ORIGINAL ARTICLE

Pre-procedural Mouth Rinses to Reduce Droplet Contamination During Ultrasonic Periodontal Scaling

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ABSTRACT

Introduction: Dental procedures, including ultrasonic scaling, can generate aerosols and droplets, contaminating the dental room and spreading infectious pathogens. To prevent infection, dental associations recommend pre-procedural mouthwash. Various mouthwashes, such as povidone-iodine, chlorhexidine, aloe vera extract and mouthwash with essential oil, are available, but scientific evidence is needed to evaluate the efficacy of their use as preprocedural mouthrinse. Objective: To assess the effectiveness of four commercially available mouth rinses as preprocedural rinses in reducing the number of viable bacteria in dental aerosol generated during ultrasonic scaling. **Materials and methods:** Twenty eight participants were chosen at random to rinse with any of the mouthwashes for 30 seconds. The mouthwashes used in this study are Betadine®, Minosep®, Listerine® and Aloclair® No dilution of mouthwash was performed throughout this study. The mouthwash is commercially available with a ready-to-use solution. While doing ultrasonic scaling, agar medium plates were placed on the patient's, dentist's, and dental assistant's chests. The plate is then incubated to count how many colonies have formed. The data collected were analyzed using two-factor ANOVA without repeated measures. **Results:** The mouthwash does not have any impact on the variable reduction CFU in Patient-Dentist-Dental Assistant. However, the data clearly indicates that all mouthwashes effectively decrease the amount of colonies. **Conclusion:** The reduction in CFU after rinse with those mouthwash highlights the significance of preprocedural mouthwash in lowering oral bacteria numbers prior to minimizing bacteria in dental aerosol formation. Therefore, pre-procedural mouthrinsemay be considered beneficial.

Keywords: Mouthwash, Pre-procedural mouthwash, Ultrasonic scaling, Aerosol, Droplet

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INTRODUCTION

In dentistry, maintaining proper infection control protocols is of utmost importance. Over the past few decades, the importance of hygiene in dental practice has evolved significantly. The challenges are the emergence of more virulent bacterial strains and the rise of multidrug resistance bacterial. Also, the number of people taking immunomodulatory treatments increases, making them more vulnerable to infections. Meanwhile, dentistry has developed various rotating instruments and other new tools. Dental treatment with rotary instruments generates a significant amount of aerosols and droplet, consisting of tiny particles suspended in the air. These aerosols and droplet can raise the risk of transmitting infections that may spread through the air and surface.

The oral cavity contains a wide variety of infectious agents as well as the normal flora. Most airborne organisms that accumulate substantial concentrations are Gram-positive coccus and rod bacteria, endospore-forming bacteria, and fungi. Previous studies have shown that respiratory pathogens (P. *aeruginosa, S. aureus, S. pneumoniae,* and H. *influenzae*) can colonise the oral biofilm and the tongue's surface.(1,2) Another previous study has shown a higher ratio of aerobes to anaerobes in individuals with periodontitis compared to those with normal gingiva.(3)

Aerosols contain many kinds of airborne particles that can be characterised as either liquid or solid, originating from humans, animals, instruments, or machinery. The term "splatter" or "droplet" refers to the presence of airborne particles with a diameter exceeding 50 μm and exhibiting ballistic behaviour; this indicates that the splatter or droplets are expelled with significant force from the operational location and move in a bullet-like manner until they reach the ground or make contact with it. Such particles cannot be suspended in the air because they are too big and only remain airborne for a short period. (4,5)

Almost all dental procedures create splatter as well as droplets. Dental procedures that generate the aerosolization of oral bacteria have the potential to cross-contaminate the dental room and spread infectious pathogens to the dental staff as well as the patient. During dental procedures, the patient, dental staff, and dentist are all cognizant of the release of airborne particles, which can be observed as visible aerosol clouds are composed of watery and particulate matter. This is the reason why both patients and dental personnel are susceptible to exposure to aerosolized microorganisms during dental procedures.

Biofilms, which are made up of microorganisms, can also form on the dental unit water lines. The use of high-speed rotary instruments generates aerosols that comprise microorganisms originating from the oral cavity, making people worry about how far these aerosols and droplets spread and how much disease they cause in the dentist's office. We need to find out how far microorganisms in the air can travel in a dentist's office where high-speed rotary instruments are used. The estimated distance of the contaminated area from the patient's mouth was between 1 and 1.5 metres. (6,7)

There is a recognized association between dental treatments that generate aerosols (AGPs) and the potential transmission of infectious pathogens. Due to the transmission of severe acute respiratory syndrome (SARS) via aerosols, it is time to look over the steps used to keep aerosols from spreading infections. *Mycobacterium tuberculosis*, the germ that causes tuberculosis, is the most dangerous thing that could be in clouds. Some dental treatments can cause oral bacteria to become airborne, which might cause contagious agents to disseminate between the dentist and the patient through cross-contamination in the dental office.(4,8) So, any method for lowering the number of live bacteria in these droplets might reduce the potential of this kind of cross-contamination occurs.

The ultrasonic scaling creates droplets that change the number of microbes in the air. Dental associations recommend using mouthwash before a treatment to stop the spread of infections in dental offices that use procedures that make aerosols and droplets. (9)

There are many kinds of mouthwash at the market. However, there needs to be scientific proof that using mouthwash before a procedure is helpful. Betadine®, Minosep®, Listerine® and Aloclair® mouthwash are readily available on the market. So, this study aimed to assess the effectiveness of those commercially available mouth rinses as preprocedural rinses in reducing the number of viable aerob bacteria in dental aerosol generated during ultrasonic scaling.

MATERIALS AND METHODS

A group of 28 outpatients from both genders, aged between 25 and 40 years, was selected from the student clinic at Universitas Padjadjaran Dental Hospital. The research study acquired approval from the Research Ethics Committee at Universitas Padjadjaran Bandung (752/UN6.KEP/EC/2023). The researchers obtained written informed consent from the chosen participants. Each participant had a comprehensive dental examination and an interview to meet the specified inclusion and exclusion criteria.

Patients with at least 20 fixed teeth, diagnosed with chronic gingivitis, did not smoke, and had not used antibiotics or mouthwash in the past month were chosen for the study. Patients who were allergic to povidone-iodine, chlorhexidine, essential oil, and aloe vera, along with those who had a disease that affected the production of salivary glands, were pregnant or had a prior diagnosis of systemic diseases were ineligible to participate in the study.

Everyone who was going to get the treatment was picked at random. The patients were randomized into four treatment groups , and seven people are in each one. The first group was rinsed with povidone-iodine mouthwash (Betadine® mouthwash and gargle). The second group was rinsed with 0.2% chlorhexidine digluconate (Minosep ®). The third group rinsed with Mouthwash with Essential oil such as Eucalyptol, menthol, methyl salicylate, thymol (Listerine® Multiprotect Zero) — moreover, the fourth group rinsed with aloe vera extract mouthwash (Aloclair® plus oral rinse mouthwash). The control group consists of data collected from subjects who did not rinse before the treatment. No dilution of mouthwash was performed throughout this study. The mouthwash is commercially available with a ready-to-use solution.

Ultrasonic scaling (Refine Max Piezo 3) was done on all the selected patient. The operatory's surfaces were cleaned with 70% ethyl alcohol before the procedure. Nutrient agar plates collected the droplets and counted the colony-forming units (CFUs) overall. During the research, the dental chair and ultrasonic scaler were set to the same position and settings. Each treatment included a patient, a dentist, and a dental assistant. Each treatment also needed two sets of plates to count the CFU before (non-rinsing as control) and after the rinsing. The plate is kept in three different places: on the chest of the patient, the dentist, and the dental assistant. The plate was stick at the chest participant with double tape to standardized distance of the plates was maintained throughout the study. The first plate was put on the patient's chest, roughly 20 cm from their oral area. A second plate was put on the dentist's chest and the third plate was put on the dental assistant's chest. All of the plate's position as shown in Figure 1. Prior to the procedure, the doctor flushed the ultrasonic device for two minutes in order to eliminate contaminants that had been sitting in the water lines.

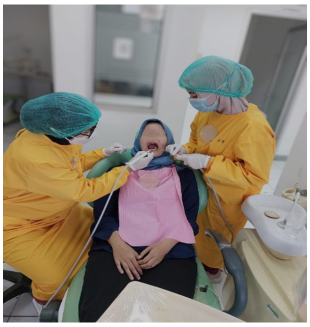

Figure 1: Patient, Dentist and dental assistance position

Without preprocedural mouth rinse, the scaling was done on half of the jaw for about one minute with three open plates placed on the chests, keeping it for the next 30 seconds until all the droplets landed, and then cap and take the plate. Then, patient were given a mouth rinse at random and instructed to gargle it and hold it in their mouths for 30 seconds before spitting it out. Another new set of three open plates was put in the same place, and the scaling was done again for another half of the jaw for a minute, and keep the plate open for the next 30 seconds. Then, cap the plate and take the plate for the next step. Droplet samples on an agar plate were grown using aerobic culture, the plate was incubated at 37°C for twenty-four hours. In this research, the colonies were counted after incubation to determine the number of colony-forming units (CFU) using the standard plate count method.

The collected data were assessed using the Shapiro-Wilk test to tests for normal distribution of Reduction CFU and Levene test to see the variance equality. Two-factor ANOVA without repeated measures was done to test the effect of two independent variable which is mouth wash variant and the reduction of CFU in patient, dentist and dental assistant chest.

RESULTS

The data of total colony in each plate was analyzed. The reduction of CFU obtained from reducing the CFU data before mouthrinse to CFU data after mouthrinse. The results for the mean and standard deviation for the concentrations of bacterial aerosols reduction before and after rinse with mouthwash in different plate positions are summarised in Table I and Figure 2. Data analysed using the Shapiro-Wilk test to Test for normal distribution of Reduction CFU are summarised in Table II. Almost all the variables have a p-value> 0.05, meaning the data is normally distributed. The Only variable "Chlorhexidine - Reduction CFU in Dentist" has a p-value of < 0.05, which means not normally distributed data. Data analysed using Levene test to see the variance equality of each groups that available in Table III. The p-value of Levene test are $p > 0.05$ it means that the variances of the group are equal.

Table I: Mean (±SD) of bacterial (CFU) reduction before and after rinse with mouthwash in different plate positions(Patient, dentist and Dental assistance chest)

		Frequency	Mean	Std. Deviation	Minimum	Maximum
Reduction CFU in Patient	Povidone iodin	7	9	26.44	-19	61
	Chlorhexidine	7	26.57	29.06	-18	59
	Essential oil	7	11.86	17.98	-18	36
	Aloe vera	7	19.54	33.73	-28	83
Reduction CFU in Dentist	Povidone iodin	7	6.57	10.26	-10	20
	Chlorhexidine	7	4	20.03	-13	46
	Essential oil	7	18	24.13	-6	62
	Aloe vera	7	14.29	15.99	0	40
Reduction CFU in Dental Assistant	Povidone iodin	7	6.43	13.89	-6	35
	Chlorhexidine	7	2.29	3.95	-4	6
	Essential oil	7	10.57	17.17	-6	44
	Aloe vera	7	2.14	20.29	-34	31

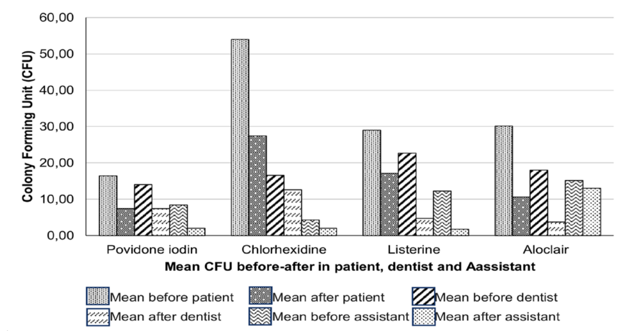

Figure 2: The Mean CFU before-after of each mouthwash in a different plate position

Table II: Shapiro-Wilk Tests for normal distribution

	Statistics	p
Povidone iodin - Reduction CFU in Patient	0.88	.212
Povidone iodin - Reduction CFU in Dentist	0.97	.918
Povidone iodin - Reduction CFU in Dental Assistant	0.83	.075
Chlorhexidine - Reduction CFU in Patient	0.91	.43
Chlorhexidine - Reduction CFU in Dentist	0.78	.028
Chlorhexidine - Reduction CFU in Dental Assistant	0.88	.218
Essential oil - Reduction CFU in Patient	0.96	.855
Essential oil - Reduction CFU in Dentist	0.9	.356
Essential oil - Reduction CFU in Dental Assistant	0.87	.185
Aloe vera - Reduction CFU in Patient	0.92	.484
Aloe vera - Reduction CFU in Dentist	0.87	.191
Aloe vera - Reduction CFU in Dental Assistant	0.95	.733

Table III: Levene test of variance equality

Test	F	df1	df2	p
Levene's Test (Mean)	1.33	11	72	.226
Brown-Forsythe-Test (Median)	0.99	11	72	.467

The results of Two-factor ANOVA without repeated measures are summarised in Table IV. A two-factor analysis of variance without repeated measures was conducted to test whether there was a difference between the groups of the independent variable Mouthwash with respect to the dependent variable, a difference between the groups of the independent variable Reduction CFU in Patient-Reduction CFU in Dentist-Reduction CFU in Dental Assistant with respect to the dependent variable and whether there was an interaction between the two variables Mouthwash and Reduction CFU in Patient-Reduction CFU in Dentist-Reduction CFU in Dental Assistant in relation to the dependent variable.

Table IV: Results of Two-factor ANOVA without repeated measures of bacterial (CFU) reduction before and after rinse with different mouthwash in different plate positions (Patient, dentist and Dental assistance chest)

Table IV: Results of Two-factor ANOVA without repeated measures of bacterial (CFU) reduction before and after rinse with different mouthwash in different plate positions (Patient, dentist and Dental assistance chest) (CONT.)

	Type III Sum of Squares	df	Mean Squares	F	p	Eta_p^2
Mouthwash	431.42	3	143.81	0.33	.805	0.01
Reduction CFU in Patient-Reduction CFU in Dentist-Reduction CFU in Dental Assistant	1816.99	2	908.49	2.07	.133	0.05
Mouthwash x Reduction CFU in Patient-Reduction CFU in Dentist-Reduction CFU in Dental Assistant	2119.7	6	353.28	0.81	.569	0.06
Error	31583.81	72	438.66			

The two-factor analysis of variance without repeated measures showed that there is no significant difference between the groups of the independent variable Mouthwash in relation to the dependent variable p=.805, that there is no significant difference between the groups of the independent variable Reduction CFU in Patient-Reduction CFU in Dentist-Reduction CFU in Dental Assistant in relation to the dependent variable p=.133 and that there is no interaction between the two variables Mouthwash and Reduction CFU in Patient-Reduction CFU in Dentist-Reduction CFU in Dental Assistant in relation to the dependent variable, p=.569.

The result that there is no significant difference between the groups of the independent variable Mouthwash in relation to the dependent variable. There is no significant difference between the groups of the independent variable Reduction CFU in Patient-Reduction CFU in Dentist-Reduction CFU in Dental Assistant in relation to the dependent variable. The mouthwash does not have any impact on the variable reduction CFU in Patient-

Reduction CFU in Dentist-Reduction CFU in Dental Assistant.

However, the data clearly indicates that all mouthwashes effectively decrease the amount of colonies present as seen in Figure 2.

DISCUSSION

The research found that all mouthwashes tested (povidone-iodine, chlorhexidinen digluconate, mouthwash with essential oil, and mouthwash from aloe vera extract) successfully reduced the number of bacterial colonies, despite knowing that the mouth represents a distinctive ecological niche that offers optimal conditions for the growth of bacteria. Prior research has shown a 33.9% decrease in the concentration of bacteria after the use of distilled water as a mouthwash. This suggests that washing with distilled water only effectively eliminates a particular amount of microbial load.(10) Substantial research indicates that preprocedural mouth rinses effectively decrease the number of bacteria in the dental aerosol.(11)

The largest mean CFU reduction value in this research is chlorhexidine in patients chest. The smallest mean CFU reduction value is chlorhexidine and aloevera in dental assistance chest. Using high-speed rotating instruments creates temporary air contamination, which increases when bacteria settle, leading to an alteration in air quality. (12) The research findings suggest a possible danger of hospital-acquired infections associated with dental treatments, particularly when the generation of microbial aerosols and droplets is generated by high-speed rotating tools.

This research found that the patient's plate constantly showed the highest colonies. The occurrence is believed to be because droplets or aerosols fell directly onto the patient's chest plate, which was placed horizontally. This aligns with the nature of the descent of aerosols and droplets, which result in the particles landing on the floor or other surfaces inside the dental operatory. (13) A recent investigation by Bently et al. found that most of the splatter during dental treatments went towards the patient's chest and the operator's face. (14) Due to the lack of certainty, it is important to regard all patients as possible sources of infection.

Due to recurrent exposure to pathogens in saliva and blood, dental practitioners have a higher risk of becoming infected with certain infectious diseases. The ultrasonic scaling technique is known to generate droplets and aerosols, which have been seen to significantly alter the ambient air's microbial composition. Aerosols act as a route for the transmission of infectious pathogens between individuals, hence leading to cross-contamination.

Although this study did not identify the microorganisms on the plates, we know from previous research that dental procedures have been shown to produce aerosols of oral bacteria, mostly *Streptococci* and *Staphylococci. Bacillus sp.* is a common indoor airborne bacterium that can lead to hypersensitivity pneumonitis. *Bacillus species* are a kind of Gram-positive bacteria characterised by their ability to produce endospores and resistance to high temperatures and chemical agents. These bacteria are often found in various environmental sources such as soil, dust, and water. *Mycobacterium tuberculosis* has also been discovered in the airborne particles generated by a high-speed handpiece that was used for performing dental treatments on people who had active TB. (14) Furthermore, recent studies have discovered invasive pathogens such as Legionella spp. that might potentially pollute the air during dental procedures.(6)

In the current study, the efficacy of chlorhexidine mouth rinse in lowering microbial colony-forming units (CFUs) was shown to be better than other mouth rinse. This might be due to the fact that chlorhexidine acts effectively against a wide range of microbes. (15) The results obtained were consistent with the research conducted by Alberto, Ghassan, and Kayrouz, which examined the impact of preprocedural rinsing with chlorhexidine. Their study revealed that this practice had a significant and long-lasting influence on the aerobic and facultative microorganisms present in the oral cavity, potentially leading to various advantageous outcomes in clinical settings. (16) Another research has shown that pre-procedural mouth washing with chlorhexidine significantly reduces aerosol contamination during periodontal prophylaxis, in comparison to rinsing with water, without rinsing at all, with herbal and tea tree mouthwash.(17–19)

Although not having of statistically significant evidence, the use of mouthwash containing essential oils does not lead to a substantial decrease in bacteria, this research also aligns with earlier research showing that using a mouthwash containing essential oils before a dental operation effectively reduces the spreading of bacteria in the oral bioaerosol produced during dental treatment. (20)

Although this research did not provide statistically significant results on the efficacy of mouthwash in lowering bacterial counts, it is important to note that a significant reduction in bacterial counts was seen across almost all plates subsequent to preprocedural mouthrinse. The use of pre-procedural mouthrinse is strongly advised for all patients as a means of mitigating the potential for infection. This study revealed that the plate position with the highest amount of bacteria is in the patient's chest area. Although the growing bacteria on the plate come from the patient's oral cavity, it is advisable for patients to use personal protection equipment in order to protect their chest area from being contaminated during dental procedures.

Several techniques have been explored to reduce or minimise the presence of bacterial aerosols during dental procedures. In actuality, however, it is not feasible to altogether remove bacterial aerosols during dental procedures. One such strategy involves the use of a rubber dam, which has been shown to have a substantial impact in minimising contamination. Using an extra-oral vacuum aspirator when treating patients will stop the spread of oral streptococci by reducing the spread of the splatter. Applying an antiseptic mouth rinse to the patient before dental treatment is another efficient technique. The addition of extraoral high-volume evacuators (eHVE) together with preprocedural mouth rinse may effectively reduce bacterial contamination within dental offices.(21,22) It is important to emphasise the protection of the face and hair, as well as personal hygiene practises, among workers after work. This is crucial in order to prevent the spread of hospital microorganisms in the community. (5) To prevent hospital pathogens from spreading to other people in the community, all dental staff should be advised to protect their faces and hair while working and perform good personal hygiene after work.

Nevertheless, it is important to consider the limitations of this research when interpreting these findings. This research had a small sample size, so for further study, it is better to increase the sample size and consider the impact of subject characteristics, such as age and gender. The limitation of this study is that it did not assess participants' plaque index scores, whereas oral hygiene conditions will influence variations in microorganisms in the oral cavity. Bacterial and fungal identification was also not performed in this research.

CONCLUSION

Understanding how dangerous that dental aerosols, can help dental staff to minimized exposure to improve their and patient health. The reduction in CFU after rinse with mouthwash highlights the significance of preprocedural mouthwash in lowering oral bacteria numbers prior to minimizing bacteria in dental aerosol formation. Therefore, the use of a pre-procedural mouthrinse may be considered beneficial.

ACKNOWLEDGEMENT

The authors express our gratitude to RSGM Unpad for granting permission to conduct this study. We affirm that we have no financial affiliation. The authors declare that there is no conflict of interests regarding the publication of this paper.

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