**Stop Drill, Make a Change: An *In Vivo* Study**

**Mehak Dogra**, Monika P Gupta, Tasneem Sheikh, Huidrom Nirmala, Ashanka Bhardwaj, Apa Juntavee

**ABSTRACT**

**Background:** The chemomechanical method of caries removal is a modality that is non-invasive, cost-effective, and if some caries preventive measures could be added to them, then it might render the remaining dentin more resistant to future caries attacks also. Thereby, this study is conducted to evaluate the *in vivo* aspect of newly developed “one man army material—Apacaries gel”.

**Aim and objective:** To evaluate and compare the antimicrobial efficacy, efficiency, and pain perception of a chemomechanical caries removal agent (Apacaries gel) with a conventional method.

**Design:** Twenty children (aged 6–12 years) with bilateral occlusal caries making a sample size of 40 were included in the study. Group I: caries removal using rotary instruments and Group II: caries removal using Apacaries gel (*n* = 20 each). Caries removal time and pain perception were measured using a stopwatch and Wong–Baker Pain Scale. Dentin samples of both groups were taken before and after caries removal for microbiological analysis.

**Statistical analysis used:** The data were statistically analyzed using the Student’s *t*-test to compare the two groups.

**Results:** There was a non-significant difference in bacterial count while a significant difference was seen in time consumption and pain perception in both methods of caries removal.

**Conclusion:** Chemomechanical caries removal (Apacaries gel) can be an effective clinical alternative treatment for caries removal in children.

**Key messages:** It is the only *in vivo* study on “Apacaries gel—a one man army” which eliciting the unique property of prevention of dental caries.

**Keywords:** Apacaries gel, Antimicrobial efficacy, Chemomechanical caries removal agent.

*International Journal of Clinical Pediatric Dentistry* (2021): 10.5005/jp-journals-10005-1945

---

**INTRODUCTION**

In dentistry, dental caries is the most common oral condition whose eradication is essential for the welfare of children. The caries removal by drilling causes pain and discomfort which eventually induces fear and anxiety acting as barriers to treatment. Moreover, drilling causes rapid and excessive removal of tooth structure along with harmful thermal and pressure effects to the pulp which brings us to a more gentle, comfortable, and conservative caries excavation method, i.e., chemomechanical caries removal method. This method provides minimal thermal changes, less vibration, and pain, along with the removal of infected dentin only.

Chemomechanical agents for dental caries removal have developed, starting with the use of 5% sodium hypochlorite (NaOCl), by Habib et al. till Papacaries including GK-101 by Goldman et al. (1972), Caridex approved by FDI in USA (1984), “Carisolv” by Swedish researchers, “Papacarie®” developed in Brazil by Bassadori et al. and Carie—in India. Besides various advantages, they have some disadvantages too like less shelf life, generally used on large extensive carious lesions, and no adequate preventive properties.

Thus, brings us to a novel chemomechanical caries removal agent, i.e., Apacaries gel introduced in 2012, by Apa Juntavee. It is composed of polyphenol in mangosteen extracts and papain, mixed in a gel preparation and named Apacaries gel. Along with the various advantages of chemomechanical agent it also has the added advantage of being preventive which makes the remaining affected dentin more resistant to future caries attacks.

There is no *in vivo* study reported using Apacaries gel to date. Hence, the present *in vivo* study aimed to evaluate and compare the antimicrobial efficacy, efficiency, and pain perception of chemomechanical caries removal agent (Apacaries gel) with a conventional method.

---

**MATERIALS AND METHODS**

A randomized clinical trial was conducted in the dental clinic involving two contralateral cavitated molars making the sample size of 40. The occlusal caries of comparable depths (<1.5–2 mm measured with a WHO Periodontal probe) and equal-sized cavity openings (diameter 1.5–2 mm measured with a metallic caliper) with brown and softened dentin were included in the study. Parents/guardians responsible for each child were fully informed about the present study, and a consent form authorizing their child’s participation in the study was taken.

Total 40 contralateral molars were divided equally for the conventional and chemomechanical methods of caries removal. In each child, one tooth was randomly selected to be treated with Apacaries gel (chemomechanical agent) and the other with the conventional method of caries removal. Both methods of caries removal were carried out under rubber dam isolation (Fig. 1).
Division of Samples
The carious teeth were called “samples” and were randomly divided into two groups as follows:

Group I: Caries Removal by Conventional Method of Caries Removal (Fig. 2)
Caries removal was done using a sterile No. 16 straight bur on a contra-angle micromotor handpiece at slow and intermittent speed, without water spray. The local anesthesia was not used to maintain the same environment for evaluating the pain perception. But it was taken care of wherever the patient is not being able to sustain the procedure due to anxiety and low pain threshold, there, LA was administrated, but those cases were not included in the study. The caries removal was evaluated according to Erikson’s criteria by the dental explorer.

Group II: Caries Removal by Chemomechanical Method (Fig. 3)
Caries removal was done using Apacaries gel. The Apacaries gel was removed from the refrigerator 30 minutes before treatment to thaw as per the manufacturer’s instructions. The gel was applied into the cavity and left for 30 to 40 seconds and the softened dentin tissue was removed using the excavator in a pendulum motion without pressure. The remaining gel was removed with a cotton pellet soaked in saline. This procedure was repeated as many times as necessary until the gel stopped changing its color.

Microbial Cultivation and Evaluation
A microbiological evaluation was done preoperatively and postoperatively for each sample. The preoperative sample from the superficial carious lesion was collected and stored in a sterile vial containing 10 mL of normal saline with the help of a sterile spoon excavator. The postoperative sample was then taken from the same cavity floor similarly (Figs 4 to 7).

Thereafter, the dentin samples of both groups were processed in the microbiological laboratory within 1 hour of collection. A sterile loop full of caries sample was collected from the vial and cultured in MacConkey agar medium under aseptic condition. The plates were incubated at 37°C for 48 hours. Post-incubation, the plates were evaluated for microbial growth under the light microscope (Figs 8 and 9).

Time Consumption
The preparation time for each caries-removal technique was recorded from the beginning of caries removal until the complete removal using a stopwatch in both methods.
Stop Drill, Make a Change: An In Vivo Study

International Journal of Clinical Pediatric Dentistry, Volume 14 Issue 2 (March–April 2021)

Pain Perception
After the complete caries removal, the Wong-Baker Faces Pain Scale was used to evaluate the pain perception of the child during the procedure in both the methods, and accordingly the pain scores were given.

Data were analyzed statistically using the t-test for time, pain assessment, and microbiological evaluation at 0.05 level of significance.

Results
In the present study, 40 molars obtained from the 20 children who were included in the study were evaluated in terms of microbiological assessment, time taken for caries removal and pain response while using both conventional and chemomechanical methods of caries removal.

Microbial Count (Fig. 10)
Table 1 shows the total viable bacterial count before and after caries removal. The mean reduction percentage of total viable count in the conventional method was 75.92 ± 2.49 when compared with 61.85 ± 8.31 in the chemomechanical method of caries removal. But, the difference was statistically non-significant (p > 0.05).

Time Consumption (Fig. 11)
Table 2 shows that the mean time required for caries removal with the chemomechanical method (4.64 ± 1.00 seconds) is statistically
Stop Drill, Make a Change: An In Vivo Study

Table 1: Comparison of means of percentage reduction of bacterial count in conventional and CMCR (Apacaries gel) t-test for two independent groups

| Variable         | N  | Mean ± Std. deviation | t value | d.f. | p value |
|------------------|----|-----------------------|---------|------|---------|
| % Reduction conventional | 20 | 75.928 ± 2.4971       | 2.109   | 12   | 0.057** |
| % Reduction CMCR   | 20 | 61.857 ± 8.3164       |         |      |         |

**Distribution non-significantly different from baseline, p < 0.01, t paired test

Table 2: Distribution of means ± SD of time taken in conventional and CMCR (Apacaries gel)

| Group            | N  | Mean ± Std. deviation | Std. error mean | p value |
|------------------|----|-----------------------|-----------------|---------|
| Time taken       |    |                       |                 |         |
| Conventional     | 20 | 1.5229 ± 0.35799      | 0.13531         | 0.000*  |
| CMCR             | 20 | 4.6414 ± 1.00285      | 0.37904         |         |

*Distribution non-significantly different from baseline, p < 0.01, t paired test

Table 3: Pain perception in conventional and CMCR (Apacaries gel)

| Group    | Grade |
|----------|-------|
| Pain perception | Conventional | II |
|           | CMCR   | I   |

more when compared with the conventional method of caries removal (1.52 ± 0.35 seconds) (p < 0.05).

Pain Perception

Table 3 shows that the mean value of pain score while using the Wong-Baker Faces Pain Scale was significantly higher for the conventional method when compared with the chemomechanical method of caries removal (p < 0.05).

Discussion

The conventional treatment for caries removal is fearful and anxiety-inducing among many patients due to high-pitched noise, vibration leading to rotary instruments.

Thus, there arose a need to shift toward the more trusted alternative, i.e., chemomechanical caries removal method which not only removes infected tissues but also preserves the healthy dental structure, avoiding pulp irritation and patient discomfort.

Various chemomechanical agents like carie care, carisolv, papacaries, etc., were used since antiquity but no literature was evident in accordance to imparting any preventive effect. Thus, brings us to the newly introduced chemomechanical caries removal agent Apacaries gel. It was introduced by Apa Juntavee at Khon Kaen University, Thailand, in the year 2012.

Apacaries gel was composed of polyphenol in mangosteen extracts and papain, mixed in a gel preparation. The mangosteen extract was obtained by mangosteen pericarp powder which mainly consists of α-mangostin component and Garcinia mangostana L which—a potent inhibitor of acid production by S. mutans. These components were active against membrane enzymes, including F(H+)-ATPase and the phosphoenolpyruvate sugar phosphotransferase system, and also inhibited the glycolytic enzymes aldolase, glyceraldehyde-3-phosphate dehydrogenase, and lactic dehydrogenase. Other targets of α-mangostin included inhibition of malolactic fermentation by S. mutans by increasing alkali production from malate to neutralizes the acid production of S. mutans and inhibits NADH oxidase (major respiratory enzyme in S. mutans). The mangosteen is also anti-inflammatory, anti-histamine, anti-oxidant, anti-bacterial.

The papain can cleave the bonds of the amino acids of gram-negative bacteria and, result in perturbing the membrane permeability. Singh et al. stated that papain is bactericidal and bacteriostatic properties which inhibit the growth of gram-positive and gram-negative organisms.

Thereby conjointly, both papain and mangosteen extract have a synergistic effect on removing as well as inhibiting further progress of caries and leaving the remaining affected dentin more resistant to further caries attack. Papain present removes the infected dentin followed by the reduction in S. mutans due to the inhibitory effect of mangosteen extract. Juntavee et al. also stated the inhibition zone of mangosteen extract and papain mixture in gel preparation was larger than the zones for the separate components individually. So, Apacaries gel is a newly developed chemomechanical caries removal agent which is one of its own kind. An in vitro study for Apacaries gel shows that 1 mg/mL mangosteen extract mixed with papain in Apacaries gel can effectively inhibit S. mutans within 2 minutes.

In the present study, the efficacy was determined in terms of the total viable count for the complete caries removal. The efficiency was recorded based on the time consumption required along with the pain perception.

In the conventional method of caries removal, the mean percentage viable count (75.92) was comparable to the chemomechanical caries removal method (61.85). In the
conventional method, the affected dentin too had slight microbial invasion as it precedes infected dentin but without demineralization.1 Whereas, in the chemomechanical method of caries removal, the caries was removed by scraping with a spoon excavator which might be left some of the infected dentin behind where microbes were present more than affected dentin. Subramaniam et al. also conducted similar studies and obtain comparable microbial results.7

The time required for removal of caries by the chemomechanical caries removal method took an average of 4.6 seconds whereas the conventional method took only 1.52 seconds which is statistically significant. The result might be due to multiple applications of the gel as prolonged time was needed for excavation with a spoon excavator.8 This result was also in accordance with various studies conducted by Matsumoto et al. and Pandit et al. who also supported the more time consumption by various chemomechanical methods.9,10

In respect to pain perception, the chemomechanical method of caries removal showed a more comfortable and painless treatment option when compared with the conventional method. The main reason behind the difference may be that papain acts only on the dead infected cells leaving behind undamaged healthy tissues whereas in conventional the excessive cutting of healthy teeth along with noise and vibration induces pain and anxiety among children. Pandit et al. and Singh et al. also supported the splitting property of papain.1,10

**Conclusion**

Conventional and chemomechanical methods achieve similar results in terms of effectiveness. As both the methods were equally efficient but Apacaries gel is a minimally invasive method that is easy to apply, cost-effective, hassle-free along with preventive effects. Thus, the chemomechanical caries removal method can be recommended for patients seeking an alternative to conventional treatment and instill a positive behavior in children.

**References**

1. Singh S, Singh DJ, Jaidka S, et al. Comparative clinical evaluation of chemomechanical caries removal agent Papacarie® with conventional method among rural population in India - in vivo study. Braz J Oral Sci 2011;10(3):193–198. DOI: 10.1007/s12663-011-0189-x.
2. Anusavice KJ, Kincheloe JE. Comparison of pain associated with mechanical and chemomechanical removal of caries. J Dent Res 1987;66(11):1680–1683. DOI: 10.1177/0022034876066011501.
3. Juntavee A, Peerapattana J, Ratanathongkam A, et al. The antibacterial effects of apacaries gel on Streptococcus mutans - an in vitro study. Int J Clin Paediat Dentis 2014;7(2):77–81. DOI: 10.5005/jp-journals-10005-1241.
4. Arvidsson A, Liedberg B, Moller K, et al. Chemical and topographic analysis of dentine surfaces after Carisolv treatment. J Dentist 2002;30(2-3):67–75. DOI: 10.1016/s0300-5712(01)00051-3.
5. Dammashke T, Eickmeier M, Schafer E, et al. Effectiveness of carisolv with NaOCl and Ca(OH)2. Acta Odontolig Scandinav 2005;65(2):110–114. DOI: 10.1080/00016350510019810.
6. Juntavee A, Juntavee N, Peerapattana J, et al. Comparison of marginal microleakage of glass ionomer restorations in primary molars prepared by chemomechanical caries removal (CMCR), erbium:yttrium aluminium-garnet (Er:YAG) laser and atrumatic restorative technique (ART). Int J Clin Pediat Dentis 2013;6(2):75–79. DOI: 10.5005/jp-journals-10005-1193.
7. Subramaniam P, Gihotra K. Antimicrobial efficacy of an indigenously prepared caries removing gel. Contemp Clin Dentis 2011;1(1):13–16. DOI: 10.4103/0976-237X.79294.
8. Divya G, Prasad MG, Kumar AAV, et al. Evaluation of the efficacy of caries removal using polymer bur, stainless steel bur, carisolv, papacarie – an in vitro comparative study. J Clin Diagnos Res 2015;9(7):ZC42-ZC46. DOI: 10.7860/JCDR/2015/12705.6202.
9. Matsumoto SFB, Motta LJ, Alfaya TA, et al. Assessment of chemomechanical removal of carious lesions using Papacarie Duo™: randomized longitudinal clinical trial. Indian J Dent Res 2013;24(4):488–492. DOI: 10.4103/0970-9290.118393.
10. Pandit IK, Srivastava N, Gugnani N, et al. Various methods of caries removal in children: a comparative clinical study. J Indian Soc Pedod Prev Dent 2007(2):93–96. DOI: 10.4103/0970-4388.33456.