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Comparative Evaluation of Caries Removal Efficacy Between Chemomechanical Agents & Conventional Methods Regarding Time Consumption: An in Vivo Study

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Abstract--Introduction: The use of minimally invasive procedures and attention to patient comfort are of great importance, especially for dental treatment in young children. This has led to the development of chemomechanical methods for caries removal. Aim: To evaluate and compare the efficacy in terms of time consumption between the chemomechanical caries removal agent Papacarie and conventional method of caries removal. Methods: Subjects for this study were chosen from the outpatients of the Dept of Pediatric & Preventive Dentistry, Karpaga Vinayaga Institute of Dental Sciences. Twenty five

children (age 6 -10 years) with bilateral frank cavitated lesions were included in this study. Bilateral primary teeth with comparable degrees of carious destruction were chosen in each child for caries removal with Papacarie and rotary instruments. The time taken for caries removal was measured using stopwatch. Results The time taken for caries removal in chemomechanical caries removal method was longer than the conventional method which was assessed using the student t test. Conclusions: Papacarie can be an effective clinical alternative treatment for the removal of occlusal dentinal caries in cavitated primary molars but requires longer time as compared to conventional method.

Keywords--caries removal, comparative evaluation, conventional methods, time consumption, young children.

Introduction

Dental caries is one of the most prevalent oral diseases, known since times immemorial. World Health Organization (WHO) defines dental caries as a 'localized posterupted pathological process of external origin, involving softening of hard tooth tissues and proceeding to the formation of a cavity'. Removal of caries through invasive techniques cause excessive loss of sound tooth structure while modern dentistry aims to preserve tooth structure using minimally invasive procedure ([Kumar et al., 2012](#)).

Caries excavation has traditionally been performed using rotary and sharp-edged hand instruments but it is difficult to establish the amount of dentin to be removed due to the lack of objective clinical markers., generation of heat, vibration, and noise and also mechanical preparation might induce pain and discomfort ([Pravin Maru et al., 2014](#)). To overcome these drawbacks, alternative methods have been proposed, including chemomechanical techniques, air abrasion, sono-abrasion, ultrasonic instrumentation and lasers.

The chemomechanical caries removal (CMCR) is a conservative caries excavation method that selectively removes infected carious dentin in a gentler, comfortable manner, with less pain, less vibration and minimal thermal changes. It facilitates delivery of atraumatic, bactericidal and bacteriostatic activity ([Diwakar, 2018](#)). It helps establish a positive response from children as it is the most acceptable behavior management method ([Diwakar, 2018](#)). Carisolv is the most studied and commonly used agent, while Papacarie could be a promising CMCR agent in the future.

Papacarie was introduced in 2003 as a biocompatible gel with conservative, antibacterial and atraumatic properties, which reduces the risk of pulp exposure ([Kumar et al., 2012](#)). This agent relies on the action of the proteolytic agents such as papain and sodium hypochlorite to further degrade the partially demineralized and altered dentinal matrix that has been previously exposed to bacterial action, thus facilitating its removal and preventing damage to the underlying remineralizable tissues ([Venkataraghavan et al., 2013](#)). Clinical efficiency or the

time factor may be crucial for acceptance of a treatment, especially in children and medically compromised patients.

Various in vivo and in vitro studies have been done using different CMCR agents namely, Carisolv, India but literature on the efficacy of chemomechanical caries removal using papain gel was not evaluated. Thus the need to evaluate Papacarie especially in young children arose. This study mainly aims in determining the time required for effective caries removal using Papacarie and the conventional rotary instruments.

Aim

To evaluate and compare the efficacy of chemomechanical caries removal agent (papain gel) with that of conventional method of caries removal in terms of time consumption.

Materials and Methods

The study was carried out in the Department of Pediatric & Preventive dentistry. It was carried out for a period of 8 months from 20.08.2019 to 20.06.2020., among the outpatients visiting the department. This study was started after getting clearance from the Institutional Ethical Committee. Children in the age group of 6 to 10 years were selected for the study. The child's parent/guardian was informed regarding the details of the study and a written consent was obtained authorizing their child's participation.

Inclusion criteria

- Children in the age group of 6-10 years were selected for the study.
- Bilateral carious lesions of permanent molars (3 -4mm in size) extending into dentine and not involving the pulp. (D3 of W.H.O. classification of carious lesions).
- Radiographic assessment of carious lesions extending into dentine.

Exclusion criteria

- Presence of proximal caries as observed in a bitewing radiograph.
- Teeth with clinical signs and symptoms of pulpitis and abscess.
- Teeth with pathologic mobility.

Bilateral carious lesions of the mandibular primary molars from 25 children in split mouth design in the age group of 6-10 years were selected and categorised into control and experimental groups for the study. Mandibular primary molars with frank cavitated lesions in the occlusal surface, having brown and softened dentine were chosen. The clinical assessment of caries was done using an explorer/radiographic assessment. In the control group, in the right side of the patient's mouth conventional method of caries removal was performed while in the left side of the same patient, CMCR was done.

Caries removal by the conventional method (Group A)

Conventional caries removal was carried out using a sterile No.16 straight bur at slow and intermittent speed, without water spray. The time for completion of the procedure was recorded using a stop watch. After caries removal, dentine was considered caries free, using clinical (optical and tactile) criteria.

Caries removal by chemomechanical method (Group B)

The chemomechanical agent used in this study was papacarie imported from formula and acao, Brazil. According to the manufacturer's instructions, the syringe containing chemomechanical agent was removed from the refrigerator 30 min before treatment. The gel was applied (0.05ml) with the help of an applicator tip into the cavity and left for 30-40s. The softened dentine tissue was removed using the excavator in a pendulum motion in a pressureless manner. The remaining gel was removed with cotton pellet soaked in saline. This procedure was repeated as many times as necessary, until the darkish color of the gel was revealed. The cavity was washed or rinsed between the gel applications. The cavities were considered caries-free when there was no change in the color of the gel. The time for completion of the procedure was recorded using a stop watch.

Results

In the present study, 50 primary molars obtained from 25 children aged 6 to 10 years were evaluated in terms of time spent for caries removal and microbiological assessment by mechanical and chemomechanical methods. The results of the following study were tabulated and analyzed as follows. Table 1 compares the time consumption of caries excavation by the conventional and chemomechanical method. The mean value of time taken for caries removal using both conventional & chemomechanical methods is shown in table 2. The time taken for caries excavation by mechanical method ranged between 321 to 508 seconds where as the time taken for carries removal by chemomechanical method varied between 521 to 708 seconds. The mean time required for caries removal with the chemomechanical method was 618.2s with standard deviation of 51.3 as shown in the table, while for conventional method it was 419.28s with standard deviation 52.3. The difference between them i.e. 198.92 seconds was statistically significant $p < 0.05$ (Table 2).

Discussion

Restorative dental treatment of carious teeth in children, which involves removal of caries with conventional drill, is associated with psychological trauma, mainly due to fear and anxiety in children and their parents (Ayer Jr et al., 1983). The aversion to noise of rotary instruments and anesthesia are the main factors for this situation. Most of the time, such factors not only delay the dental treatment but also lead to avoidance of dental treatment by children, resulting in the advancement of the caries process to emergency situations (Maru et al., 2014). Unfortunately, in these situations, the treatment becomes more complicated, making the use of anesthesia mandatory. On the other hand, in every field of dentistry, awareness toward the importance of reserving tooth tissue, combined

with a patient-friendly approach is becoming self-evident. It has been shown that operative dental treatment often leads to an increasing scale resulting in further operative and more invasive treatment. Wherever possible, tissue should be preserved and invasive treatment minimum (Maru et al., 2014).

CMCR is one such method that eliminates infected dentin via a chemical agent (Maru et al., 2014). This process not only removes infected tissue, but also preserves healthy tooth structure, avoiding pulpal irritation and patient discomfort. Instead of drilling, this method uses a chemical agent assisted by an atraumatic mechanical force to remove soft carious structure (Ganesh & Parikh, 2011). With newer materials getting introduced in CMCR, there is renewed interest in this procedure which selectively removes carious dentin and avoids the painful and unnecessary removal of sound dentin.

Papacarie is a gel containing papain and chloramine that is used in combination with manual tools for the minimally invasive removal of carious tissue (Motta et al., 2014). Papain, the main ingredient of Papacarie, is an enzyme similar to human pepsin, used in food technology and pharmaceutical and cosmetic industries (Jawa et al., 2010). This method eliminates the need for local anesthesia and the use of a bur, thereby reducing the destruction caused to sound dental tissue. Several studies have investigated the efficacy of this gel and have reported satisfactory results regarding the time required for the procedure, clinical follow-up, complaints of pain, patient acceptance and cost (Ayer Jr et al., 1983; Maru et al., 2014). Researchers have also tested the cytotoxicity of the substance at different concentrations in fibroblast cultures, demonstrating its safety for use in pediatric patients (Motta et al., 2014).

Flindt demonstrated that papain acts only in infected tissues because infected tissues lack plasmatic anti protease called AI anti trypsin (Guzman & DE GUZMAN, 1953), this is only present in sound tissues and it inhibit protein digestion (Udod & Storozhuk, 1981). The absence of AI antitrypsin enzyme in infected tissues allows papain to break the partially degraded molecules. Dawkins et al. showed that papain has bactericidal and bacteriostatic properties which inhibit the growth of gram positive and gram negative organism. In addition to papain, Papacarie also contains chloramines, toluidine blue, salts and thickening vehicle. Chloramine has bactericidal and disinfectant properties. The antiseptic properties of chloramine were recently documented in an in vitro study (Guzman & DE GUZMAN, 1953). These are broadly used to chemically soften the carious dentine. According to Maragakis et al. (2001), the partially degraded collagen in carious dentine was chlorinated by chemomechanical caries removal solutions. The chlorination affects the secondary or quaternary structure of collagen, by disrupting hydrogen bonding and thus facilitating the carious tissue removal (Maragakis et al., 2001).

In the present study, the efficacy of Papacarie in terms of time taken for caries along with its comparison with the conventional method was evaluated. In the current study the cleaning time for caries removal by mechanical method ranged from 321 to 508 seconds with a mean duration of 414.28 seconds. This was similar to other study by Venkataraghavan et al. (2013), where the drilling method for caries removal can varied from 300 to 600seconds (5min-10min). The author

proposed that this total time taken for drilling to complete excavation could be due to the use of anaesthesia.

Our study showed that the time taken for caries removal by Papacarie method varied between 521 to 708 seconds with a mean 610 seconds. However study by [Motta et al. \(2014\)](#), found that the time required for the treatment using papacarie was 360 seconds (6 min). Some researchers assert that chemomechanical caries removal takes longer time than the drilling or excavation ([Singh et al., 2011](#)), but some says that it can take a shorter time ([Ganesh & Parikh, 2011](#)). In the present study it was observed that chemomechanical caries removal was approximately 198.92 seconds longer in removing caries which was statistically highly significant. This result is consistent with those of [Jawa et al. \(2010\)](#), and [Bussadori et al. \(2005\)](#), It has been stated that Papacarie requires more than one application for its action to work. [Carrillo et al. \(2008\)](#), reported that the chemomechanical removal of carious tissue using Papacarie had treatment duration of 8 min per tooth. The longer treatment time in that study was due to the evaluation done on special needs children. In our study reasons for increased time for caries removal by Papacarie, could be multiple applications needed for complete caries removal, differences in type and size of cavities, type of teeth and age of the patient ([Banerjee et al., 2000](#)).

Conclusion

Our study showed that the mean time taken for complete caries removal by conventional method was 419.28 secs and the mean time taken by papacarie was 618.2 secs, thus the time taken by conventional method was statistically significant over conventional method. Hence it can be concluded that Papacarie can be an effective clinical alternative treatment for the removal of occlusal dentinal caries in cavitated primary molars but requires longer time as compared to conventional method.

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Table 1

Time taken for caries removal using both conventional & chemomechanical methods

Sample No	Time (seconds)	
	Conventional	Chemomechanical
1.	492	748
2.	436	629
3	365	592
4.	475	618

5.	412	610
6.	425	581
7.	512	626
8.	405	571
9.	429	608
10.	430	645
11.	410	532
12.	461	642
13.	391	514
14.	429	672
15.	418	628
16.	334	547
17.	302	541
18.	472	653
19.	391	601
20.	354	512
21.	393	598
22.	401	612
23.	362	566
24.	471	691
25.	441	662

Table 2
Mean value of time taken for caries removal using both conventional & chemomechanical methods

S.No	Caries Removal Method	No Of Teeth	Mean Time (S)	SD	SE	Min Time	Max Time	T Value	P Value
1.	Conventional	25	419.28	49.3		302	512	11.61	<0.05
2.	Chemomechanical	25	618.33	51.4	15.3	512	748		



Figure 1. Caries removal process