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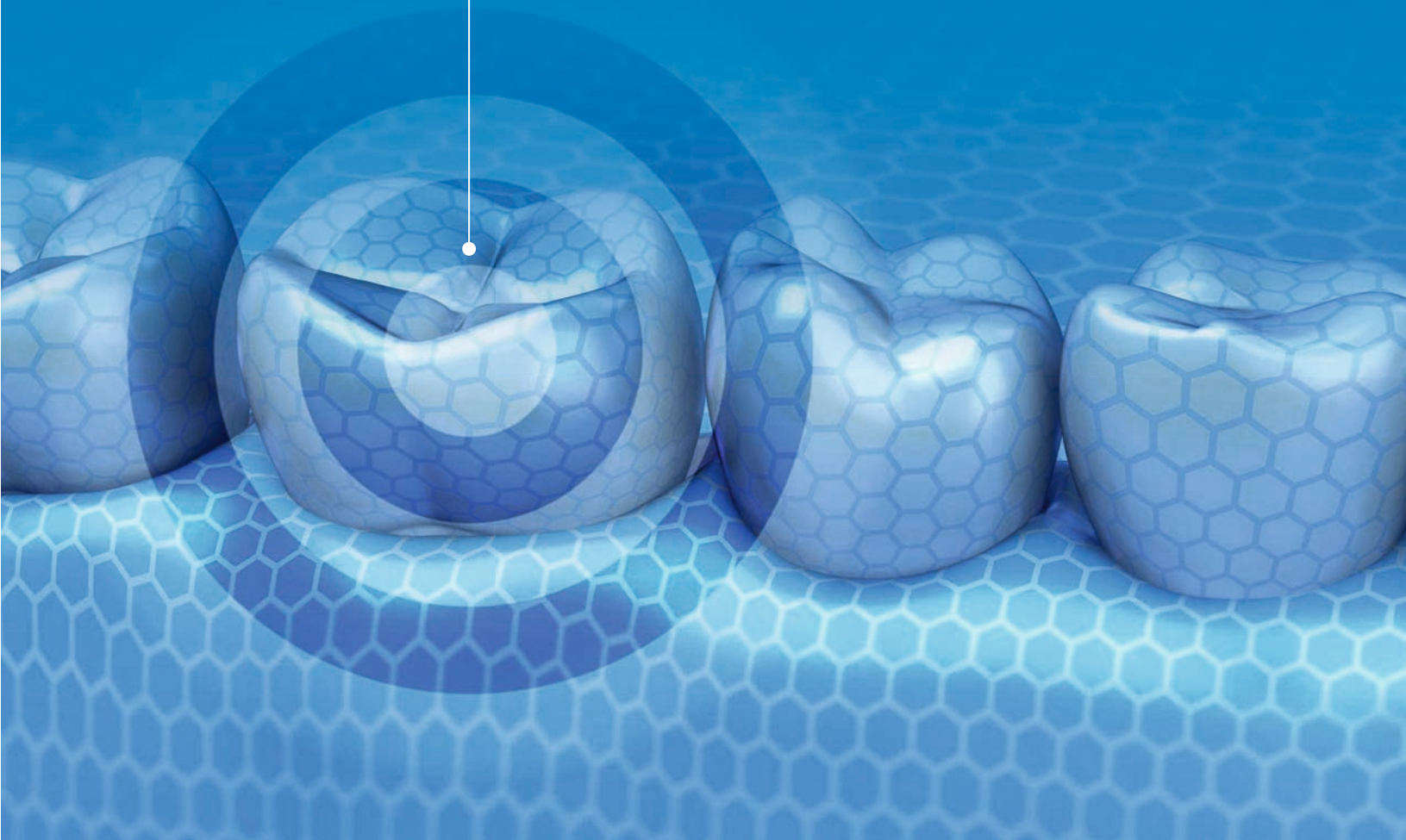

ORIGINAL ARTICLE

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

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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.

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)

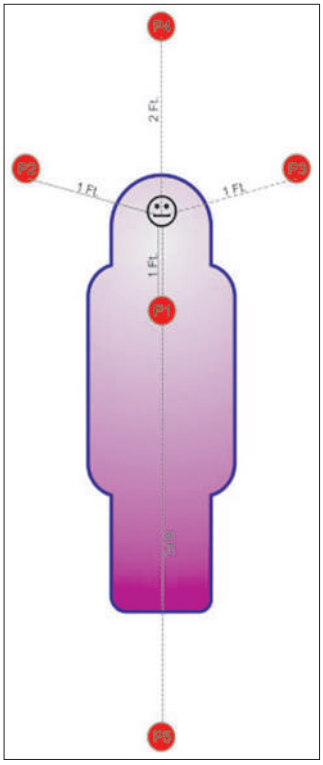

Figure 1: Culture plate locations

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

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

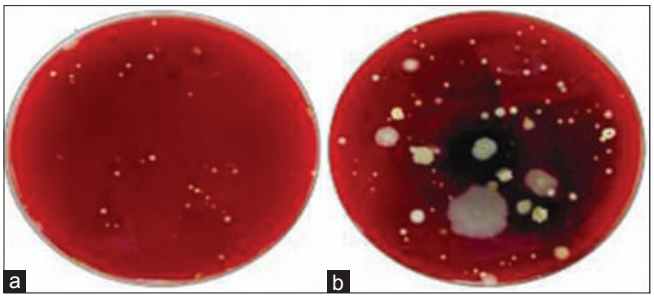

Figure 2: Colony formation in culture plate for groups a and b

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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Research Article

ANTIBACTERIAL EFFECTS OF 0.1% CHLORINE DIOXIDE ON *ACTINOMYCES* SP. AS AN AGENT OF BLACK STAIN

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ABSTRACT

Objective: This study aimed to assess the antibacterial effects of 0.1% chlorine dioxide and 0.1% chlorhexidine mouthrinses on the bacterial viability of *Actinomyces* sp. as an agent of black stain.

Methods: The authors conducted a clinical trial involving 16 children ages 6–11 with at least 8 black-stained teeth. Subjects were randomized into 2 groups and instructed to rinse with chlorine dioxide or chlorhexidine mouthrinse twice daily. At baseline and after 7 days, samples of black stain plaque were collected, and *Actinomyces* sp. was cultured. Its bacterial viability was evaluated using an 3-(4,5-dimethylthiazol-2-yl)-2,5-diphenyl-2H-tetrazolium bromide assay.

Results: After 7 days, *Actinomyces* sp. viability was remarkably reduced in both groups, and there was a significantly higher reduction in viability in the 0.1% chlorine dioxide group than there was in the 0.1% chlorhexidine group.

Conclusion: Mouthrinse containing 0.1% chlorine dioxide has a greater antibacterial effect against *Actinomyces* sp. than mouthrinse containing 0.1% chlorhexidine.

Keywords: *Actinomyces* sp., Black stain, Bacterial viability, Chlorine dioxide, Chlorhexidine.

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INTRODUCTION

Dental black stain is a type of extrinsic discoloration that can affect deciduous and permanent teeth. The clinical diagnosis of dental black stain is based on the presence of pigmented dark lines that run parallel to the gingival margin, rarely extending beyond the cervical-third of the tooth crown [*1,2].

The prevalence of black stain varies by age, population, and country. In Europe, the prevalence of black stain varies from 2% (Great Britain) to 4% (Poland), 6% (Italy), and 7% (Valencia, Spain). In South America, the prevalence ranges from 6% (Peru) to 15% (Brazil). On the Asian continent, it varies from 16% (Philippines) to 18% (India) [3,4]. In Indonesia, the prevalence of black stain is approximately 5% [5].

The etiology factors of black stain are not fully understood, although certain types of bacteria seem to be involved [6]. The previous studies have reported a relationship between black stain and chromogenic bacteria such as *Actinomyces* sp. and *Prevotella melaninogenica*. The majority of bacteria (90%) that can be isolated from black stain are facultative aerobic and anaerobic Gram-positive rods, which are identified as *Actinomyces* sp. [6,7].

Black stain tends to recur despite good personal oral hygiene but less may grow when biofilm control procedures are performed meticulously [7]. *Antibacterial mouthrinse has been considered an effective method of controlling dental plaque [8]. Evidence in the dental literature supports chlorhexidine as the gold standard of biofilm-preventing antiplaque and antigingivitis agents [9]. However, regardless of chlorhexidine potent antimicrobial properties, local side effects such as tooth staining restrict how long each patient can use it [9,10]. Since there is no significant difference between the antimicrobial efficacy of 0.1% and 0.2% chlorhexidine, dentists recommend mouthrinses with the lower concentration (0.1%) [11].

Chlorine dioxide has been widely used in various fields because it is safe and has strong antibacterial properties [12,13**]. *In dentistry, chlorine dioxide has been used in the treatment of oral, and especially periodontal diseases [14]. The main advantages of this product are that it is non-staining, alcohol-free, and non-irritating, that it does not cause taste alteration, and that it is free of sodium lauryl sulfate [15]. Chlorine dioxide mouthrinses have been widely used in developed countries such as Japan and North America [12]. A previous study suggests that 0.1% chlorine dioxide is effective as an antibacterial agent and does not cause side effects, such as a reduced sense of taste or tooth discoloration [16].

Studies that focus on the black stain and its treatment are rarely found in the dental literature [6]. The aim of this study was to assess the antibacterial effects of mouthrinses containing either 0.1% chlorine dioxide or 0.1% chlorhexidine on the bacterial viability of *Actinomyces* sp. as an agent of black stain.

METHODS

Subjects

The subjects were 16 children aged 6–11 who were recruited from two elementary schools in Jakarta and the Pediatric Dentistry Clinic at the Faculty of Dentistry, Universitas Indonesia. All subjects had at least 8 black-stained teeth (deciduous or permanent), no medical disorders, and deft indices of ≤5. No subjects were undergoing antibiotic or other antimicrobial therapy, and all were able to participate in the experiment. The subjects and their parents received verbal and written information about the study, and the parents of all subjects signed forms giving their consent for their children to participate. Oral examinations were conducted to assess the oral status of the subjects before the experiment. No subjects reported using commercial mouthrinse or antibacterial toothpaste on a regular basis. All dental examinations, both baseline and follow-up, were conducted by a single trained examiner.

The study design, protocol, and informed consent were approved by the Ethics Committee of the Faculty of Dentistry, Universitas Indonesia. The procedures, possible benefits, and possible discomforts or risks were fully explained to the subjects and the subjects' parents.

Study design

This study was a randomized, single-blind clinical trial, and laboratory observation. Each subject was randomly assigned to one of 2 groups. The group 1 subjects (n=8) were instructed to rinse with 10 ml of experimental mouthrinse containing 0.1% chlorine dioxide for 7 days, twice per day (after breakfast and before sleeping) for 30 s each time. Those in Group 2 (n=8) were instructed to rinse in the same way with a mouthrinse containing 0.1% chlorhexidine.

At baseline and after 7 days, samples of black stain plaque were collected from the subjects into sterile Eppendorf tubes using new metal excavators. All samples were placed on ice before being immediately sent to the Oral Biology Laboratorium at the Faculty of Dentistr y, Universitas Indonesia.

***Actinomyces* sp. colonization and identification**

Brain heart infusion (BHI) broth (1 ml) was added to the Eppendorf tubes containing samples of black stain plaque. The contents of each Eppendorf tube were homogenized using a vortex mixer, and 20 µl of the bacterial suspension were transferredto *Actinomyces* agar, used as a selective medium for *Actinomyces* sp. The agar plate was placed inside an anaerobic jar (containing 80% N_2, 10% H_2, and 10% CO_2) and incubated for 48 h at 37°C. The identification of the *Actinomyces* sp. culture was done by visual inspection and the Gram staining procedure.

Viability test using an 3-(4,5-dimethylthiazol-2-yl)-2,5-diphenyl-2H-tetrazolium bromide (MTT) assay

One loopful of the identified *Actinomyces* sp. colony was transferred to fresh BHI broth. The broth was homogenized using a vortex mixer, and 200 µl of the bacterial suspension were transferred to each well of a 96-well microplate. The microplate was placed inside an anaerobic jar (containing 80% N_2, 10% H_2, and 10% CO_2) and incubated for 24 h at 37°C.

Each well was washed with phosphate-buffered saline solution, and 50 µl 5 mg/ml of MTT solution were added. The microplate was again placed inside the anaerobic jar (containing 80% N_2, 10% H_2, and 10% CO_2) and incubated for 3 h at 37°C while covered with aluminum foil. Acidified isopropanol (100 µl) was added to each well, and the microplate was placed on an orbital shaker (50 rpm) for 1 h at 25°C [17]. The optical density (OD) was read using an ELISA reader at a wavelength of 490 nm.

There were no significant differences in any OD measures between the two groups at the baseline measurement.

Statistical analysis

Paired subjects' t-tests were used to compare *Actinomyces* sp. bacterial viability (based on OD measures) at baseline and after 7 days of rinsing with the 0.1% chlorine dioxide and 0.1% chlorhexidine mouthrinses. Individual subjects' t-tests were used to compare *Actinomyces* sp. bacterial viability between the two mouthrinses.

RESULTS

All 16 subjects completed the study. The *Actinomyces* sp. bacterial viabilities, based on OD measures, are listed in Table 1. At baseline, there were no statistically significant differences in *Actinomyces* sp. bacterial viability (OD measures) between the two groups. After 7 days of rinsing, there were statistically significant differences compared with baseline in *Actinomyces* sp. bacterial viability in both the chlorine dioxide and the chlorhexidine groups, with p=0.001 and p=0.010 (p<0.05), respectively.

The mean value differences in *Actinomyces* sp. bacterial viability between the two mouthrinses, based on OD measures, are listed in Table 2. Statistically significant differences between the two mouthrinses were found, with p=0.012 (p<0.05). A statistically significantly greater reduction in *Actinomyces* sp. bacterial viability was found in the chlorine dioxide group after 7 days compared to that found in the chlorhexidine group after the same period.

DISCUSSION

This was a preliminary study on finding alternative treatments for preventing black stain recurrence in children. Recurrence is caused by ferric sulfide precipitation, and the study aimed to prevent it by reducing *Actinomyces* sp. viability as one of the etiological factors of black stain. In this randomized clinical trial, two mouthrinses were compared, one containing chlorine dioxide and the other containing chlorhexidine.

The antibacterial agent used in this study was a commercially available 0.1% chlorine dioxide mouthrinse (Oxyfresh, Oxyfresh Worldwide Inc., Idaho, USA). Research reports that chlorine dioxide-based mouthrinse is a proven bactericidal agent against bacterial pathogens that cause periodontitis, for example, *Aggregatibacter actinomycetemcomitans*, *Fusobacterium nucleatum*, *Porphyromonas gingivalis,* and *Prevotella intermedia* [17-19]. This research concludes that chlorine dioxide gel effectively kills the Gram-positive bacteria *Streptococcus mitis* and *Streptococcus constellatus* [18]. Until now, however, there has been a limited study of the effectiveness of chlorine dioxide against the Gram-positive bacteria *Actinomyces* sp., especially in association with black stain. Black stain treatment is currently done by scaling and selective polishing, but the recurrence rate is high enough to cause esthetic problems [8,9].

The age range selected for the subjects was 6–11 years, which is the period of mixed dentition. Children in this age range are also able to rinse and follow oral hygiene instructions. The literature states that black stain is quite common in children and can be found in both deciduous and permanent teeth [6,18**]. In accordance with the enamel surface properties of deciduous teeth, i.e., higher permeability and porosity levels than permanent teeth, the black stain is often found in primary teeth [5].

Of the 147 children examined, 16 had black stain and were then divided randomly into 2 groups. The first group consisted of 8 children, who were given a 0.1% chlorine dioxide mouthrinse for 7 days. The second group also consisted of 8 children, who were given a 0.1% chlorhexidine

Table 1: Comparison of the mean values of *Actinomyces* sp. bacterial viability at baseline and after 7 days of rinsing

Mouthrinses	n	Mean±SD		p
		Bacterial viability (OD) baseline	Bacterial viability (OD) 7 days after	
Chlorine dioxide (0.1%)	8	0.73±0.11	0.40±0.21	0.001
Chlorhexidine (0.1%)	8	0.67±0.18	0.54±0.09	0.010

Paired subjects' t-tests; significance level based on p<0.05. SD: Standard diviation, OD: Optical density

Table 2: Comparison of the mean value differences in *Actinomyces* sp. bacterial viability between the two mouthrinses

Mouthrinses	n	Δ bacterial viability (OD) mean±SD	p
Chlorine dioxide (0.1%)	8	0.33±0.17	0.012
Chlorhexidine (0.1%)	8	0.13±0.10	

Individual student's t-test; significance level based on p<0.05. SD: Standard diviation, OD: Optical density

mouthrinse for 7 days. The rinsing period was determined as 7 days based on a previous study, which showed a decrease in the number of Gram-negative anaerobic bacteria in saliva after 7 days of rinsing with 0.1% chlorine dioxide [13]. Gram-negative bacteria have complex cell walls, making them more difficult to penetrate with chlorine dioxide [14]. Since the cell walls of Gram-positive bacteria are simpler, chlorine dioxide can easily penetrate the cell walls of Gram-positive bacteria such as *Actinomyces* sp., and the number of bacteria can be reduced within 7 days.

Subject homogenization was done by choosing subjects who had good oral hygiene, had deft indices of ≤5, and werein the middle-to-upper socioeconomic level. The subject selection was conducted in two elementary schools and the Pediatric Dentistry Clinic Universitas Indonesia, serving the middle-to-upper socioeconomic level in Jakarta. Research in China reports that children of higher socioeconomic status are associated with an increased incidence of black stain. The mean value of the deft indices in the black stain group was also significantly lower than that in the group without black stain [2]. An immunological study examining bacterial attachment confirms that a higher number of *Actinomyces naeslundii* in dental biofilms is associated with low caries rates (low deft index values) [4]. In this study, the gender of the subject was not considered. Only 2 of the 16 subjects were female, and research in China reports no significant relationship between black stain and gender [2].

This study used black stain plaque samples because previous research has proven that the quantity of *Actinomyces* sp. is more abundant in the plaque samples of children with black stain than in those of children without black stain [18-20]. In this study, dental plaque and black stain were not distinguished from each other because previous research shows that there is no significant difference between the quantity of *Actinomyces* sp. in dental plaque and that in black stain [20]. Samples were not taken from saliva because the previous studies show that, although the quantity of *Actinomyces* sp. in the saliva of children with black stain is higher than that in the saliva of children without it, the difference is not statistically significant [5].

Microbiological samples of *Actinomyces* sp. were taken from black stain plaque according to the inclusion criteria. Samples were taken in the morning within 2–4 h after tooth brushing in accordance with previous research confirming that relatively stable amounts of *Actinomyces* sp. can be found in the early stages of plaque formation within 0–6 h after tooth brushing [21].

Acytotoxicity assay can be used to assess the antibacterial effects of certain substances. The cytotoxicity of a substance can be measured in various ways, one of which is through the decrease in cell viability following its application. The MTT assay has become the preferred method of determining cell viability through the activity of mitochondrial reductase enzymes, expressed by OD. The value of OD is proportional to the number of living cells [17,22].

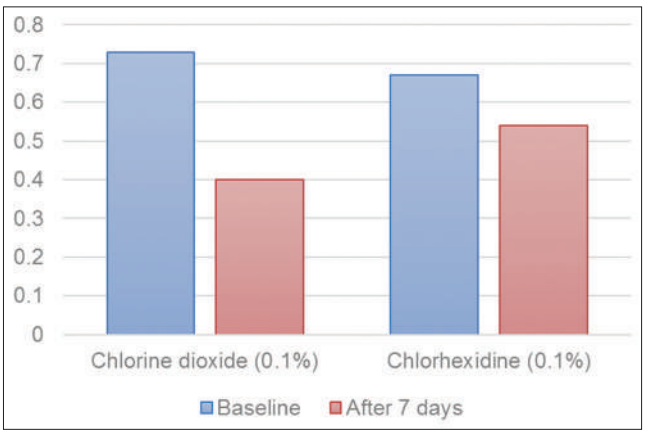

Fig. 1: Comparison of the mean values of *Actinomyces* sp. bacterial viability at baseline and after 7 days of rinsing

In this study, the antibacterial properties of 0.1% chlorine dioxide and 0.1% chlorhexidine were expressed in the reduction of *Actinomyces* sp. bacterial viability, based on the value of the OD. Statistical analysis using paired subjects' t-tests, listed in Table 1, resulted in the conclusion that, compared with the baseline, and there were statistically significant differences in *Actinomyces* sp. bacterial viability in both the chlorine dioxide and chlorhexidine groups after 7 days of rinsing. This result was consistent with the literature, which states that 0.1% chlorine dioxide and 0.1% chlorhexidine have strong antibacterial properties and can kill bacteria in the oral cavity [12,13**].

The previous research suggests that rinsing with a 0.1% chlorine dioxide mouthrinse for 7 days effectively reduces the number of Gram-positive and Gram-negative anaerobic bacteria in the oral cavity. Another study on the bactericidal activity of chlorine dioxide states that chlorine dioxide mouthrinse can kill up to 90% of oral pathogens in <30 min and that the effect lasts up to 7 h [13,23**].

A statistical analysis using individual subjects' t-tests, which are shown in Table 2, resulted in the conclusion that there was a significant difference between the two mouthrinses. The chlorine dioxide group exhibited a statistically significantly greater reduction in the bacterial viability of *Actinomyces* sp. than did the chlorhexidine group. It can be concluded that a 0.1% chlorine dioxide mouthrinse has a stronger antibacterial effect against *Actinomyces* sp. than a 0.1% chlorhexidine mouthrinse.

Chlorine dioxide is an antibacterial agent that penetrates the bacterial cell wall and binds to the vital amino acids (cysteine, methionine, tyrosine, and tryptophan) that are essential for microorganisms in the cell wall and bacterial cytoplasm [*13,24-26]. Chlorine dioxide destabilizes the permeability of the bacterial cell membrane, causing the cell wall to rupture [14]. The resulting disturbance of the nutrient transport system through the cell wall will kill the bacterium [25]. Chlorine dioxide also limits the proliferation of anaerobic bacteria through oxygenation and the neutralization of the toxins (bacterial proteolytic enzymes) that bacteria produce in the oral cavity [15].

In vitro studies suggest that chlorine dioxide is less toxic to human gingival cells than chlorhexidine. Chlorine dioxide does not form chlorinated hydrocarbons when in contact with organic compounds, so it is not carcinogenic or allergenic. Study subjects also do not complain of changes in taste after using 0.1% chlorine dioxide mouthrinse [13,23,24**]. All of these advantages make chlorine dioxide a safe antibacterial agent that can be used by children.

Chlorhexidine was used in this study because it has been recognized as the gold standard of antibacterial agents. Research conducted *in vitro* shows that 0.2% chlorhexidine mouthrinse is effective against the majority of oral bacteria, including *Actinomyces viscosus* [9]. A 6-month longitudinal study reported increased staining in a group rinsing with chlorhexidine, in comparison with a baseline measurement, and the concentration of chlorhexidine was correlated to stain formation and the intensity of dental discoloration [10]. Research conducted with children aged 10 to 12 reports changes in the patients' sense of taste after 1 week of rinsing with a 0.2% chlorhexidine mouthrinse [10]. In this study, a mouthrinse containing 0.1% chlorhexidine was used for a more acceptable effect on taste and a lower potential for stain formation. Chlorhexidine side effects, such as staining over prolonged periods of use and taste alteration, tend to limit the usage of this mouthrinse in children.

CONCLUSIONS

We can conclude from this study that there are significant differences in *Actinomyces* sp. bacterial viability after 7 days of rinsing with 0.1%

chlorine dioxide and 0.1% chlorhexidine mouth rinses. These mouth rinses are effective in reducing *Actinomyces* sp. bacterial viability, which is widely considered an etiological factor of black stain.

We can also conclude that there are significant differences between the two mouthrinses. After 7 days of rinsing, there was a significantly greater reduction in *Actinomyces* sp. bacterial viability in the chlorine dioxide group than there was in the chlorhexidine group. Therefore, it can be concluded that mouthrinse containing 0.1% chlorine dioxide has a greater antibacterial effect against *Actinomyces* sp. than mouthrinse containing 0.1% chlorhexidine.

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Research Article

A prospective experimental comparative study on the clinical and antimicrobial effects of chlorine dioxide based toothpaste and mouthrinse in periodontitis patients- A One Year Follow-up Study

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Abstract

Aim: The present study was aimed to assess and compare the clinical and antimicrobial effects of sodium chlorite based toothpaste and mouthrinse in periodontitis patients.

Materials and methods: A total 50 generalized chronic periodontitis patient between the ages of 18 and 55 years were enrolled in the study and divided under two categories (A and B). Clinical and microbiological parameters were recorded prior to phase 1 therapy; and subjects were put on conventional oral hygiene regime and sodium chlorite based toothpaste and mouthrinse.

Results: The results of this study showed that there was significant decrease in clinical and microbiological parameters from baseline to 12 months in both the groups ($p < 0.01$). The subjects under test group (sodium chlorite based toothpaste and mouthrinse) showed a highly significant reduction to all the parameters as compared to subjects under group B.

Conclusion: sodium chlorite based toothpaste and mouthrinse will be a true alternative for maintaining oral hygiene.

Keywords: Chlorine Dioxide, Mouthrinse**,** Periodontitis

1.Introduction

Mouth acts as a window to lot of systemic diseases and serves as a port of entry of the various infections that can alter and affect the immune status of the person. The oral cavity has the potential to harbor at least 600 different bacterial species, and in any given patient, more than 150 species may be present, surfaces of tooth can have as many as billion bacteria in its attached bacterial plaque.[1] Periodontitis is a destructive inflammatory disease of the supporting tissues of the teeth and is caused either by specific microorganisms or by a group of specific microorganisms, resulting in progressive destruction of periodontal ligament and alveolar bone with periodontal pocket formation, gingival recession, or both.[2] Dental plaque biofilm cannot be eliminated. However, the pathogenic nature of the dental plaque biofilm can be reduced by reducing the bio-burden (total microbial load and different pathogenic isolates within that dental plaque biofilm) and maintaining a normal flora with appropriate oral hygiene methods.[3]

Toothbrushing is the most common and most accessible means of preventive oral health care available. The primary purpose of brushing the teeth with a dentifrice is to clean the accessible tooth surfaces so as to minimize the accumulation of dental plaque, stains and food debris. Toothpaste manufacture over the last several decades has been driven by a combination of dental research findings and marketing forces. The recent past has witnessed

resurgence in the use of sodium chlorite based dentifrices; the main application of sodium chlorite is the generation of chlorine dioxide. An insufficient amount of clinical trials on sodium chlorite based mouth rinses and dentifrices has been reported, which is in stark contrast with a plethora of such for conventional oral care products. In, addition as only a limited number of studies on sodium chlorite based products (Dentifrice and Mouthrinse) have been published, it has not been determined whether they are superior, equivalent or substandard to conventional dentifrices and mouthrinse in improving oral health.

Hence an attempt has been made in the present study to assess and compare the clinical and antimicrobial effects of sodium chlorite based toothpaste and mouthwash in periodontitis patients with conventional alcohol based toothpaste and mouthwash without sodium chlorite.

2. Materials and Methods

The present study was conducted in the Department of Periodontology, Pravara Institute of Medical Sciences, Loni, Maharashtra, India. The research protocol was approved by the University Research and Ethical Committee. Verbal and written informed consent was obtained from all subjects prior to their voluntarily enrollment in the study.

2.1 Study population

The subjects enrolled in this study were selected from the Outpatient Department of Periodontology, Pravara Institute of Medical Sciences, Loni, Ahmednagar, Maharashtra, India. The study included a total of 50 subjects with chronic periodontitis and all 50 subjects were grouped into two categories (A and B) and each group was comprised of 25 subjects each as illustrated in Table 1. Exclusion criteria for the patient enrolled in the study were: (1) Presence of any systemic neurological disorder (e.g. epilepsy or schizophrenia), (2) presence of a disease with possible effects on the immune system (e.g. chronic infections or cancer), (3) patient who have received antibiotics or nonsteroidal anti-inflammatory drug (like ibuprofen) in past 9-11 weeks, (4) patients who have received periodontal treatment in past 6 months, (5) pregnant and lactating mother, (6) patient with artificial prosthesis, (7) patients who smokes or consumes tobacco in any form, (8) patients suffering with arthritis, (9) patient with any type of heart disease (myocardial infarction, coronary heart disease, etc.), (10) female patient using intrauterine birth control devices or birth control pills, (11) obese individuals (30 and above range as per WHO body mass index cut-off for weight categories for Asians), (12) presence of diabetes mellitus (13) participants not willing to participate in the study.

2.2 Clinical Protocol

Patients received a verbal description about the clinical protocol to be followed in this clinical study. In order to have the unbiased and accurate clinical data, we followed a double blind protocol in the study for enrollment of the patients in terms of treatment plan (Phase 1 Therapy). Also categorization of patients were done randomly, with oral products regime (With and without chlorine dioxide) to be followed after the phase 1 therapy. After enrollment of the subjects in the study, Phase 1 therapy (Complete scaling and root planing) was done by similar EMS ultrasonic scaler to all the subjects enrolled in the study. Subjects under both the groups were advised to brush twice daily 5 minutes with modified bass method technique (Technique demonstrated to each subject) and similar medium bristle tooth brushes were provided to each of the subject during the study course to maintain standardization. The subjects were further advised for a mouthrinse twice daily (10 ml in quantity for 1 minute).

2.3 Clinical parameters protocol

Clinical parameters of periodontal disease that were evaluated were gingival index (GI), plaque index (PI) and clinical attachment loss (CAL).

2.3.1 Gingival index

The teeth selected as index teeth were 16, 12, 24, 32, 36 and 44. The tissues surrounding each tooth were divided into four gingival scoring units: Disto-facial papilla, facial gingival margin, mesio-facial papilla and the entire lingual gingival margin. A blunt instrument such as a periodontal probe was used to assess the bleeding tendency of the tissues. The index for each index tooth was recorded and then calculated by dividing total number of index teeth examined. This provided the GI for the individual.

2.3.2 Plaque index

All teeth were examined on four surfaces (i.e. mesiobuccal, buccal, distobuccal and lingual/palatal) after using a disclosing agent. Plaque Index = Total plaque score/Number of surfaces examined

2.3.3 Clinical attachment loss

The clinical attachment level was examined with William's graduated probe. Clinical attachment level (CAL) represents distance from cementoenamel junction to the base of the gingival sulcus or periodontal pocket. Average CAL of the person is calculated by dividing the total clinical attachment

level by the number of teeth examined. Chronic periodontitis is sub classified as mild or slight, moderate and severe periodontitis based on CAL according to American Academy of Periodontology 1999 classification of periodontal diseases. If gingival recession is present then, loss of attachment is calculated by the distance between the cement enamel and gingival margin to be added to pocket depth.

2.4 Microbiological protocol

Subgingival plaque samples were collected for specific bacterial examination that is, *Aggregatibacter actinomycetemcomitans* (Aa), *Fusobacterium nucleatum* (Fn), *Porphyromonas gingivalis* (Pg) and *Prevotella intermedia* (Pi). Subgingival plaque samples were then collected from the sample sites using the standardized paper point (Dentsply)® which were inserted to the depth of the periodontal pocket until resistance was felt. The paper points were retained for 20 s in the collection sites. The samples site selected was maxillary first molar in all the cases to maintain the standard protocol. After 20 s the paper point was removed from the sample site and immediately transferred into Robertson's cooked meat transport (RCM) in a test tube for specific bacterial culturing. In the laboratory, the RCM was subjected to vortex homogenization for 60 s before incubated anaerobically (Gas pack system) for 2-3 days.

3. Results

Distribution of mean and standard deviation values of all the clinical and microbiological parameters of both the groups (A and B) were illustrated in Tables 2 and 3. By applying Student's Paired 't' test, there was a significant decreased from baseline to 12 months for mean values of clinical and microbiological parameters in both the groups i.e. $p<0.01$; while group A shows higher decrease than group B. Graph 1 shows comparison of mean values of clinical parameters in Group A and Group B at 12 months i.e. by applying Student's Unpaired 't' test there was a highly significant difference between mean values of clinical parameters of GI and PI in Group A as compared with Group B (i.e. $p<0.01$). Similarly, Comparison of mean values of microbiological parameters in Group A and Group B at 12 months i.e. By applying Student's Unpaired 't' test there was a highly significant difference between mean values of *Aggregatibacter Actinomycetemcomitans, Fusobacterium Nucleatum, Porphyromonas Gingivalis and Prevotella Intermedia* in Group A as compared with Group B (i.e. $p<0.01$) as seen in Figure 2.

Table.1: Distribution of chronic periodontitis patients in study groups (A and B)

Group	Patient Clinical Protocol	No. of Subjects
A	Chronic periodontitis patients with complete oral prophylaxis (Scaling and Root Planing) followed by use of chlorine dioxide based toothpaste and mouthrinse. (Oxyfresh® Toothpaste and Oxyfresh® Mouthrinse)	**25**
B	Chronic periodontitis patients with complete oral prophylaxis (Scaling and Root Planing) followed by use of conventional alcohol based toothpaste and mouthrinse. (Conventional Alcohol based toothpaste and Mouthrinse)	**25**

Table 2 Distribution of mean and standard deviation values of clinical parameter in Groups (A and B)

Groups	Clinical Parameters	Baseline	6th Month	12th Month
Group A	**GI**	2.76±0.27	1.25±0.29	0.66±0.27
	Pl	2.64±0.26	1.13±0.26	0.552±0.24
	PD	5.92±0.81	3.68±0.62	2.68±0.62
	CAL	5.92±0.81	3.68±0.55	2.68±0.55
Group B	**GI**	2.84±0.10	1.46±0.24	0.85±0.10
	PI	2.82±0.10	1.45±0.21	0.80±0.088
	PD	5.92±0.64	3.72±0.67	2.72±0.67
	CAL	5.92±0.81	3.72±0.61	2.72±0.61

GI: Gingival Index; PI: Plaque Index; PD: Probing Depth and CAL: Clinical Attachment Loss

Table 3 Distribution of mean and standard deviation CFU values of Microbiological parameter in Groups (A and B)

Groups	Microbiological Parameters	Baseline	6th Month	12th Month
Group A	***Aa***	31.52±6.64	23.04±6.71	17.52±6.64
	Fn	32.32±5.81	23.88±5.92	18.36±5.75
	Pg	30.4±6.09	21.88±6.21	16.36±6.10
	Pi	31.72±6.06	23.32±5.89	17.80±5.96
Group B	***Aa***	32.52±5.79	26.04±5.88	21.52±5.78
	Fn	31.56±5.41	25.12±5.47	20.6±5.35
	Pg	30.88±5.52	24.4±5.53	19.88±5.52
	Pi	31.64±6.10	25.20±5.98	20.72±6.08

CFU: Colony Forming Units;_Aa: Aggregatibacter Actinomycetemcomitans; Fn: Fusobacterium Nucleatum; Pg: Porphyromonas Gingivalis and Pi: Prevotella Intermedia

Table No.4: Comparison of mean values of clinical parameters in Group A and Group B at 12 months

Clinical parameters at 12 months	Group A Mean ± SD	Group B Mean ± SD	Unpaired 't' test value	'p' value	Result
Gingival Index (GI)	0.66±0.27	0.85±0.10	3.33	p<0.01	highly significant
Plaque Index (PI)	0.55±0.24	0.80±0.088	14.26	p<0.01	highly significant
Clinical Attachment Loss (CAL)	2.68±0.55	2.72±0.61	0.25	p>0.05	not significant
Probing Depth (PD)	2.68±0.62	2.72±0.67	0.22	p>0.05	not significant

Table No. 5: Comparison of mean values of microbiological parameters in Group A and Group B at 12 months

Microbiological parameters at 12 months	Group A Mean ± SD	Group B Mean ± SD	Unpaired 't' test value	'p' value	Result
Aggregatibacter Actinomycetemcomitans	17.52±6.64	21.52±5.78	3.78	p<0.01	highly significant
Fusobacterium Nucleatum	18.36±5.75	20.6±5.35	2.47	p<0.01	highly significant
Porphyromonas Gingivalis	16.36±6.10	19.88±5.52	3.59	p<0.01	highly significant
Prevotella Intermedia	17.80±6.09	20.72±6.21	3.25	p<0.01	highly significant

Figure 1: Graph showing Comparison of mean values of clinical parameters in Group A and Group B at 12months

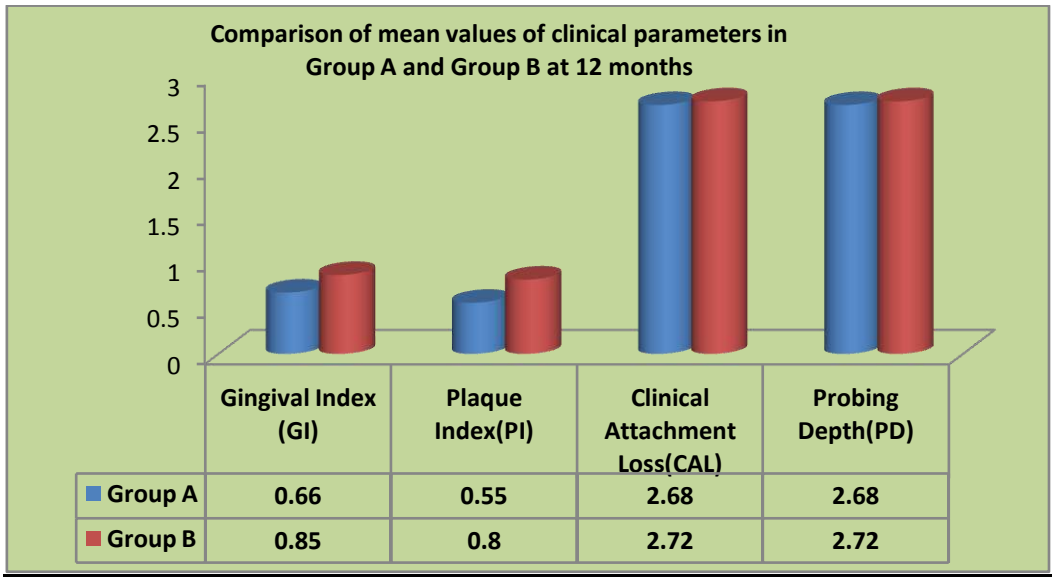
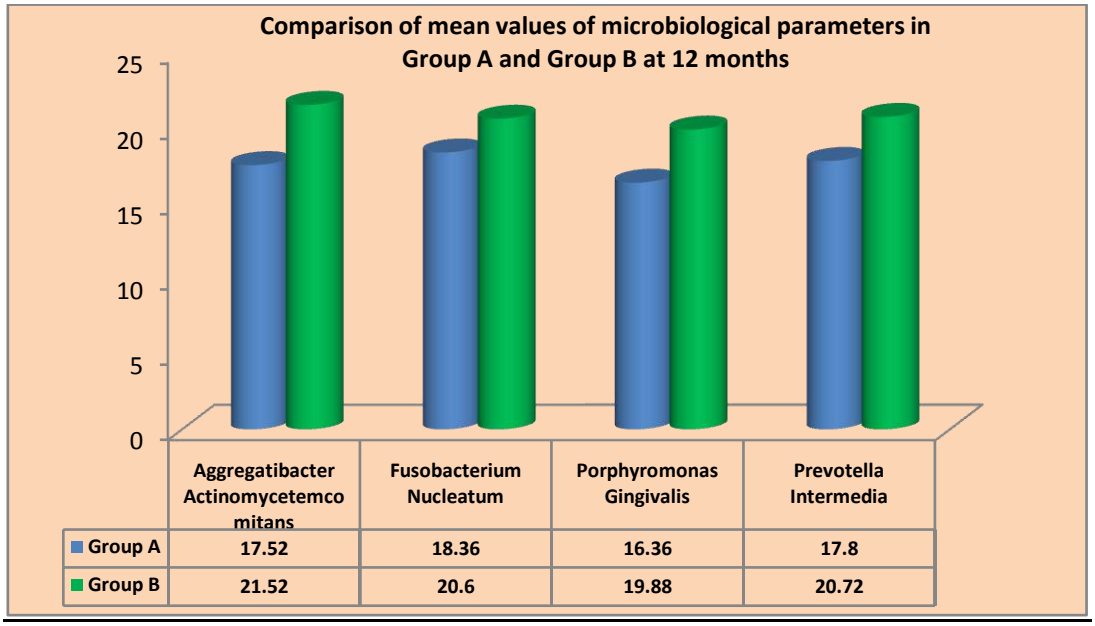


Figure 2: Graph showing Comparison of mean values of microbiological parameters in Group A and Group B at 12 months



4. Discussion

The significant clinical and microbiological improvement in Group A subjects (chlorine dioxide based toothpaste and mouth rinse) support that the hypothesis that Sodium Chlorite (Stabilized chlorine dioxide) may acts as a strong ingredient to restrict the proliferation of sub gingival anaerobic microbiota via oxygenation and neutralization of toxins (Bacterial proteolytic enzymes) produces by the bacteria in the oral cavity. The stabilized chlorine dioxide based products used in this study (Oxyfresh® Power Paste, and Oxyfresh® Power Rinse) also destroy the volatile sulfide compounds, which further reduce the triggering of gingival inflammation. The key benefits for these products also include non staining, alcohol free, non-irritating, no taste alterations, and sodium lauryl sulfate free (Foaming agent in toothpaste that initiate canker sore).

This study also revealed that the bactericidal activity of stabilized chlorine dioxide oral rinse (Oxyfresh® Power Rinse) has marked bactericidal effects against with pathogens of periodontitis, i.e. *Aa*, *Fn*, *Pg* and *Pi*. These results are consistent with previous studies evaluating a stabilized chlorine dioxide oral rinse against polymicrobial suspensions and biofilm environments.[5][6] The zinc acetate with xylitol further prevents the colonization of initial plaque formation and removes halitosis causing volatile organic compounds.

The comparative assessment revealed that sodium chlorite (Stabled Chlorine Dioxide) based dentifrice (Oxyfresh® Power Paste) and mouth wash (Oxyfresh® Power Rinse) has an edge over the conventional based dentifrice and mouth wash due to the above mentioned hypothesis and mechanism of the system that focus on the oxygenation of anaerobic environment and lead to disruption of the biofilm.

Well-designed multi centric longitudinal clinical trials with more number of subjects in different demographic locations for longer duration period should be done to evaluate the completely the effect of chlorine dioxide based oral hygiene products.

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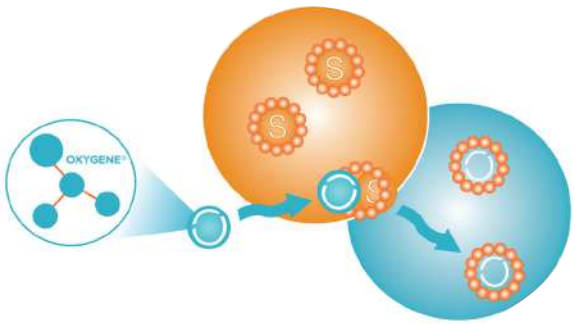

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Oxygene® se ha utilizado en la línea de productos dentales de Oxyfresh, incluidos enjuagues, pastas y geles, durante muchos años, atacando con éxito a las bacterias que causan el mal aliento. Se ha demostrado que la línea de enjuague bucal sin alcohol tiene un efecto antibacteriano similar al de la clorhexidina, pero sin las manchas y, a diferencia de la clorhexidina, se puede usar a largo plazo. Todo esto, complementado con aceites naturales de agradable sabor a menta o menta-limón, conlleva a un aliento fresco prolongado.

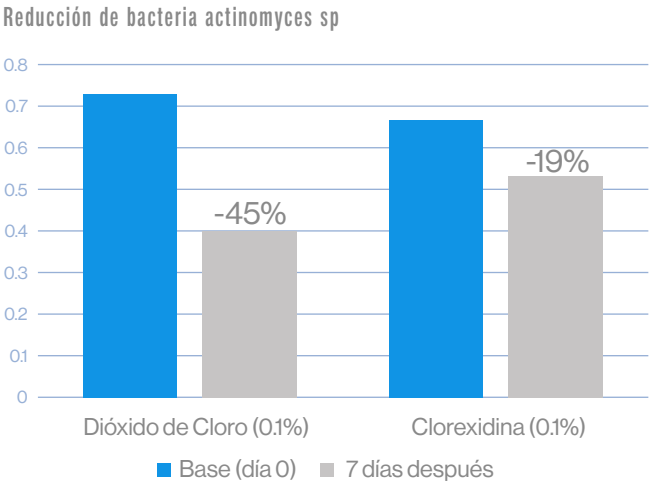
Desde el año 1999 se ha comprobado la eficacia de Oxyfresh en el combate del mal aliento, con un estudio de la Clinical Research Associate, que demuestra su **acción prolongada de aliento fresco un 33% mayor que el competidor que le sigue más cercano.**

PROTECCIÓN PERIODONTAL CONTRA LAS BACTERIAS

Estudios y años de experiencia clínica avalan al Dioxido de Cloro Estabilizado, fórmula base de Oxyfresh, como una solución más efectiva para eliminar las bacterias patológicas.

El **"International workshop on Dental Research hosted by Faculty of Dentistry Universitas Indonesia, Jakarta, 2017"**, demuestra que:

El efecto antibacterial de los enjuagues bucales con Dióxido de Cloro es más del doble del efecto de la Clorhexidina, sobre la viabilidad de la bacteria actinomyces sp como agente de las manchas negras.



El **"Journal of Biomedical and Advance Research 2015"** publicó los siguientes resultados de su estudio:

Los grupos de personas que usaron Oxyfresh vieron grandes mejoras en:

- ✓**Reducción de placa**
- ✓**Encías retraídas mejoradas**
- ✓**Fortalecimiento del tejido de las encías**
- ✓**Reducción de las bacterias que causan la periodontitis**

Por su parte, el **"European Journal of General Dentistry 2015 and Dental Hypotheses 2015"**, publicó:

"Los elementos microbiológicos disminuyeron en un 69% cuando se usa el enjuague Oxyfresh antes de los procedimientos."

PROTECCIÓN DE ÁREAS EROSIONADAS

Pro-Relief ayuda a brindar poder curativo gracias al zinc y ácido fólico en su fórmula. Muchas personas confían en Oxyfresh para calmar el dolor y promover la curación de las encías y la boca irritadas o inflamadas. La fórmula única del gel que incluye zinc, ácido fólico, 6 aceites esenciales y el ingrediente patentado Oxygene®, da alivio a problemas como llagas, ligeras irritaciones de la boca, hinchazón de la lengua y aftas bucales.

REFRESCA Y ESTIMULA EL FLUJO DE SALIVA

Los enjuagues bucales a base de alcohol producen una serie de consecuencias indeseadas. Son tan potentes que matan tanto a las bacterias malas como a las buenas, produciendo un desequilibrio. Otro efecto secundario, muy perjudicial, es que producen sequedad bucal, lo que puede conllevar diferentes afecciones o enfermedades orales. Los enjuagues bucales pueden producir lesiones en los tejidos internos de la boca. Son muchos los efectos negativos del alcohol en los enjuagues bucales.

Por eso, los enjuagues bucales Oxyfresh no contienen alcohol. Y, en particular, el enjuague bucal Oxyfresh Lemon Mint está hecho, además, con aloe vera, como calmante refrescante, junto con aceites esenciales hidratantes, xilitol, más el doble de zinc y Oxygene® para mantener la frescura por aún mayor tiempo.

¿Cómo funciona Oxygene®?

Los productos Oxyfresh, a diferencia de otras opciones, no disimulan los malos olores, mezclándose con ellos; sino que los neutralizan por completo.

Oxyfresh usa el poder de la ciencia para neutralizar el mal aliento que producen los VSC (compuestos volátiles de azufre).

Recomendado por dentistas y expertos en higiene bucal:

"He estado usando y recomendando productos Oxyfresh durante casi 20 años. Muchos productos han ido y venido desde entonces, pero nada puede compararse con la eficacia y la satisfacción del paciente que caracterizan cada producto Oxyfresh."

Dr. Gerald Crouch, Cirujano Dentista (DDS)
San Antonio, Texas.

"Utilizamos productos Oxyfresh con nuestros pacientes en el Instituto Nash porque se ha demostrado que son seguros para la estética dental, para mantener el aliento fresco y los tejidos sanos, y para mantener la sensibilidad siempre baja.
¡A nuestros pacientes les encanta y nosotros no podemos estar más contentos!"

Robin Glauss, Higienista Dental Registrada (RDH) y Dr. Ross Nash, Cirujano Dentista (DMD)
Miembros de la Academia Americana de Odontología Estética.
Charlotte, Carolina del Norte, Estados Unidos.

"Los productos Oxyfresh han sido parte integral de nuestra oficina durante más de 15 años. A nuestros pacientes les encanta cómo hace que su boca se sienta limpia y fresca sin efectos innecesarios de tinción ni abrasión."

Dra. Kimberly Nguyen, Cirujano Dentista (DDS)
Fullerton, California.

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BENEFICIOS

ENJUAGUE BUCAL FRESH BREATH
ALIENTO FRESCO

- Aliento fresco prolongado
- Protección periodontal contra las bacterias
- Refresca y estimula el flujo de saliva
- Endulzado naturalmente con Xilitol – Se ha demostrado que el xilitol inhibe la formulación de placa, bacterias y caries

Pídalo aquí »

ENJUAGUE BUCAL PRO FORMULA
PROTECCIÓN BUCAL

- Protección periodontal contra las bacterias
- Aliento fresco prolongado
- Refresca y estimula el flujo de saliva
- Endulzado naturalmente con Xilitol – Se ha demostrado que el xilitol inhibe la formulación de placa, bacterias y caries

Pídalo aquí »

GEL DENTAL PRO RELIEF
ALIVIO BUCAL

- Alivio para calmar las llagas en la boca causadas por morder la mejilla interna o por procedimientos dentales
- Alivio rápido para las encías sensibles
- Promueve la curación, neutralizando las bacterias e hidratando el tejido para ayudar en el proceso de curación
- Proporciona humedad al tejido seco o irritado
- Endulzado naturalmente con Xilitol – Se ha demostrado que el xilitol inhibe la formulación de placa, bacterias y caries

Pídalo aquí »

PASTA DENTAL FRESH BREATH
ALIENTO FRESCO

- Aliento fresco prolongado
- Protección periodontal contra las bacterias
- Protección de áreas erosionadas
- Baja abrasión para mayor protección del esmalte dental
- Endulzado naturalmente con Xilitol – Se ha demostrado que el xilitol inhibe la formulación de placa, bacterias y caries

Pídalo aquí »

PASTA DENTAL PRO FORMULA
PROTECCIÓN BUCAL

- Protección periodontal contra las bacterias
- Aliento fresco prolongado
- Ayuda a mantener la estética dental en zonas tratadas
- Protección de áreas erosionadas
- Baja abrasión para mayor protección del esmalte dental

Pídalo aquí »

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