Article published online: 2021-11-01

ORIGINAL ARTICLE

Chlorine dioxide: An ideal preprocedural mouthrinse in dental set-up

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ABSTRACT

Background: Aerosols generated during ultrasonic scaling is a potential risk factor for cross-contamination in dental settings. The aim of this study is to evaluate and compare the efficacy of commercially available chlorine dioxide as preprocedural mouthrinses in reducing the level of viable bacteria in aerosols. **Materials and Methods**: This single-center clinical double-blinded study was conducted over a period of 4 months. A total of 80 patients were divided randomly into two groups (A and B) of 40 patients each to receive the chlorine dioxide mouthwash and water as preprocedural rinse. The aerosol produced by the ultrasonic unit was collected at five standardized location with respect to the reference point, that is, the mouth of the patient. The blood agar plates were incubated at 37°C for 48 h, and total number of colony-forming units (CFUs) was counted and statistically analyzed. **Results:** The results showed that CFUs in test group A were significantly reduced compared with control group B, $P < 0.001$ (analysis of variance). The numbers of CFUs were highest in the patient chest area and lowest at the patient front, that is, 6 o' clock position. **Conclusion:** This study proves that a regular preprocedural mouthrinse with chlorine dioxide could significantly reduce aerosols generated during professional oral prophylaxis.

Key words
Aerosols, chlorine dioxide, mouthrinses, ultrasonic scaling

INTRODUCTION

The oral cavity is a reservoir for a large number of microorganisms including bacteria and viruses. This ecological niche can be a pool for opportunistic and pathogenic microorganisms that can pose a risk for cross-contamination and infection and may even cause systemic infections. 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. There are a number of possible means by which transmission of viral and bacterial pathogens can occur in the dental practice. The patient's own saliva and blood are major vectors of cross-transmission. Blood-borne contamination can occur by exposure to the infectious material through the nonintact skin and mucosal lesions.[1] The use of an antimicrobial mouthrinse by the patient before dental procedures is based on a similar principle of reducing the number of oral microorganisms. This reduction also reduces the number of microorganisms that may escape a patient's mouth during dental care through aerosols, spatter, or direct contact. Aerosols are of great concern since they can remain suspended in the air for a great length of time. Hygienists utilizing prophy cups and ultrasonic scalers need to focus on limiting splatter and aerosols as well as lowering the amount of bacteria.[2,3] These aerosols may be inhaled into the lungs to reach the alveoli or may come in contact with the skin or mucous membranes. Most of the aerosols produced during treatment procedures have a diameter of 5 μm or less, and these can cause respiratory or other health problems because they can penetrate into, and remain within the lungs.[4,5] Chlorhexidine gluconate, a bisbiguanide, is considered to be the most effective anti-plaque agent,[6] but it also has some side-effects, notably tooth staining, taste alteration, enhanced supragingival calculus formation and less commonly desquamation of the oral mucosa.[7] Hence, in this clinical study an attempt has been made to evaluate the efficacy of preprocedural rinse of chlorine dioxide based mouthrinse (Oxyfresh® Power

Access this article online	
Quick Response Code:	Website: www.ejgd.org
	DOI: 10.4103/2278-9626.163321

Rinse) in reducing the microbial content of the aerosol in dental office.

MATERIALS AND METHODS

Study population

Totally, 80 systemically healthy individuals, age ranged 18–55 years were selected for participation in the study as illustrated in Table 1. Inclusion criteria was: Dentition with ≥20 teeth (minimum of five teeth per quadrant), with plaque index (PI) (Silness and Loe) and gingival index (Loe and Silness) scores between 2 and 3 were selected in the study. Patients with other oral lesions, wearing any fixed or removable prosthesis, and with any past history of systemic illness or allergy to components of mouth rinse were excluded from the study. The selected subjects were further instructed not to mouthrinse on the day of appointment. All subjects were explained the purpose of the study and informed consent was obtained from them. The study was approved by the Institutional Ethical Committee.

Study design

This was a clinical double-blinded interventional study; the preprocedural rinse was given to participants, and once the patients performed the rinse, the same operator performed scaling. The operator was not involved in any evaluations before or after. The treatment group was concealed from the patient, operator, and microbiologist. Study populations were randomly assigned into two groups who underwent prophylaxis after preprocedural rinsing for 1 min before scaling was performed, that is, test group (A) - Chlorine dioxide mouthrinse and control group (B) - Sterile water. The key ingredients of the chlorine dioxide mouthrinse used in the study is deionized water; zinc acetate; sodium citrate; chlorine dioxide concentrate (15% solution); xylitol; sucralose; aloe powder; sodium hydroxide and citric acid. In addition, it is nonalcoholic preparation, with no dye and color. To avoid aerosol contamination, the operating area was fumigated on the day before the treatment. Only one patient/day was treated on alternate days with ultrasound scaling. Before ultrasonic scaling, agar plates were placed on five standardized positions for aerosol collection in context to a reference point, that is, patient's mouth as illustrated in Table 2.

Clinical protocol

Oral prophylaxis was done on a randomly selected quadrant (control side) with the ultrasonic scaler for a period of 10 min. After the gap of 30 min, fair fresh blood agar plates were kept on the similar fixed position from the reference point as shown in Figure 1 (culture plate locations). The subjects were instructed to rinse with 10 ml mouthrinse (control and test) for a period of 1 min. Oral prophylaxis was again done with the same ultrasonic scaler on the other side (test side) of the same arch for a period of 10 min. Coolant water flow and power setting were adjusted on a medium mode. The amount of water flow from the ultrasonic scaler during 1 min was then measured using a graduated cylinder. Based on these measurements, a water coolant volume of 15 ml/min was used during all the measurements of aerosol contamination. Following the 10 min sampling

Table 1: Age and sex wise distribution of subjects

Age (years)	Group A: Chlorine dioxide (*n*=40)		Group B: Sterile water (*n*=40)	
	Male	Female	Male	Female
<20	2	0	1	0
20-30	2	5	3	4
30-40	11	11	10	9
40-50	4	4	4	6
>50	1	0	3	0
Total	20	20	21	19
Mean±SD	31.24±11.24	32.24±10.24	30.95±11.32	32.58±12.04

SD – Standard deviation

Table 2: Standardized distances of plates

Plate number	Plate position
Plate 1	1 feet from the reference point (at patient chest)
Plate 2	1 feet from the reference point (at operator position)
Plate 3	1 feet from the reference point (at assistant position)
Plate 4	2 feet from the reference point (at 12 o'clock position)
Plate 5	8 feet from the reference point (at 6 o'clock position)

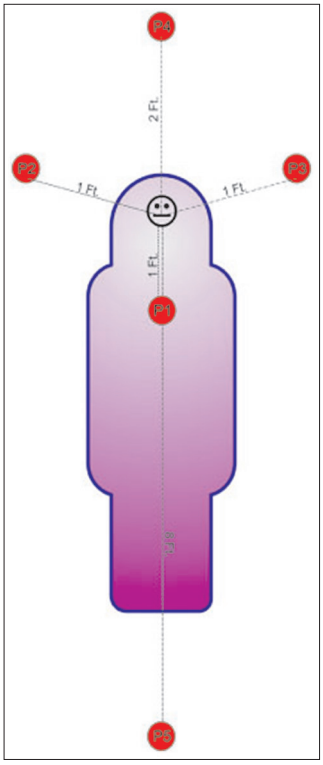

Figure 1: Culture plate locations

period, blood agar plates were covered and taken off the tray. All agar plates were sent for microbiological analysis to the microbiological laboratory for the colony-forming unit (CFU) count on the same day of ultrasonic scaling procedure.

RESULTS

By applying Student's unpaired *t*-test there was no significant difference between mean values of index (gingival index) and PI in both the groups (test and control) as illustrated in Table 3; that confirmed that all the subjects involved in both the groups in this study were equally affected with gingival inflammation. By applying Student's paired *t*-test there was a highly significant difference between mean values of CFUs values at all the plates from pre to post in test group A (chlorine dioxide) where value of $P < 0.01$; while no significant difference observed in control group B (sterile water) where value of $P > 0.05$ as shown in Table 4. By applying Student's unpaired *t*-test there was a highly significant difference between mean values of post-CFU in groups A and B in all the plates as shown in Table 5.

Table 3: Comparison of mean and SD values of GI and PI

Clinical parameters	Mean±SD (*n*=40)		Student's unpaired *t*-test value and significance
	Group A: Chlorine dioxide	Group B: Sterile water	
GI	2.757±0.277	2.7425±0.227	0.41, *P*>0.05, not significant
PI	2.675±0.225	2.68±0.2345	0.13, *P*>0.05, not significant

GI – Gingival index; PI – Plaque index; SD – Standard deviation

Table 4: Comparison of mean and SD values of CFUs from pre to post

Culture plates	Mean±SD (*n*=40)	
	Group A: Chlorine dioxide	Group B: Sterile water
Plate 1 pre	93.325±3.83	92.50±3.01
Plate 1 post	13.625±1.61	90.6±2.84
Plate 2 pre	89.35±4.31	92.32±3.45
Plate 2 post	12.75±1.373	90.37±2.72
Plate 3 pre	89.425±2.84	90.63±3.06
Plate 3 post	13.175±1.13	88.56±3.36
Plate 4 pre	74.325±4.33	74.36±3.03
Plate 4 post	10.65±1.63	71.51±3.30
Plate 5 pre	55.85±2.38	56.27±2.95
Plate 5 post	6.025±1.35	54.35±3.13

SD – Standard deviation; CFUs – Colony forming units

Table 5: Comparison of mean and SD values of CFUs from post to post

Plates	Mean±SD (*n*=40)		Student's unpaired *t*-test and *P* with significance
	Group A: Chlorine dioxide	Group B: Sterile wate	
Plate 1	13.625±1.61	90.6±2.84	*t*=149.18, *P*<0.01, highly significant
Plate 2	12.75±1.373	90.37±2.72	*t*=357.69 *P*<0.01, highly significant
Plate 3	13.175±1.13	88.56±3.36	*t*=347.39 *P*<0.01, highly significant
Plate 4	10.65±1.63	71.51±3.30	*t*=280.64 *P*<0.01, highly significant
Plate 5	6.025±1.35	54.35±3.13	*t*=222.70 *P*<0.01, highly significant

SD – Standard deviation; CFUs – Colony forming units

DISCUSSION

Aerosol and splatter are a concern in dentistry because of their potential effects on the health of the immune-compromised patients and on dental personnel. There are also regulations by the Occupational Safety and Health Administration about aerosol contamination abolition as a part of standards for indoor air quality. One of the reports indicated that the ultrasonic scaler is the greatest producer of contaminated aerosol and splatter.[8] Use of an antiseptic mouthwash by the patient prior to ultrasonic scaling has also been shown to be effective in reducing bacterial aerosols during treatment.[9] When chlorine dioxide was used as a preprocedural rinse, fewer CFUs were developed than without preprocedural rinse. The enhanced efficacy of chlorine dioxide in reducing the CFUs could be because of the reason that sodium chlorite (stabilized chlorine dioxide) may acts as a strong component to obliterate the microbiota via oxygenation and neutralization of toxins. The stabilized chlorine dioxide based products also destroy the volatile sulfide compounds, which further reduce the triggering of gingival inflammation. Chlorine dioxide also plays a vital role in damaging the cell membrane of the bacteria. The percentage changes for value of CFU from pre to post were 85.59% in plate 1, 85.73% in plate 2, in 85.27% plate 3, 85.67% in plate 4 and 89.21% in plate 5, respectively. These results confirmed that the preprocedural rinse with chlorine dioxide based mouth rinse was competent enough to reduce the viable bacterial count in aerosol during ultrasonic scaling in the dental operatory. The highest bacterial counts were detected on the plate 1 positioned at the patient's chest as illustrated in Figure 2 (colony formation in culture plate for groups A and B). These findings agrees with that of Bentley and Nancy[10] who observed that the larger salivary droplets generated during dental procedures settle rapidly from the air with heavy contamination on patient's chest. Next higher counts were found on the plates 2, positioned towards operator followed by plate 3, positioned towards the assistant side. Furthermore, a moderate bacterial contamination was found on plates 4 and 5 respectively. Compliance to the preprocedural is the main hurdle, and most of the conventional mouthrinse are alcohol based that leads to burning sensations, dryness, taste alterations and staining.[6,7] Chlorine dioxide based mouth rinse would be a true alternative in reducing the aerosol contamination with the advantage over the traditional alcohol based mouth rinse as they are more

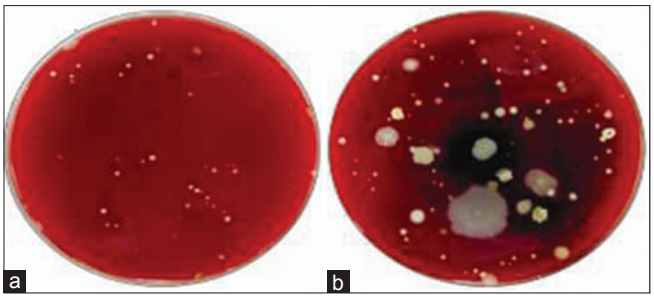

Figure 2: Colony formation in culture plate for groups a and b

tissue friendly with no side-effects and good compliance among the patients.

CONCLUSION

Preprocedural rinse used by patients before a dental procedure are anticipated to reduce the number of pathogens released by a patient in the form of aerosols or spatter that subsequently can contaminate equipment, operatory surfaces, and dental health care personnel. Though aerosol production cannot be totally eradicated with infection control procedures, the hazards of these aerosols can be minimized by preprocedural rinsing. The results of this study confirmed that Prerinsing with chlorine dioxide based mouthrinse (Oxyfresh® Power Rinse) was effective in reducing the aerosol contamination. More longitudinal multi centric studies with larger subjects will be planned to precisely analyze and compare the effectiveness of the chlorine dioxide bases mouth rinses with alcohol based mouthrinses.

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How to cite this article: Saini R. Chlorine dioxide: An ideal preprocedural mouthrinse in dental set-up. Eur J Gen Dent 2015;4:113-6.

Source of Support: Nil, **Conflict of Interest:** None declared.