

Comparative Evaluation of the Efficiency and Effectiveness of Chemo-Mechanical Caries Removal Agent, Apacaries Gel with Conventional Method via Rotary Instrument

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ABSTRACT

Background: The recent scenario demands the eradication of dental caries which always remained challenging besides having ample treatment modalities like air-abrasion, ultrasonic instrumentation, laser and chemomechanical method. Chemomechanical method of caries removal being non-invasive, cost-effective always remains the choice of treatment but if some caries preventive measures could be added in them then it might become more resistant to future caries attack. Apacaries Gel is one such newly introduced material. Thus, this is an in vitro study to comparatively evaluate the efficiency and effectiveness of chemo-mechanical caries removal agent i.e., Apacaries Gel with conventional method via rotary instrument. 40 exfoliated deciduous molars with caries involving dentin upto varying degree were selected for the study for assessing the microhardness of remaining dentine. After removal of the caries with the respective methods, the efficacy and efficiency were evaluated by Vicker's Hardness Tester. Though complete removal of caries was achieved in both the methods with no-significant difference, but there was non-significant difference found between both the groups regarding remaining dentine microhardness. Thus, concluding that Apacaries Gel can be recommended as an efficient, easy to perform, comfortable, hasselfree and less destructive solution for the patient seeking an alternative to the conventional method especially in children.

Keywords: Dental caries, conventional rotary instrument, chemomechanical caries removal agent, Apacaries Gel.

INTRODUCTION

A "mindful practice" is the objective that continuously monitors and re-evaluates the results and the techniques over with the introspection. The human tooth which is a marvel of nature needs to be protected otherwise it will be lost mainly due to dental caries. Thus, dental caries is one of the common occurring oral conditions whose impedance is required for the welfare of mankind especially in children. As various methods were used since antiquity from the hand instruments to

recently introduce newly rotary instruments but still the removal of dental caries is a task. This may be due to various drawbacks like pain, annoying sounds, vibration etc, which eventually leads to fear and anxiety and act as barrier to the receipt of treatment and thus leads to further deterioration of teeth.¹ As a famous quote stated that "the beginning of ANXIETY is the end of faith, and the beginning of true faith is the end of ANXIETY". Thereby, instilling the positive behaviour in children should be the first step towards adentiphobic future.

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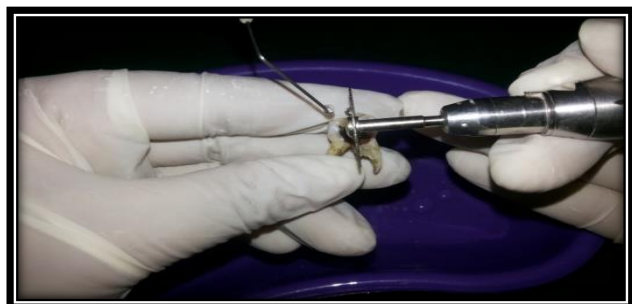


Fig 1: Mesio-distal sectioning of Samples.

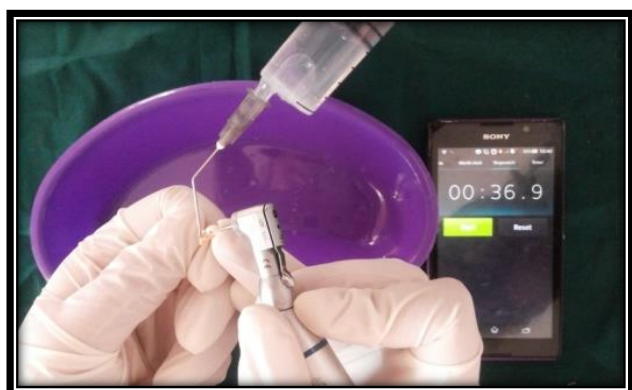


Fig 2: Caries removed by conventional method

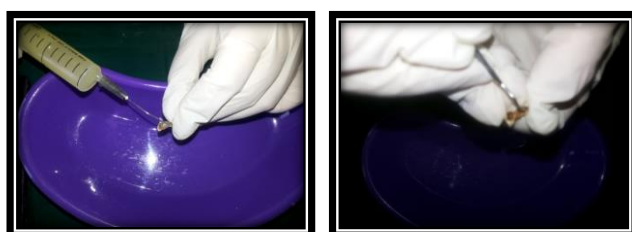


Fig 3: Caries removed by Apacaries Gel



Figure 4: Testing of samples by Digital Vickers Microhardness Tester

Thus, chemomechanical removal of caries has been developed as an alternative to overcome these lapses. These agents used for dental caries removal have been developed, starting with the use of 5% sodium hypochlorite (Naocl), by *Habib et al* followed by GK-101 or n-monochloroglycine by *Goldman et al* (1972), Caridex approved by FDI in 1984 in USA, "Carisolv" by Swedish researchers, "Papacarie®" developed in Brazil in 2003 by *Bassadori et al* ² and Carie-Care in India. Besides having various advantages, these chemomechanical agents also have several disadvantages less shelf life, generally used on large extensive carious lesions only leaving affected dentine and have no preventive properties.

Hence, it brings us to a novel chemomechanical caries removal agent i.e., Apacaries gel.⁴ Along with the various advantages of chemomechanical agent it also has the added advantage of being preventive which leaves the remaining affected dentine more resistant to future caries attack.

Therefore, the aim of the present study was to compare the efficiency and effectiveness of chemo-mechanical caries removal agent i.e., Apacaries Gel with conventional method via rotary instrument in terms of microhardness evaluation along with the time factor required for caries removal by both the methods.

MATERIALS AND METHODS

40 exfoliated deciduous molars with caries involving dentin upto varying degree were selected for the study. The stored teeth were autoclaved and cleaned using ultrasonic scaler to remove the debris. Sampled teeth were stored in 0.1% thymol solution at room temperature to avoid dehydration and further sectioned through the centre of the lesion mesio-distally by using rotating disk bur making the sample size of 80 [Figures 1]. These sampled teeth were further randomly divided into two groups i.e., Group A- The carious lesions were removed by conventional method & Group B- by chemomechanical caries removal method. (Table 1)

Removal of caries

Conventional method of caries removal

The one part of the carious lesion of each samples i.e., Group A was removed using round bur with slow and intermittent speed micromotor (Figure 2).

Chemo- mechanical caries removal method

Whereas the other half of carious tissue of samples i.e., Group B was removed by using Apacaries Gel (Figure 4). Before applying the gel, it was removed from the refrigerator half an hour before to thaw. It was applied with the help of an applicator tip on the carious lesion and left for 30-40 seconds. The time of application was measured by using stopwatch. The softened dentine was removed using the spoon excavator in a pendulum motion without applying pressure. The remaining gel was removed with cotton pellet soaked in saline. This procedure was repeated 1 to 4 times according to the extent and depth of caries.

The complete removal of caries by both the methods of caries removal was checked according to Erikson criteria {i.e., optical (colour) and tactile (hardness)}. The colour was checked visually and hardness of the lesion was checked by the dental explorer until a leather-hard texture and sharp scratching sound was heard. The preparation time for each caries removal technique was evaluated by using stopwatch (Figure 3).

Preparation of samples for measuring microhardness

Samples of both the groups (group A - caries removed by conventional method and B - caries removed by chemo-mechanical caries removal method) were smoothened sequentially with 400, 500 and 600 grit sandpapers. Standardized blocks were prepared by filling the plastic pipe of 15mm diameter with acrylic resin. Care was taken to mount the prepared samples on it before acrylic resin gets harden. The samples were mounted in such a way that the occlusal surface was exposed to external environment. These blocks were again smoothed sequentially with sandpaper of 400, 500 and 600 grit. The blocks were then stored in a container having distilled water with few crystals of thymol for maintaining hydration. (Figure 4)

Time assessment

The preparation time for each caries-removal technique in all the samples (n=40) was evaluated using a stopwatch. The total time taken for caries removal was calculated from the beginning of removing caries till its complete removal in seconds in both the methods.

RESULTS

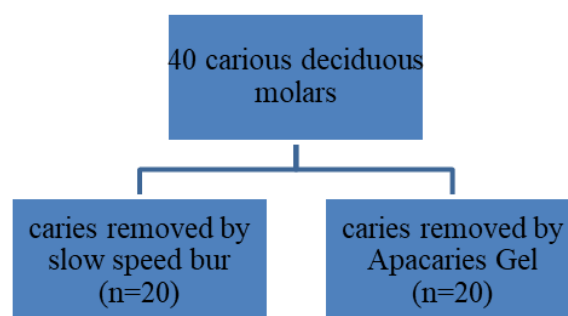


Table 1: Division of Sample.

Microhardness evaluation (Table 2)

Table 2 showed the mean values of microhardness in Group A (conventional method of caries removal) and Group B (chemo-mechanical method of caries removal). The mean value of microhardness was found to be 194.55 ± 6.41 for group A and 187.5 ± 6.10 for group B which was high in group A (conventional method of caries removal) followed by group B (chemo-mechanical method of caries removal). After applying Mann-Whitney test (or U-test), it was revealed that there was non-significant difference found between Group A and Group B with p value of 0.001.

Table 2: Mean values of microhardness in Group A and Group B

Group *	N	Mean	Std. Deviation	Mean Rank	Mann-Whitney U	p Value
A ₁	20	194.55	6.41	20.50	200.00	0.001**
A ₂	20	187.5	6.10	20.50		

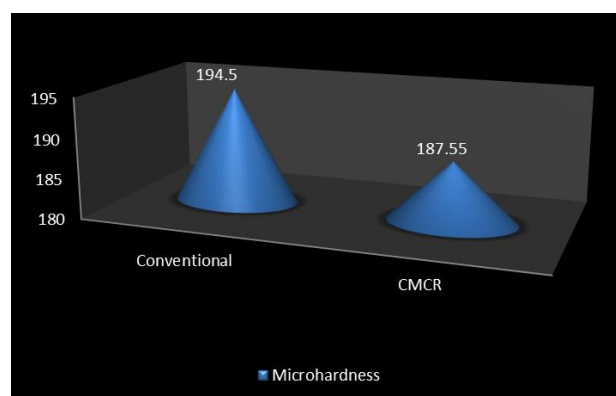
Time assessment (Table 3)

Table 3 showed that the mean value of time taken for caries removal was found to be 0.74 ± 0.27 minute for conventional method (Group A) and 1.85 ± 0.77 for chemo-mechanical method (Group B).

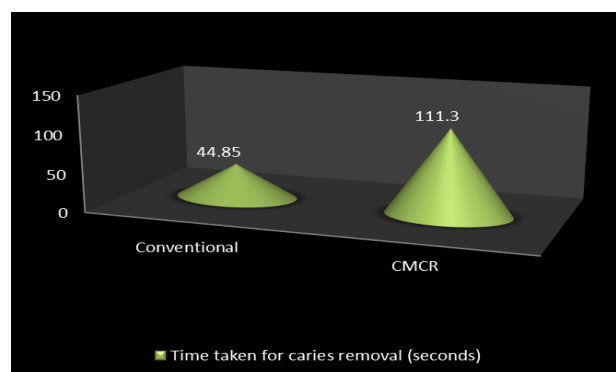
It was noted that time taken for caries removal was more in chemo-mechanical method (Group B) than conventional method (Group A) which was significant.

Table 3: Mean values of time taken for caries removal in conventional method (Group A) and by chemomechanical method (Group B)

Group *	N	Mean (in seconds)	Std. Deviation	Mean Rank	Mann-Whitney U	p Value
Group A	40	44.85	16.413	21.40	36.00	0.000*
Group B	40	111.3	46.559	59.60		



Graph 1: Graphical representation of mean of microhardness of both the groups.



Graph 2: Graphical representation of mean of time taken for caries removal of both the groups.

DISCUSSION

Fear and anxiety which are known barriers to the receptivity of dental treatments were the main rationale behind the advent of the chemomechanical caries removal agent. Since, the

emergence of the chemomechanical caries removal agent in 1975 by Habib *et al* there were enormous furtherance undergone to achieve the archetypal chemomechanical caries removal agent. Despites of the various chemomechanical agents like carie care, papacaries etc, no literature is found on the their preventive aspect.³ To overcome this flaw of chemomechanical caries removal agent- Apacaries Gel was introduced in 2012, by Apa Juntavee which is composed of polyphenol in mangosteen extracts and papain in a gel preparation and also has the added advantage of being preventive which makes the remaining affected dentine more resistant to future caries attack.⁴

The newly introduced "Apacaries gel" was composed of polyphenol in mangosteen extracts and papain in a gel preparation.⁴ The mangosteen extract was obtained by mangosteen pericarp powder which mainly consist of α -mangostin component and *Garcinia mangostana L* which -a potent inhibitor of acid production by *S. mutans*. These component 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*).^{4,5} 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. Dawkins et al stated that Papain is bactericidal and bacteriostatic properties¹ which inhibit the growth of gram positive and gram negative organism. Thereby conjointly, both Papain as well as mangosteen extract have synergistic effect on removing as well as inhibiting further progress of caries and leaving the remaining affected dentine more resistant to further caries attack. Papain present removes the infected dentine followed by the reduction in *S.mutans* due to the inhibitory effect of mangosteen extract. Apa Juntavee et al (2014) also stated the inhibition zone of

mangosteen extract and papain mixture in gel preparation was larger than the zones for the separate components individually.⁴ 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.⁵

A split-tooth methodology was used in the present study for standardization purposes which allows the comparisons to be made between different, paired excavation methods as stated by Magalhães CS et al⁶, Singh D J et al⁷. All samples were sectioned into two halves mesio-distally by using rotating disk bur in micromotor to avoid desiccation of the sample due to heat produced. Out of two samples obtained by splitting, the carious lesion of one sample was removed with conventional method using round bur with slow and intermittent speed micromotor whereas the other sample was prepared with chemomechanical method of the caries removal.

The caries removal was considered to be complete when the explorer did not stick in the dentin, and there was no 'tug-back' sensation. It was evaluated by checking its colour visually and hardness of the lesion by the dental explorer until a leather-hard texture and sharp scratching sound was heard. This was in accordance with Erikson criteria (1991). Similarly, studies done by **Magalhaes CS et al (2006), Qasim AS et al (2008), Jawa D et al (2010), Ramamoorthi S et al (2013)**, they also confirmed complete excavation of caries by Erikson criteria.^{6,7, 8, 10} Correa FNP, Filho LER, Rodrigues CRMD⁹ prepared standardized blocks which were smoothened sequentially with 400, 500 and 600 grit sandpapers for measuring the remaining dentine microhardness as flat surface was needed for accurate measurements. Vickers hardness tester was used as the square shape which was prepared by Vickers indenter is close to the outer surface and the DEJ.¹⁰

The time taken for caries removal was recorded using a stop watch in both conventional as well as chemomechanical method of caries removal. The time taken for complete caries removal was calculated, from the start of the procedure to the

completion of caries removal. There was non-significant difference between both the groups in remaining dentine microhardness. As in chemomechanical method there was selective removal of caries-infected dentine only, which has lower hardness values as compared to sound dentine. Whereas, in conventional method, some of the affected dentine was removed along with infected dentine which has higher hardness values as compared to infected dentine. But the percentage of this removal was minimal in the present study because there was a conscious and cautious effort made to remove the infected dentin only, leaving behind the affected dentine thereby resulting in comparable hardness in both the groups.⁶ The similar results was found in the study conducted by Correa FNP et al (2007), Qasim AS and Suliman AA (2008), Flückiger L(2008) and Jaya S et al (2011) who concluded that the hardness of the remaining dentin after carious tissue removal was lower than that obtained on healthy dentin, without significant difference between the different means of carious tissue removal. ^{10, 11, 12, 13}

The reason for lower hardness of the remaining dentin after carious tissue removal by chemomechanical method of caries removal is due to selective removal of caries-infected dentine only, leaving behind the caries-affected dentine, which has lower hardness values as compared to sound dentine. While using conventional method, some of the affected dentine removed along with infected dentine leading to appearance of sound dentine which has higher hardness values as compared to infected dentine. But the percentage of this removal was minimal in the present study because there was a conscious and cautious effort made to remove the infected dentin only, leaving behind the affected dentine thereby resulting in comparable hardness in both the groups.⁶

Whereas, in some studies reported by Hamama HH (2013) and Magalhães CS (2006) stated that there was significant difference between conventional and chemomechanical caries removal method. As stated by authors, this is due to incomplete removal of the caries during using chemomechanical agent. ^{6, 14} Chemomechanical method took significantly more time because of multiple applications of the gel for complete caries removal. Moreover, the extended time may be due

to prolonged time for excavation with spoon excavator.¹⁵

CONCLUSION

In the present study it can be concluded that the chemomechanical method of caries removal involving dentin in cavitated primary molars by means of Apacaries Gel was comparable to that of the conventional drilling method in terms of efficacy and efficiency. This shows that it could be a suitable non-invasive, economic, less painful, hasselfree alternative method for caries removal along with the preventive aspect of further resist the caries attack and has great potential for use in pediatric operative dentistry. We recommend further studies to authenticate these results.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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