion and unsupported enamel was adjusted (if necessary) using air rotor with diamond round bur (MANI INC Number 45).

Following parameters were evaluated.

Efficacy of caries removal:-

After the caries removal, propylene glycol-based caries detecting dye (SNOOPTM) was applied on the cavity for 10 seconds. Washing was done with water and the cavity was dried. The efficacy was evaluated using Ericson D et al. scale (1999) by the second independent co-investigator.

Ericson D et al. scale (1999) Score Definition

0 Caries removed completely

1 Caries present in base of the cavity

2 Caries present in base and/or one wall

3 Caries present in base and/or two walls

4 Caries present in base and/or more than two walls

5 Caries present in bases, walls & margins of the cavity.

The Caries removal efficiency (Time Taken):- The caries removal time for each technique was evaluated using a digital stopwatch (Taksun). For the group I (Air rotor group) (Mechanical group), the time was noted from the beginning of caries removal with bur until it was free from caries based on the clinical

criteria. For the group II (Carie-Care™ group) (Chemomechanical group), the time taken from the initiation of gel application until the end of the caries removal procedure was noted. Time required for improving the access to the lesion with air rotor and adjustment of margins was also included. Time was noted in seconds and it was converted into minutes.

Pain severity and patient's preference:-

1. After completion of caries removal in each tooth, patient was asked about pain experienced during each caries removal procedure using Wong-Baker faces pain rating scale. The patient was asked to choose the face that best describes his/her own pain.
2. The patient was asked about which treatment he or she preferred.

The stained remaining caries was excavated by continuing the same method of caries removal till the cavity showed no staining after application of caries detector dye. Then all the teeth were restored with type IX Glass ionomer cement (GC Fuji).

Data were collected and statistically analyzed using EPI Info 2007 software. The descriptive data was described using frequency, percentage and means. Mean values of remaining caries (for determination of caries removal efficacy), caries removal time (for determination of caries removal efficiency) and pain severity scores were calculated and compared for statistical significance using "unpaired t test". P-value <0.05 was considered to be statistically significant.

RESULT:

The study was conducted on 30 children comprising of 13 males and 17 females aged 7.1years±1.5165 with minimum age 5 years and maximum age 10 years.

Table 1 indicates frequency and percentage of preferences for caries removal methods. 26.7% (n=8) patients preferred mechanical method (air rotor) while 73.3% (n=22) patients preferred chemomechanical method (Carie-Care™).

Table 2 illustrates the comparison of mean values of remaining caries (Ericson D et al scale) for determination of caries removal efficacy in group I

and group II. On comparing the mean values of remaining caries, it can be noted that highest efficacy was seen in group I (mean=0.17) while least in group II (mean=0.83). There was a highly significant difference ($P<0.01$) in efficacy of caries removal in group I and group II. Hence mechanical method (air rotor) was more efficacious than chemomechanical method (Carie-CareTM).

Table 3 depicts the mean time required for caries removal in group I and group II. The mean time \pm standard deviation for caries removal in group I was 3.535 ± 0.7117 minutes (212.13 ± 42.704 seconds) whereas the mean time for the caries removal in group II was 9.744 ± 2.0309 minutes (584.67 ± 121.852 seconds). There was a highly significant difference ($P<0.01$) in time required for caries removal in group I and group II. Hence mechanical method (air rotor) was more efficient than chemomechanical method (Carie-CareTM) for caries removal.

Table 4 shows the mean rank for pain severity based on Wong Baker faces pain rating scale in group I and group II. On comparing the pain scores in group I and group II, a highly significant difference was noted ($P<0.01$) with minimum mean pain score in group II (mean=2.27) followed by group I (mean=4.13). Pain severity was more with mechanical method (air rotor) than chemomechanical method (Carie-CareTM).

DISCUSSION:

There are a number of techniques available for caries excavation as following¹⁷

1. Mechanical non rotary method using hand instruments Mechanical rotary method
2. Air abrasion
3. Ultrasonics and sonic abrasion
4. Photoablation-LASER
5. Chemomechanical caries removal:- Sodium Hypochlorite, GK-101(N-monochloroglycine), GK-101E (N-monochloro-D-2 aminobutyrate) (CaridexTM), CarisolvTM, PapacarieTM, Carie-CareTM

However, because of lack of literature on Carie-CareTM, this study was conducted to evaluate and

compare the chemo mechanical caries removal using Carie-CareTM with mechanical method of caries excavation using air rotor in cavitated primary molars.

The study showed mean score of remaining caries with air rotor (0.17) was less than Carie-CareTM (0.83). Air rotor showed higher caries removal efficacy than Carie-CareTM gel. Affected dentin which should be preserved is usually removed by air rotor. This excess removal is due to lack of tactile sense and its high cutting speed¹⁸. Kumar KS et al (2016)¹⁹ observed

1.05 mean caries removal efficacy in clinical settings while 0.90 mean efficacy in community-based settings using Carie-CareTM method and Ericson D et al criterion. The results are in accordance with the present study. A study conducted by Hegde RJ et al (2016)²⁰ also showed similar results for caries removal efficacy using Carie-CareTM. They found higher caries removal efficacy with mechanical method than CMCR method. Rajakumar S et al (2013)²¹ observed highest efficacy with air rotor followed by Carie-Care and hand excavation. Peters MC et al (2006)²² stated that clinicians should not expect complete caries removal while using CMCR. However increased patient comfort may make CMCR useful in minimal invasive treatment. Remaining caries can be sealed under quality restoration thus deprivation of fermentable carbohydrates from bacteria leads to inactivation of carious progression.

In the present study time taken for caries removal was longer with CMCR method using Carie-CareTM (mean=9.744 minutes) than Mechanical method using air rotor (mean=3.535 minutes). Hegde RJ et al (2016)²⁰ observed that mean time taken by air rotor was 3.63 ± 1.86 minutes while carie-care took 10.56 ± 3.94 minutes. Venkataraghavan K et al (2013)¹⁶ noted higher mean time required for caries excavation with Carie-CareTM (10.5 minutes) than caries excavation with drilling (5.9 minutes). The more time taken by CMCR method can be because of repeated applications required for Carie-CareTM gel. Moreover, its action of caries softening requires 60 seconds after each application²³. In a study conducted by Kumar KS et al (2016)¹⁹ found that mean time taken by Carie-CareTM in clinical based

settings and community-based settings was 7 minutes and 6.67 minutes respectively. Hegde AM et al (2014)²⁴ found average time taken for CMCR with Carie-Care™ was 7 minutes while for mechanical method it was 4.9 minutes in the primary teeth. Konde S et al (2011)²⁵ found contradictory result that the time taken for treating primary molars with papacarie was significantly less as compared to the conventional method (air rotor handpiece with a straight fissure bur SF-41). Behavior tends to deteriorate in a time dependent manner. Maintaining a balance between treatment duration and efficient behavior is of vital importance in dental practice for children²³. Interestingly, Geetha Priya et al (2014)¹⁰ stated that the operative time with CMCR method did not adversely affect the behavioral responses of children.

In the present study mean pain scores in mechanical and CMCR group showed a highly significant difference ($P < 0.01$) with lower mean pain score in the CMCR group (mean=2.27) followed by the mechanical group (mean=4.13). Anusavice and kincheloe (1987)²⁶ stated that excavation of decayed dentin causes less or no pain while cutting sound dentin commonly results in pain. Less pain with Carie-Care™ may be attributed to preservation of sound dentin, selective removal of infected dentin and also to the presence of clove oil which has analgesic, anti-inflammatory properties²¹. A study was conducted by Pathivada L et al (2016)²⁷ using Carie-Care™, Carisolv and air rotor on permanent molars. They concluded that CMCR methods are less painful than air rotor. Hegde RJ et al (2016)²⁰ found similar result regarding pain during caries excavation. The mean pain scores of air rotor and Carie-Care were 30.18 ± 18.43 and 5.50 ± 4.16 respectively. Rajakumar S et al (2013)²¹ and Venkataraghavan K et al (2013)¹⁶ stated that pain and discomfort was higher with air rotor followed by Carie-Care™. Kumar KS et al (2016)¹⁹ found mean pain score using Carie-Care™ (1.9) was the least followed by ART (2.3) and polymer burs (3.4).

In the present study 26.7% (n=8) patients preferred mechanical method (air rotor) while 73.3% (n=22) patients preferred chemo-mechanical method (Carie-Care™). Reasons for preferring CMCR can be

because of less noise, no drilling, no vibrations and less pain experienced. Reasons for preferring air rotor by children can be attributed to its rapid action and no sight like fearful Carie-Care™ gel syringe. Lozano-Chourio MA et al (2006)²⁸ found that 71% patients preferred Carisolv method over air rotor method. Bergmann J et al (2005)²⁹ found that 65% percent patients in their study chose CMCR (Carisolv) method and no one chose drilling. 13% patients did not mind either. 22% children could not state their preferences. Hegde S et al (2016)²³ in their study reported that 48% children preferred Papacarie, 26% preferred Carisolv and 24% preferred rotary excavation. Maragakis et al (2001)³ in their study reported contradictory results compared to our study. 31.25% children preferred Carisolv while 68.75% children preferred the air rotor, because 'it was quicker', 'there was no bad taste', or 'they finished sooner'.

CONCLUSION:

Carie-Care™ can be used for the removal of occlusal dentinal caries in cavitated primary molars in children as it appeared to be less painful, even though the time taken was longer than air rotor. Due to the limitations of Carie-Care™ such as longer treatment time and unable to adjust enamel margins; it can't replace air rotor in routine practice but it can be used as a proficient option in children as it causes less pain and preserves affected dentin with sufficient removal of infected dentin for minimal invasive treatment of carious dentin.

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Figures



Figure 3: Application of Carie-Care™ gel (Group II)

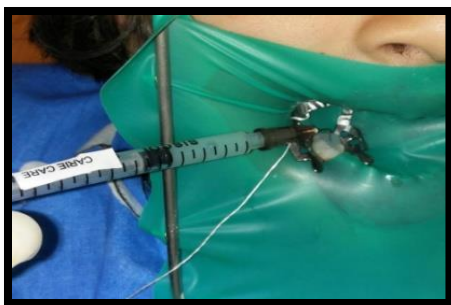


Figure 4: Caries excavation using spoon excavator (Group II)



Table 1- Comparison of frequency and percentage of preferences for caries removal methods

Preference	Frequency	Percentage
Group I (Air rotor)	8	26.7
Group II (CMCR)	22	73.3
Total	30	100

Table 2- Comparison of mean values of remaining caries (Ericson D et al scale) for assessment of caries removal efficacy

Groups	Number of samples	Mean	Standard deviation	Standard error mean	P value
Group I	30	0.17	0.379	0.069	<0.01**
Group II	30	0.83	0.874	0.160	

****Highly significant**

Table 3- Comparison of mean time taken (in minutes)

Groups	Number of samples	Mean	Standard deviation	Standard error mean	P value
Group I	30	3.535	0.71175	0.12995	<0.01**
Group II	30	9.744	2.0309	0.3708	

****Highly significant****Table 4- Comparison of mean pain scores**

Groups	Number of samples	Mean	Standard deviation	Standard error mean	P value
Group I	30	4.13	1.479	.270	<0.01**
Group II	30	2.27	1.639	.299	

****Highly significant**