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Comparative evaluation of four ultrasonic coolant liquids on aerosol contamination generated during ultrasonic scaling procedure in chronic periodontitis patients

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Abstract

Investigations show that antimicrobial solutions when utilized for pre-rinse can decline the quantity of microorganisms in aerosol. Various liquids can also be utilized as coolant in the ultrasonic devices and are used preciously to reduce aerosol contamination. Thus this study was designed to evaluate the effect of chlorhexidine, povidone iodine, and herbal mouthwash as an ultrasonic liquid coolant on aerosol in comparison with distilled water.

Material and methods A total of 100 patients having diagnosed with Generalized Chronic periodontitis and based on the inclusion criteria were randomly selected and distributed among 4 groups, Group I undergoing ultrasonic scaling with distilled water, Group II ultrasonic scaling with chlorhexidine 0.2% diluted in 1:1 ratio in 1 litre of water. Group III ultrasonic scaling with povidone Iodine 2% in 1:1 ratio in 1 litre of water, Group IV ultrasonic scaling with herbal mouthwash in 1:1 dilution in 1 liter of water. Blood agar culture plate was placed in a fumigated chamber for 10 minutes as control. Blood agar culture plates were placed at a distance of four feet from the patient's head on the right side, left side, front, above and behind the patient's head. After the procedure the plates were left uncovered for 20 minutes at the pre-

designated sites for gravitometric settling of airborne bacteria.

Result. No significant bacteria were detected in control cultures. It was found among test groups that Group II showed significant reduction in bacterial count when compared to Hiora. But the reduction in comparison to distilled water and povidone iodine was not significant. The lowest mean count was seen for group II in all the positions.

Conclusion Chlorhexidine and Povidone Iodine can be used as an effective ultrasonic coolant as it showed the least mean CFU between all the groups and at all different positions.

Keywords: Aerosol, Chlorhexidine, Herbal mouthwash, Ultrasonic coolant

Introduction

The oral cavity houses several microorganisms. The transmission of infection from oral cavity through splatter and aerosol has been understood to be a risk factor for dentists and hygienist alike.[(1)] Certain dental instruments like the dental air-rotor handpieces, three way air–water syringes, sonic and ultrasonic scalers produce the aerosols while working[(1)], and previous studies show that they lead to rise in the Colony Forming Units (CFUs) when comparison was performed for pre- and post- use.[(2–4)] Aerosols are considered the suspension of particles either solid or liquid in nature which may contain viruses, bacteria and other microbes which are held suspended in the gas for few seconds.[(5)] Aerosols generated while using a power-driven scaler contains droplets which remain suspended in the operatory for a long time.[(6)]

The past few decade have the publication of various studies that show that utilizing antimicrobial solutions for the purpose of pre-procedural rinse reduce these microorganisms in the aerosol. Veksler et al., in 1991[(7)] have assessed that rinse before procedure with 0.12% Chlorhexidine (CHX) gluconate decreases the quantity of microbial content in oral cavity. Povidone iodine (PVP) is also effective in reducing the microbial content for the duration of the therapy. Diluted povidone iodine is found to have activity against "*Aggregatibacter actinomycetemcomitans" (AA), "Porphyromonas gingivalis" (Pg) and other* pathogens in vitro and in vivo [(6,8)]. Allergic sensitivity of PVP is uncommon. However, PVP must not be utilized in patients who exhibit allergy to iodine [(8,9)].

Chlorhexidine is the dentist's most favored oral wash. It is the "Gold standard" and have been used in several studies. Cat-ion behavior of CHX reduce the absorption via oral mucosa due to which it shows little toxicity and good tolerance. Systemic toxicity is also less because of the same [(10,11)].

HiOra herbal mouthwash used contains salvadora persica (Miswak), terminalia bellerica (bibhitaka), piper betle (nagavalli), it shows antiplaque properties. It contains active ingredient that destroy common oral bacteria. Tannins in Miswak reduces the action of Glucosyl Transferase thus decreasing plaque and gingivitis. The alkaloid found in Salvadora persica is "Salvadorine", which produces trimethylamine. It presents bactericidal effect. [(12,13)]

The study aimed to evaluate the effect of chlorhexidine, povidone iodine, and herbal mouthwash as an ultrasonic liquid coolant on aerosol in comparison with distilled water.

Materials and Methods

The study population was selected from those patients that reported to the OPD of Department of Periodontology, Sri Aurobindo College of Dentistry, Indore. After obtaining the approval of the Institutional ethical committee all participants were informed about the benefits and risks of the procedure and an informed consent form, agreeing to

the required treatment plan, was obtained, signed by the patients. Patients of both the sexes were included in the study.

Inclusion Criteria

Generalized Chronic periodontitis patients will be randomly selected and distributed from patients attending the department of periodontology, Sri Aurobindo College of Dentistry, Indore, presenting with

1. Probing pocket depth ≤ 4mm.
2. Motivated and compliant patient

Exclusion Criteria

1. Patients presenting any uncontrolled systemic diseases or conditions
2. Tobacco consumers in any form,
3. Pregnant and lactating females,
4. History of previous periodontal treatment within 6 months.
5. Patients on antibiotics in last 6 months will be excluded.

A minimum number of 120 patients were selected from those diagnosed as having chronic periodontitis, satisfying the inclusion criteria and exclusion criteria. Moreover out of these 120 Patients, 100 were randomly selected for the study. These 100 patients were randomly be allocated to four the groups:

Group I (n=25) - ultrasonic scaling with distilled water

Group II (n=25)-ultrasonic scaling with chlorhexidine 0.2% diluted in 1:1 ratio in 1 litre of water.

Group III (n=25) - ultrasonic scaling with povidone Iodine 2% in 1:1 ratio in 1 litre of water.

Group IV (n=25) - ultrasonic scaling with Hiora® herbal mouthwash in 1:1 dilution in 1 litre of water

Ultrasonic Scaling procedure was executed on the patients using scalers with same water and also power settings. The procedures was performed by three different operators who were selected by lottery method and procedure was conducted in a secure fumigated room with no external or internal ventilation and source of air. The control culture of the room was performed to check the amount of microorganism in the room. The diluted solutions were freshly prepared on the day, and fresh products were used for each patient. The scaling procedure was performed for 20 minutes in a fumigated room, where no other procedure had been performed prior to scaling on the same day. The culture plates were placed at a distance of four feet from the patient's head on the right side, left side, behind the patient, front of the patient and above the patient (Figure 1). After the procedure the agar plates were left uncovered in the operatory for 20 minutes at the fixed sites for gravitometric settling of contaminated aerosol. After gravitometric settling, the culture plates were carefully closed and moved to laboratory for their incubation at 37^{o}C for 48 hours after which the colony counting was done.

Figure 1: Positioning of blood agar plates in relation to patient's head

Data Collection and Methods

Number of colony forming units (CFUs) were counted on each culture plate at all the locations for each group. (Figure 2)

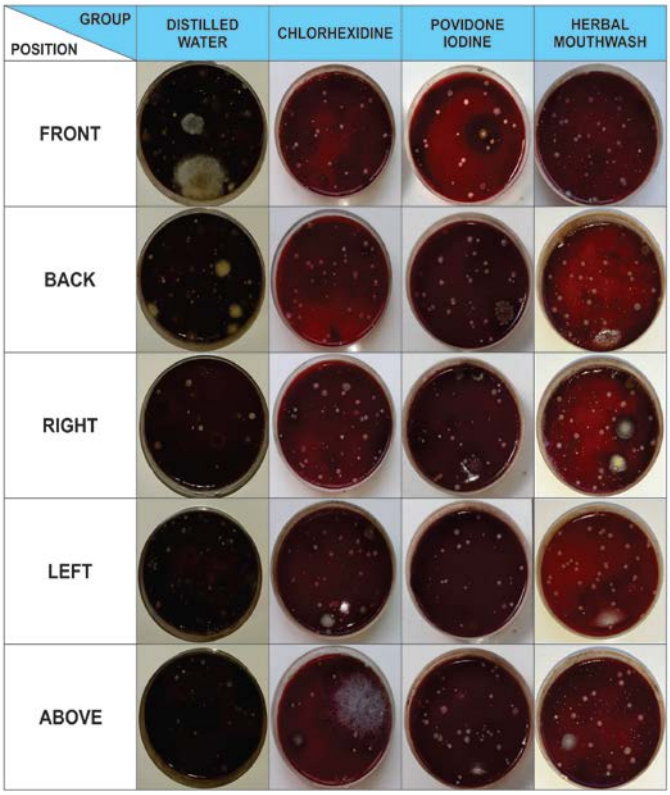

Figure 2: Pictures showing blood agar plates for different positions for each group after an incubation period of 48 hours at 37^{O}C.

Statistical Analysis Plan

For determination of overall inference, one way-ANOVA test was performed. Tukey's Post hoc test was utilized for intergroup comparison of CFU. p- Value of <0.05 was considered statistically significant

Result

Table 1 compares different groups for colony forming units (CFU). The study found that there were significant difference in the CFU between the 4 groups (p value = 0.001). On comparing different groups it was found that there was significantly more mean CFU in the herbal mouthwash group (25.25±11.11) in comparison to the other three groups. The least number of mean CFU was observed in the group II i.e. Chlorhexidine group (5.96±1.95). There were no statistically significant difference found between the other three groups.

Table 1: comparison of Colony Forming Unit on all sides among different groups

Group	Mean	Standard Deviation	P Value
Group I- distilled water	9.4667	1.91707	0.001 *
Group II- chlorhexidine	5.9600	1.95701	
Group III- povidone Iodine	8.7000	2.02619	
Group IV- herbal mouthwash	25.2500	11.11228	
Total	10.3692	7.95363	

* Statistically Significant

Table 2 shows the post hoc analysis of the 4 groups confirming the result with group IV showing higher mean CFU than the three groups and the difference was statistically significant. Of the other groups, the mean CFU was least for the chlorhexidine group in comparison to group III (povidone iodine) and group I (distilled water) but the results were not statistically significant. (Figure 3)

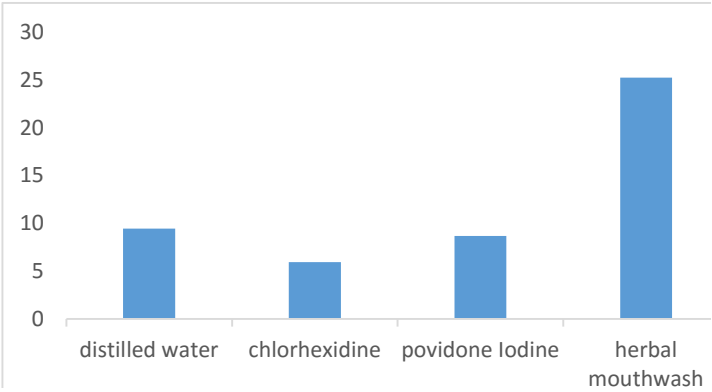

Figure 3: comparison of Colony Forming Unit on all sides among different groups

Table 2: Comparison of mean colony count on all sides among different groups by tukey's post hoc test.

Main Group	Comparison Group	Mean Difference (I-J)	Std. Error	Sig.
distilled water	chlorhexidine	3.50667	1.68551	.174
	povidone Iodine	.76667	1.88445	.977
	herbal mouthwash	-15.78333*	2.10688	.000*
chlorhexidine	povidone Iodine	-2.74000	1.68551	.374
	herbal mouthwash	-19.29000*	1.93099	.000*
povidone Iodine	herbal mouthwash	-16.55000*	2.10688	.000*

Post Hoc Tukey Test, * Significant

Table 3 shows the mean CFU count at different positions for all the groups with the least mean CFU was observed in the position above the patient's head, the analysis showed that there were significantly high CFU for Herbal mouthwash at all the positions except the above position where the distilled water group showed the highest mean CFU. (Table 3)

Discussion

Periodontitis is a disease with origin contributed to multiple factors which results in the tissue destruction of the dental supporting structures. Dental plaque is home to various oral microorganisms. Removal of plaque is necessary which can be achieved by using mechanical devices. However, the complete removal of plaque and also calculus is very difficult. Incomplete removal of microbes could lead to the problems.

Table 3: Comparison of mean colony count among different positions

Position	Group	Mean	Std. Deviation	P Value
Front	distilled water	7.8333	1.19342	0.01*
	chlorhexidine	6.1000	3.07622	
	povidone Iodine	7.3333	2.30940	
	herbal mouthwash	31.0100	17.06291	
Back	distilled water	8.8333	1.52753	0.01*
	chlorhexidine	5.9500	1.82021	
	povidone Iodine	7.1667	1.33712	
	herbal mouthwash	26.3750	11.92761	
Right	distilled water	9.5833	2.15146	0.01*
	chlorhexidine	6.2000	2.30788	
	povidone Iodine	8.4167	1.50504	
	herbal mouthwash	26.5000	12.07122	
Left	distilled water	9.1667	2.16725	0.01*
	chlorhexidine	5.5000	2.76253	
	povidone Iodine	9.8333	2.85509	
	herbal mouthwash	36.5000	18.82248	
Above	distilled water	11.9167	6.34548	0.01*
	chlorhexidine	6.0500	2.79991	
	povidone Iodine	10.7500	6.67594	
	herbal mouthwash	5.8750	2.53194	

* Significant

In dental practice, certain dental treatment procedures like scaling using power-driven scalers, prosthetic tooth preparation, excavation of carious tooth, etc., leads to production of aerosols in the operatory which may contain pathogens[6,14].

Various techniques to control airborne contaminants produced by dental procedures are being proposed since a long time such as barriers for protection, pre-procedural rinsing, high-volume suction evacuator, high-efficiency particulate air room filters and ultraviolet light ray treatment of ventilation system [15].

Barrier protectors are standard precautionary measure they are inexpensive but have limited filter capacity for aerosols furthermore an improperly fitted mask can cause leakage and thus render ineffective.

Rinsing prior to the procedure is believed to be highly effective in reducing the amount of planktonic microscopic organisms. Its effect on structured biofilms i.e. plaque, is still questioned. [15]

It is an established fact that rinsing with chlorhexidine mouthwash and povidone iodine mouthwash will bring

down the count of microbes but the pocket penetration is less[16–18]. The length of ultrasonic scaler's tip is approximately 7mm. The coolant used in these scalers extend apically to the tip thus delivering the coolant liquid at the very tip of the scaler.[19]

The use of other chemical agents as coolant liquid can reduce the dental aerosol contaminant content. Chlorhexidine which has antimicrobial nature because of its action at the inner cell membrane. Because of its known activity as a broad spectrum antimicrobial agent and relatively high substantivity to other agents, it is considered the gold standard for chemical plaque control [20].

Povidone Iodine PI is better for rapid antimicrobial activity which is different from which exhibits substantivity effect.[21] Iodine, a halogen has a wide range of antibacterial action and is also effective against fungi, viruses and protozoa. Since povidone slowly and continuously releases free iodine into solution, these qualities help to maintain antimicrobial competence for an extensive duration and to decline toxicity[22]. Herbal mouthwash HiOra has an alkaloid Salvadorine, which generates trimethylamine on chemical cleavage. It possess antibacterial effect.[12, 13]

Thus looking at these properties we designed our study to evaluate the effect of chlorhexidine, povidone iodine, and herbal mouthwash as an ultrasonic liquid coolant on aerosol in comparison with distilled water.

The American Dental Association suggested that aerosol can be limited while performing dental procedures[15].The inhalation of any among chlorhexidine gluconate (CHX)or povidone iodine (PVP) or HiOra will have no effect on the operating individuals health as studies show that aerosols remains suspended for a short time[3,6,23,24] and the chemicals are used in a diluted solution in the study.

Our study showed that significant amount of particulate aerosols and splatter while performing the procedure were generated using distilled water (table 1) and at all different positions as well (Table 3).

The highest mean CFU were recorded in Group IV (herbal mouthwash) (25.25±11.11) and the least was recorded in group II (Chlorhexidine) (5.96±1.95) (Figure 3). These results are in-line with the results of a study by Kaur et al. And also with the study done by Jawade et al. where they found that chlorhexidine reduced more microbes in aerosol than povidone iodine[25].The post hoc analysis revealed significantly less aerosol in chlorhexidine (group II) and povidone iodine (group III) group in comparison to herbal mouthwash (group IV). (Table 2)

Sahrmann in his study found that povidone iodine may be utilized as a effective agent to reduce bacterial content after subgingival procedures followed by use of povidone iodine for rinse.[26] Muir et al., in a 1978 study showed that a two minutes rinsing prior to procedure with chlorhexidine reduces contaminated aerosol during ultrasonic scaling [27]. Another study used chlorhexidine for pre-rinse along with an air polisher to reduce aerosol[28].

Kaur et al.,[13] in their study identified reduction in plaque accumulation using HiOra herbal mouthwash. Which was also found in the studies by Sofrata et al. (2007)[29] in which Salvadora persica containing mouthwash restricted plaque and showed antimicrobial tendency. But in our study herbal mouthwash showed the highest mean CFU among all four groups. Showing the least efficacy of herbal mouthwash as ultrasonic coolant liquid.

Study by Jawade et al., showed highest CFU on right side of the patients head.[6] similar results were understood from the study done by Veena et al. in which they found maximum contamination area in right side.[30] In our study for herbal mouthwash highest mean CFU was seen in the

left position where as for both distilled Water and PVP highest mean CFU was observed in the above position but for chlorhexidine highest mean CFU was observed in right position. Thus no fixed relationship for the positions could be established at a distance of four feet from the patients head in all the positions. Another important observation during the study which can be taken as disadvantage of using both chlorhexidine mouthwash and povidone Iodine as coolant liquid for ultrasonic scaling is the foaming produced by these agents during the procedure, which can restrict the visibility of the operator.

Conclusion

This study showed that chlorhexidine gluconate effectively reduces aerosol contamination during scaling when comparison was done with distilled water, povidone iodine and HiOra herbal mouthwash. Herbal Mouthwash proved significantly least effective than chlorhexidine in group II and povidone iodine in group III in reducing the amount of dental aerosol contamination. Thus both chlorhexidine and Povidone Iodine appear a suitable ultrasonic coolant for performing scaling.

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