Comparison of Efficacy of Three Different Mouthwashes in Reducing Aerosol Contamination Produced by Ultrasonic Scaler: A Pilot Study

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Abstract

Background and Objective: Aerosol produced during the procedure of scaling and root planing is a potent source of infection. Preprocedural mouthwashing has been found effective in reducing the bacterial load of the aerosol produced during the procedure. Thus, the aim of the present study was to evaluate and compare the efficacy of three different mouthwashes containing Chlorhexidine, Essential Oils & Herbal Extracts by using them as preprocedural rinsing agent in reducing the bacterial load of the aerosol produced by ultrasonic scaler. Material and Methodology: 40 subjects aged and gender matched were randomly divided into four groups on the basis of agents used for preprocedural mouthrinsing - Group I: Distilled Water (Control), Group II: Chlorhexidine (CHX), Group III: Herbal Extracts (HR) & Group IV: Essential Oils (EO). The aerosols were collected on three previously prepared and sterilised blood agar plates at three different positions in the operatory. The colony forming units were counted after incubating the plates for 48 hours. Result: At all locations, the mean CFU was highest in Group I followed by Group III, Group IV and Group II. Conclusion: In the study 0.2 % chlorhexidine was found to be most effective preprocedural mouthwash in reducing the bacterial load in the aerosol produced during ultrasonic scaling followed by essential oil and herbal mouthwash respectively.

Keywords: Aerosol, chlorhexidine, essential oil mouthwashes, herbal mouthwashes, preprocedural mouth rinsing

Introduction

The control of cross-infection has been considered to be one of the most important concerns of the dental community. The infectious agents may get transmitted to the patients, operating dental surgeon, and supporting staff through various vectors which include instruments and air.\(^1\) The spread of infection through aerosol and splatter has long been considered one of the main concerns in the dental community because of possible transmission of infectious agents and their potential harmful effects on the health of patients and dental personnel.\(^2\) Aerosols generated by dentists in their work may contain solid particles and chemicals or gasses as well as bacteria and viruses.\(^3\)

Aerosol is a suspension of solid or liquid particles containing bacteria or viruses, suspended (for at least a few seconds) in a gas. Particle size may vary from 0.001 to >100 mm.\(^4\) The smaller particles of an aerosol (0.5–100 µm in diameter) have the potential to penetrate and lodge in the smaller passages of the lungs and are thought to carry the greatest potential for transmitting infections.\(^5\) The aerosol produced by the ultrasonic scalers has a significant amount of contamination from different species of bacteria, and hence, it acts as a potential cause of infection.\(^6\) Miller reported that aerosols generated from patient’s mouth contained up to a million bacteria per cubic foot of air.\(^7\) Other studies have reported the association of these aerosols with respiratory infections, ophthalmic infections, skin infections, tuberculosis and hepatitis B.\(^8\)

Several methods have been tried to reduce aerosol contamination in dental office such as using high vacuum suction, patient

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positioning, use of rubber dam and preprocedural antibacterial mouth rinses. The commonly used mouthwashes for this purpose usually contain chlorhexidine (CHX) or essential oils (EOs) or herbal (HR) extracts.

CHX is still considered as the gold standard antimicrobial mouthwash because of its broad spectrum of bacterial activity and prolonged substantivity of approximately 12 h; however, some side effects such as taste alteration, staining of teeth, and dryness and soreness of mucosa have also been reported. EO mouthwashes have been used for years as an adjunct to tooth brushing in addressing oral hygiene. They kill microorganisms by destroying their cell walls and inhibiting their enzymatic activity. Further, plants have been exploited by man for many centuries as sources of chemotherapeutic and other medicinal drugs due to the presence of various bioactive compounds. These HR products are not only economical but also have minimal side effects. HR mouthwashes have emerged as an alternative to chemical mouthwashes with their antibacterial properties comparable to them.

Therefore, the present study was designed to evaluate and compare the efficacy of three different mouthwashes containing CHX, EO, and HR using them as preprocedural rinsing agent in reducing the bacterial load of the aerosol produced by ultrasonic scaler.

**Materials and Methods**

A total of 40 participants (24 males and 16 females) were selected from the patient pool reporting to the outpatient clinic of Department of Periodontics, Sardar Patel Post Graduate Institute of Dental and Medical Sciences, Lucknow. Inclusion criteria included patients who were scheduled for ultrasonic scaling and were having a minimum of 24 permanent teeth and a mean plaque score of 2.0–3.0 on plaque index (PI). Participants exhibiting good overall general health, nonsmokers, no history of periodontal treatment for the past 6 months, no history of antimicrobial therapy for the past 6 months, and no history of hypersensitivity to any drugs were included in the study. Exclusion criteria included pregnant and lactating females, patients with a history of trauma in the past 6 months, patients on phenytoin, calcium channel blockers, and cyclosporine medication, immunocompromised patients, or patients suffering from chronic systemic disease. An informed and written consent was obtained from each patient willing to participate in the study.

Patients selected by the above-mentioned criteria were randomly divided into four groups having ten patients each.

- **Group I (control group)** – The patients were asked to rinse with sterile water for 60 s 10 min before ultrasonic scaling
- **Group II (CHX group)** – The patients were asked to rinse with 10 ml of 0.2% chlorhexidine mouthwash (Rexidine®, Indoco Remedies Limited, Mumbai, Maharashtra, India) for 60 s 10 min before ultrasonic scaling
- **Group III (HR group)** – The patients were asked to rinse with 15 ml of mouthwash containing herbal extracts (HiOra®, Himalaya Herbal Healthcare, Bengaluru, Karnataka, India) for 60 s 10 min before ultrasonic scaling
- **Group IV (EO group)** – The patients were asked to rinse with 15 ml of mouthwash containing essential oils (Listerine®, Johnson & Johnson Private Limited, New Jersey, USA) for 60 s 10 min before ultrasonic scaling.

The demographic data (age and sex) and clinical characteristics (number of teeth present, PI, and probing depth) of four groups (control, CHX, HR, and EO) are summarized in Table 1.

Ultrasonic scaling was carried out in all the patients after preprocedural rinsing by a single-qualified dental professional in previously disinfected operatory. While the patients were undergoing treatment, the aerosols were collected on three previously prepared and sterilized blood agar plates by fixing the plates on operators chest (OC), patients chest (PC), and at a distance of 4 feet at 4 “O” clock position (FF) as shown in Figure 1. The blood agar plates were incubated for 48 h and were inspected for the number of bacterial colony-forming units (CFUs) [Figure 2]. All the samples on the blood agar plate were evaluated by the same investigator. In the present study, we were only assessing the number of bacteria in the aerosol and not the type of bacteria. The recorded data were statistically analyzed.

**Statistical analysis**

Data were summarized as mean ± standard deviation. Groups were compared by one-way analysis of variance (ANOVA), and the significance of mean difference between the groups was assessed using the post hoc test.

### Table 1: Demographic and clinical characteristics (mean±standard deviation) of four groups

| Characteristics   | Group I Control (n=10), n (%) | Group II CHX (n=10), n (%) | Group III HR (n=10), n (%) | Group IV EO (n=10), n (%) |
|-------------------|-------------------------------|-----------------------------|---------------------------|--------------------------|
| Age (years)       | 35.20±5.45                    | 37.30±4.16                  | 36.80±4.49                | 37.60±3.78               |
| Sex               |                               |                             |                           |                          |
| Male              | 6 (60.0)                      | 5 (50.0)                    | 7 (70.0)                  | 6 (60.0)                 |
| Female            | 4 (40.0)                      | 5 (50.0)                    | 3 (30.0)                  | 4 (40.0)                 |
| Number of teeth   | 28.70±1.70                    | 28.30±3.37                  | 28.60±2.80                | 28.50±2.64               |
| PI                | 2.42±0.20                     | 2.42±0.19                   | 2.43±0.29                 | 2.48±0.24                |
| PD (mm)           | 3.79±0.61                     | 3.99±0.44                   | 3.96±0.56                 | 3.97±0.62                |

PI: Plaque index, PD: Probing depth, CHX: Chlorhexidine, HR: Herbal, EO: Essential oil
done by Tukey’s post hoc test. Categorical (discrete) groups were compared by Chi-square test. A two-tailed \( P < 0.05 \) was considered statistically significant.

**RESULTS**

The mean CFU of four groups (I, II, III, and IV) at three locations (OC, PC, and FF) was counted and analyzed after 48 h and is summarized in Table 2 and also shown in Figure 3. At all locations, the mean CFU was highest in Group I followed by Group III, Group IV, and Group II. For each location, comparing the mean CFU between the groups, ANOVA revealed significantly \( (P < 0.001) \) different CFU among the groups [Table 2]. Further, Tukey test showed that the mean CFU at both OC and PC lowered significantly \( (P < 0.05 \text{ or } P < 0.01 \text{ or } P < 0.001) \) in Group II, III, and IV as compared to control group (Group I) [Table 3].

Furthermore, the mean CFU at both OC and PC also lowered significantly \( (P < 0.01 \text{ or } P < 0.001) \) in Group II and Group IV as compared to Group III. In contrast, at 4’ distance (FF), the mean CFU in both Group II and Group IV lowered significantly \( (P < 0.01 \text{ or } P < 0.001) \) as compared to control group (Group I) and also lowered significantly \( (P < 0.05) \) in Group II as compared to Group III. However, at all locations, it not differed \( (P > 0.05) \) between Group II and Group IV, i.e., found to be statistically the same.

**DISCUSSION**

The dental literature shows that some dental procedures produce aerosols and droplets that are contaminated with bacteria and blood. These aerosols represent a potential route for disease transmission. Reports confirming aerosol as a potent media for cross-infections causing measles, tuberculosis and severe acute respiratory syndrome (SARS) are well documented.\(^7,13\) Therefore, the control of aerosol production during such dental procedures is very important. The present study was carried out to compare the efficacy of three mouthwashes in reducing the bacterial count in the aerosol produced during ultrasonic scaling.

CHX 0.2% is highly effective in inhibiting subgingival plaque formation and hence prevents development of gingivitis.\(^14-18\) It has a broad spectrum of antimicrobial activity ranging from Gram-positive organisms, Gram-negative organisms, yeasts, dermatophytes to some viruses. Apart from the above benefits, it also possesses excellent substantivity property and hence is considered as gold standard mouthwash.\(^8\)

HiOra mouthwash is a nonalcoholic HR preparation made from natural herbs with their beneficial anticariogenic, antiplaque, antibiotic and anti-inflammatory properties.\(^19\) Listerine is an EO mouthwash and has significant antibacterial activity and hence is effective in inhibiting plaque accumulation.\(^10\)

The results demonstrate that the patient, operator, and people present in the operatory are exposed to a high amount of bacteria during the procedure of ultrasonic scaling. The microbial load of aerosol reduced significantly in all the three groups after preprocedural mouthwash usage in comparison to the control group. The analysis of CFUs after 48 h revealed that CHX was most effective in reducing the bacterial counts in the aerosol followed by EOs and HR mouthwashes, respectively.
In the present study, the bacterial reduction in the aerosols was found more after the use of EO mouthwash in comparison to the HR mouthwash. Hence, these results are different from those obtained by Kaim et al. The reason for the difference may be attributed to the difference in the composition of HR mouthwash used in both the studies.

The limitation of the study is that we have just counted the aerobic bacteria capable of growth on agar plates. The anaerobic bacteria and viruses have not been included in the study.

**Conclusion**

The oral cavity is a reservoir for a large number of microorganisms including bacteria and viruses. This is of particular importance in the case of routine dental practice as the risk of exposure to microorganisms in the oral cavity is increased due to the open and invasive nature of the procedures.

The present study clearly demonstrated that the patient, operator as well as the people in the operatory get exposed to a large amount of microbial population during ultrasonic scaling, and the microbial load is greatly reduced by preprocedural mouth rinsing. This reinforces the importance of preprocedural mouth rinsing for the patient and using personal protective equipments by operator and assistants while caring out the procedures to prevent cross-infection.

The aerosol production cannot be totally eliminated during ultrasonic scaling, but the putative potential of these aerosols can be minimized by preprocedural rinsing. In the present study, 0.2% CHX was found to be most effective preprocedural mouthwash in reducing the bacterial load in the aerosol produced during ultrasonic scaling followed by EO and HR mouthwash, respectively.

**Declaration of patient consent**

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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**Table 2: Colony-forming units (mean±standard deviation) of four groups at three different locations after 48 h**

| Location of agar plate | Group I Control (n=10) | Group II CHX (n=10) | Group III HR (n=10) | Group IV EO (n=10) | P  |
|------------------------|-----------------------|---------------------|---------------------|--------------------|----|
| OC                     | 227.70±32.17          | 107.70±19.46        | 192.60±35.57        | 137.90±23.68       | <0.001 |
| PC                     | 245.90±37.02          | 106.60±21.52        | 196.40±30.19        | 138.80±28.73       | <0.001 |
| FF                     | 57.40±21.71           | 25.40±7.73          | 42.60±10.51         | 30.30±10.14        | <0.001 |

OC: Operator chest, PC: Patient chest, FF: At 4’ distance at 4’O clock position.

**Table 3: For each location, comparison of mean colony-forming unit between the groups by Tukey test after 48 h**

| Comparisons                  | OC (n=10) | PC (n=10) | FF (n=10) |
|------------------------------|-----------|-----------|-----------|
| Control versus CHX           | <0.001    | <0.001    | <0.001    |
| Control versus HR            | 0.043     | 0.004     | 0.090     |
| Control versus EO            | <0.001    | <0.001    | 0.001     |
| CHX versus HR                | <0.001    | <0.001    | 0.037     |
| CHX versus EO                | 0.101     | 0.093     | 0.853     |
| HR versus EO                 | 0.001     | 0.001     | 0.201     |

CHX: Chlorhexidine, HR: Herbal, EO: Essential oil, OC: Operator chest, PC: Patient chest, FF: At 4’ distance at 4’O clock position.

**Conclusion**

The oral cavity is a reservoir for a large number of microorganisms including bacteria and viruses. This is of particular importance in the case of routine dental practice as the risk of exposure to microorganisms in the oral cavity is increased due to the open and invasive nature of the procedures.

The Aerosol production cannot be totally eliminated during ultrasonic scaling, but the putative potential of these aerosols can be minimized by preprocedural rinsing. In the present study, 0.2% CHX was found to be most effective preprocedural mouthwash in reducing the bacterial load in the aerosol produced during ultrasonic scaling followed by EO and HR mouthwash, respectively.

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Fine et al. have reported the use of various plaque control agents as preprocedural mouthwash to be effective in reducing bacterial count in aerosol when compared with distilled water or saline. Thus, the result of this study was in accordance with the present study. In agreement to our study, another study carried out to compare CHX gluconate with EOs and water demonstrated higher reduction in the bacterial counts with CHX gluconate.

In contrary to the present study, a study comparing the efficacy of aerosol reduction devices with 0.12% CHX solution as a preprocedural rinse demonstrated that the aerosol reduction suction device was better than the 0.12% CHX and distilled water in reducing the bacterial aerosol production. Furthermore, the combination of aerosol reduction device and 0.12% CHX did not improve the results further.

In another study undertaken to compare the effects of 0.12% CHX rinse v/s HR mouthwash on gingival health reported CHX to be more effective in reducing bacterial population and thereby greater reduction in gingival inflammation. The results of the present study also report CHX superior to HR mouthwash in bacterial population reduction in the aerosol produced during ultrasonic scaling. Haffajee et al. compared the antimicrobial activity of HR mouthwash compared with EO mouthwash alone and combined with 0.12% CHX against Streptococcus mutans, Streptococcus sanguis, and Actinomyces viscosus. The HR mouth rinse, containing natural ingredients, produced the largest zones of microbial inhibition when compared to EO mouthwash against all three of the bacteria tested. The present study, the bacterial reduction in the aerosols was found more after the use of EO mouthwash in comparison to the HR mouthwash. Hence, these results are different from those obtained by Kaim et al. The reason for the difference may be attributed to the difference in the composition of HR mouthwash used in both the studies.

The limitation of the study is that we have just counted the aerobic bacteria capable of growth on agar plates. The anaerobic bacteria and viruses have not been included in the study.
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Conflicts of interest
There are no conflicts of interest.

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