

ORIGINAL RESEARCH

Comparative study of antiplaque and anti-gingivitis effect of chlorhexidine and chlorine dioxide mouthwash in mild to moderate gingivitis – A randomized control study

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ABSTRACT

Background and Aim: The study was planned to assess if chlorine dioxide (ClO₂) mouthwash could be used as an alternative to chlorhexidine (CHX) mouthwash in cases of mild to moderate gingivitis. To compare the efficacy of CHX and ClO₂ mouthwash in controlling plaque and gingivitis in mild to moderate cases. **Materials and Methods:** It was a randomized double blinded study conducted in 40 patients with mild to moderate gingivitis. After obtaining informed consent, subjects were randomly divided into two groups. The baseline values and after treatment values of plaque index (PI) and gingival index (GI) were recorded in both groups. Results of both the groups were compared using unpaired t- test. P<0.05 was considered statistically significant. Statistical analysis and data management were performed using SPSS version 18 **Results:** A significant change in PI (0.00004) and GI (p value 0.00004) values was observed in subjects of chlorine dioxide (ClO₂) group after 14 days. While no such significant change in GI (p value 0.58) and PI (p value 0.45) was observed in the subjects who received chlorhexidine (CHX) mouthwash for 14 days. On intergroup comparison also no significant difference between the GI (p value) 0.417) and PI (p value 0.211) levels of CHX and ClO₂ group were observed after 14 days. **Conclusions:** ClO₂ was effective in suppressing the plaque and gingivitis in mild to moderate gingivitis. But on comparison its efficacy was similar to CHX.

Key-words: chlorhexidine, chlorine dioxide, mouthwashes

Key Messages: Chlorhexidine has proven efficacy in controlling plaque and gingivitis but relatively new chlorine dioxide mouthwash could be used as a suitable alternative to chlorhexidine in mild to moderate gingivitis as it displays similar efficacy.

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INTRODUCTION

Importance of oral hygiene and its correlation with systemic health has always been emphasized by the healthcare professionals. Amongst oral diseases, periodontal diseases are quite commonly encountered in dental practice. They could be in the form of an inflammation of the periodontal tissue and plaque build-up on the tooth surface. The risk factors for periodontal diseases may include a susceptible host,

lack of beneficial bacteria or presence of pathogenic bacteria.^[1] Studies have shown that periodontitis and gingivitis are associated with polymicrobial infections caused by bacterial biofilms.^[2] The bacteria form a biofilm through a symbiotic association with other bacteria by forming colonies in the gingival crevices.^[3] A healthy gingival sulcus consists of bacterial flora which includes Gram-positive cocci like streptococcus spp. and actinomyces spp. While a mature plaque may

consist of facultative anaerobic microorganisms like spirochaetes along with strict anaerobes, gram-negative and motile organisms.^[1] Malodorous compounds consisting of volatile sulphur compounds (VSCs) like hydrogen sulfide (H₂S), methyl mercaptan (CH₃SH) and dimethyl sulfide ((CH₃)₂S) are produced by periodontal bacteria in the saliva, coating of the tongue or in the gingival crevicular fluid.^[4,5] Early prevention of dental plaque with either chemical or mechanical methods is imperative. Plaque can be reduced by physical methods like scaling and flossing but additional measures are required, depending upon the severity of the condition.^[6] Addition of chemotherapeutic agents to routine dental care at home has demonstrated a reduction in plaque and gingivitis.^[7] Over the years, use of mouthwash has become popular after toothpastes, amongst dentists and patients because of their therapeutic efficacy and their ability to cover the entire dentition.^[8-9] With regular use, mouthwashes have been useful in decreasing microbial plaques.^[10] Amongst the chemical agents, chlorhexidine (CHX) is one of the most studied and widely used agent in preventing and reducing gingivitis.^[4] It has also shown to be effective against pathogenic organisms like *Streptococcus mutans*.^[11] It acts by interacting with the external cell components and cell membranes by inducing a leakage of intracellular contents leading to both internal and external damage leading to cell death.^[12] But use of CHX is associated with certain side effects like bitter taste, mucosal erosion and tooth discoloration.^[13] These side effects led the researchers to look for another agent showing similar or greater efficacy with minimal or lesser side effects. CIO₂ (Choline dioxide) mouthwash has shown promise by controlling the production of VSCs and reducing oral malodour in healthy subjects for at least four hours.^[14] CIO₂ oxidizes the VSCs to convert them to non-malodorous compounds by acting on its precursors cysteine and methionine.^[15] The chlorite anion is also known to be an effective bactericidal agent.^[16-18] Also being water soluble it can penetrate the biofilm rapidly increasing its antimicrobial properties.^[17,19] Its clinical efficacy on oral malodour has been evaluated and reported only in short duration (maximum 96 h) trials.^[17] To improve its stability, storage and shelf life, CIO₂ is converted at low pH to molecular chlorine dioxide through a “stabilization” process.^[17,20-21] This study was planned to compare the efficacy of CHX and CIO₂ in reducing plaque and gingivitis and based on that evaluate if CIO₂ could be used as an alternative to CHX in mild to moderate cases of gingivitis.

MATERIAL AND METHODS

It was a randomized double blinded study to compare the efficacy of CHX and CIO₂ in cases of mild to moderate gingivitis. Approval from the Institutional Ethics Committee was obtained before initiating the study. A total number of 40 patients with mild to

moderate gingivitis from the outpatient department of periodontology department were included in the study. The sample size was decided on the basis of number of patients available during the study period and willing to participate in the study after carefully explaining the study procedure. The study population consisted of 26 females and 14 males with an average age of 21.25 years. Both groups had an equal number of females and males i.e.13 and 7 respectively. A written informed consent was signed by the participants before initiating the study. Case report forms were filled and baseline readings of the GI (Gingival Index) and PI (Plaque Index) were recorded. The mouthwashes were dispensed in similar containers covered with a dark paper to avoid bias on behalf of both the investigator and patients. Patients with mild to moderate gingivitis were randomly recruited in two groups with 20 patients in each group, where one group received CHX mouthwash containing chlorhexidine 0.2% and the other group received CIO₂ (0.1%) mouthwash, containing purified water, sodium chlorite (as stabilized chlorine dioxide), sodium phosphate tribasic, flavour, citric acid, sucralose. No scaling or root planning was performed on the patients before initiating the use of mouthwashes. The effect of both the mouthwashes was assessed as monotherapy and no other treatment was prescribed to the patients during the study period. The patients were instructed to use the mouthwash twice daily after meals for 30 sec in a quantity of 10ml without dilution for 14 days. The subjects were instructed to use the mouthwashes after meals and not after brushing to ensure compliance of the subjects, as many subjects were not in a habit of brushing their teeth after meals. It was also done to maintain uniformity among subjects and prevent bias. They were also asked to refrain from using any mechanical plaque control methods like dental floss, tooth picks or chewing sticks during the period of the study. The GI and PI were recorded at baseline and after 14 days of use of the mouthwashes.

The inclusion criteria included patients who had:

1. No history of periodontal treatment in past six months.
2. Mild to moderate gingivitis
3. Not participated in similar investigation in past five weeks

The exclusion criteria included patients who were/had:

1. Pregnant or lactating females
2. Known allergies to any mouthwash, pharmaceutical products or its components or ingredients in test products.
3. Habits like smoking and tobacco chewing

The study did not exclude patients with systemic diseases as this was a preliminary study to compare the efficacy of both the mouthwashes. The quantity of plaque and gingival bleeding of patients were evaluated clinically. For quantitative plaque recording we used Silness and Loe plaque index (PI) and

gingival bleeding was evaluated using Loe and Silness gingival index (GI).^[22-23] Patients with mild inflammation of gingiva i.e. minimal change in colour with slight oedema and no bleeding were categorized as mild gingivitis, whereas patients with evident oedema and bleeding of gums were considered as moderate gingivitis.

STATISTICAL ANALYSIS

The values of GI and PI were compared at baseline and after 14th day of using the respective mouthwashes. Results of both the groups were compared using unpaired t- test. P<0.05 was considered statistically significant. Statistical analysis

and data management were performed using SPSS version 18

RESULTS

In the study, one group received CIO2 mouthwash and the other group received CHX mouthwash. Among the 20 patients in the CIO2 group, 17 patients showed improvement in the GI index compared to baseline levels and all patients showed improvement in the PI index. While in the CHX group, 13 patients showed improvement in the GI index and 12 patients showed improvement in the PI index after using the mouthwash for 14 days.

Table 1: Comparison of baseline and after treatment values of GI and PI index in CIO2 group

CIO2 intragroup comparison				
Groups	Number of patients	Mean±SD	P value	Significance
GI (baseline)	20	0.99± 0.2	0.00004	Significant
GI (after 14 days)	20	0.51± 0.3		
PI (baseline)	20	0.83±0.3	0.000	Significant
PI (after 14 days)	20	0.31±0.2		

Table 1 shows the comparison of baseline and after treatment values of GI and PI index in CIO2 group, it was observed that there was a significant change in the GI and PI index of the subjects after using CIO2 mouthwash for 14 days.

Table 2: Comparison of baseline and after treatment values of GI and PI index in CHX group

CHX intragroup comparison				
Groups	Number of patients	Mean±SD	P value	Significance
GI (baseline)	20	0.86±1.0	0.58	Not significant
GI (after 14 days)	20	0.68±1.0		
PI (baseline)	20	0.83±0.9	0.45	Not significant
PI (after 14 days)	20	0.60±1.0		

Table 2 shows the comparison of baseline and after treatment values of GI and PI index in CHX group, it was observed that there was no significant change in the GI and PI index of the subjects after using CHX mouthwash for 14 days.

Table 3: Comparison between GI and PI values of CIO2 and CHX at baseline and after 14 days of mouthwash use

Comparison between CIO2 and CHX at baseline and after 14 days of mouthwash use				
Parameter	Mean±SD CIO2	Mean±SD CHX	P value	Significance
GI (baseline)	0.99± 0.2	0.86±1.0	0.572	Not significant
GI (after 14 days)	0.51± 0.3	0.68±1.0	0.417	Not significant
PI (baseline)	0.83±0.3	0.83±0.9	1.000	Not significant
PI (after 14 days)	0.31±0.2	0.60±1.0	0.211	Not significant

Table 3 shows the comparison between GI and PI values of CIO2 and CHX at baseline and after 14 days of mouthwash use, it was observed that when we compared the GI and PI index's of CIO2 and CHX group the p values were insignificant.

DISCUSSION

Periodontal diseases can be prevented or controlled by maintaining regular dental hygiene. But many a times due to improper techniques or inadequate frequencies of mechanical dental cleaning practices, use of chemical dental cleaning agents becomes imperative. Also mechanical practices like use of toothbrush or floss have a major limitation of mobility and cannot reach all the crevices and surfaces of the oral cavity as desired. Hence chemical methods of maintaining

dental hygiene like mouthwashes have become an integral part of dental routines for prevention or treatment of periodontal diseases. With so many available options choosing the right mouthwash becomes challenging, as efficacy is most important but so is patient acceptability. CHX has proven efficacy but is known to cause oral mucositis, staining of teeth, salivary gland atresia and dysgeusia on prolonged used.^[24-25] Some studies have also mentioned about the cytotoxic activity displayed by

CHX which could lead to apoptosis and necrosis of human cells in vitro. [26-27] We compared the efficacy of CHX the gold standard in mouthwashes for periodontal diseases with CIO2 a relatively newer agent. Being a broad spectrum antiseptic, CHX is effective against gram positive, gram negative organisms along with yeasts and viruses. [27-28] Along with having a bactericidal effect, CHX remains bound to the oral mucosa causing a prolonged antiseptic effect. CIO2 is known to consume the oxidative biomolecules and have a wide range of biocidal activity effective in controlling plaque. [29] We compared the baseline and after treatment values of the PI and GI index in CIO2 and CHX group. In CIO2 group we observed a significant improvement in baseline values after 14 days, but in CHX group no such significant improvement was noted. Also on intergroup comparison of the PI and GI values of CHX and CIO2 at 14 days after treatment, the p value was insignificant. These results suggest that CIO2 showed significant efficacy in improving plaque and gingivitis but there was no significant difference between the efficacy of CHX and CIO2 on comparison.

In a similar study conducted by Paraskevas *et al.*, they compared 3 day plaque accumulation after using CHX and CIO2 mouthwashes in patients and found that CIO2 was less effective than CHX in plaque inhibition. [30] Goultschinet *et al.* compared the efficacy of high and low concentrations of CIO2 with a placebo and found that there was reduction in the dental plaque scores by 34.5% and 13.5% respectively. [31] While in another study by Shetty *et al.*, they compared the inhibition in formation of volatile sulphur compounds (VSC) with use of stabilized 0.1 %chlorine dioxide with 0.2% chlorhexidine mouthwash. They found that CIO2 showed a greater reduction in VSCs in comparison to CHX after a seven day use. [19]

Yeturu *et al.*, compared the plaque and gingival scores of patients after 15 days of use of aloe vera, CHX and CIO2. All three groups showed significant plaque reduction, but it was higher in CHX group in comparison with aloe vera group. While no significant difference was found between CHX and CIO2 group. [32] Dental plaque and gingivitis affect a large number of people and could lead to long term complications like tooth loss and dental infections. [33] It can be prevented by maintaining regular dental hygiene and reversed in mild to moderate cases by mouthwashes. Chlorine dioxide mouthwash can be used as a substitute for CHX mouthwash especially in cases where the patient experiences adverse effects to CHX.

CONCLUSION

On the basis of our results we would like to conclude that CIO2 is a good alternative for patients of mild to moderate gingivitis or who cannot tolerate CHX as there was no significant difference between their efficacies. Although further studies would be required

to explore the therapeutic potential of CIO2 in periodontal diseases.

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Conflicts of interest - None

REFERENCES

- Ljiljana K, Jelena M, Marija I, Radmila O. Microbial etiology of periodontal disease. *FU Med Biol.* 2008;15(12): 616-21.
- Haerian-Ardakani A, Rezaei M, Talebi-Ardakani M, Keshavarz Valian N, Amid R, Meimandi M, Esmailnejad A *et al.* Comparison of Antimicrobial Effects of Three Different Mouthwashes. *Iran J Public Health.* 2015;44(7):997-1003.
- Kumar PS, Griffen AL, Moeschberger ML, Leys EJ. Identification of candidate periodontal pathogens and beneficial species by quantitative 16S clonal analysis. *J Clin Microbiol.* 2005;43(8): 3944-55.
- Shinada K, Ueno M, Konishi C, Takehara S, Yokoyama S, Zaitu T *et al.* Effects of a mouthwash with chlorine dioxide on oral malodor and salivary bacteria: a randomized placebo-controlled 7-day trial. *Trials.* 2010;12 (11):14.
- Yaegaki K, Sanada K. Volatile sulfur compounds in mouth air from clinically healthy subjects and patients with periodontal disease. *J Periodontal Res.* 1992;27(4 Pt 1):233-8
- Goutham BS, Manchanda K, Sarkar AD, Prakash R, Jha K, Mohammed A. Efficacy of two commercially available Oral Rinses - Chlorhexidine and Listerine on Plaque and Gingivitis - A Comparative Study. *Journal of International Oral Health.* 2013; 5(4):56-61
- Moran J, D Pal, R Newcombe, M Addy. Comparison of phenolic and 0.2% chlorhexidine Mouthwash on the development of plaque and gingivitis. *Clin Prev Dent.* 1991;13(4):31-5
- Lyle DM. Chemotherapeutics and topical delivery systems. In: Wilkins EM, editor. *Clinical Practice of the Dental Hygienist.* 9th ed. Philadelphia, PA: Wolters Kluwer Company; 2005, 439
- Biswas G, Anup N, Acharya S, Kumawat H, Vishnani P, Tambi S. Evaluation of the efficacy of 0.2% chlorhexidine versus herbal oral rinse on plaque induced gingivitis -A randomized clinical trail. *IOSR J Nurs Health Sci.* 2014; (2):58-63
- Arunachalam LT, Sudhakar U, Vasanth J, Khumukchum S, Selvam VV. Comparison of anti-plaque and anti-gingivitis effect of curcumin and chlorhexidine mouth rinse in the treatment of gingivitis: A clinical and biochemical study. *J Indian Soc Periodontol.* 2017;21(6):478-483.
- Saffari F, DaneshArdakani M, Zandi H, Heidarzadeh H, Moshafi MH. The Effects of Chlorhexidine and Persica Mouthwashes on Colonization of *Streptococcus mutans* on Fixed Orthodontics O-rings. *J Dent Shiraz Univ Med Sci.* 2015; 16 (1): 54-57
- Pietruska M, Paniezko A, Waszkiel D, Pietruska J, Bernaez A. Efficacy of local treatment with chlorhexidine gluconate drugs on the clinical status of periodontium in chronic periodontitis patients. *Adv Med Sci.* 2006; 51(7): 162-165
- Lakade LS, Shah P, Shirol D. Comparison of antimicrobial efficacy of chlorhexidine and combination mouth rinse in reducing the Mutans

- streptococcus count in plaque. *J Indian Soc PedodPrev Dent.* 2014; 32: 91-6
14. Shinada K, Ueno M, Konishi C, Takehara S, Yokoyama S, Kawaguchi Y. A randomized double blind crossover placebo-controlled clinical trial to assess the effects of a mouthwash containing chlorine dioxide on oral malodor. *Trials.* 2008;9:71
 15. Lynch E, Sheerin A, Claxson AWD, Atherton MD, Rhodes CJ, Silwood CJL, Naughton DP, Grootveld M: Multicomponent spectroscopic investigations of salivary antioxidant consumption by an oral rinse preparation containing the stable free radical species chlorine dioxide (ClO₂). *Free Radical Res.* 1997; 26:209-34
 16. Yates R, Moran J, Addy M, Mullan PJ, Wade WG, Newcombe R: The comparative effect of acidified sodium chlorite and chlorhexidine mouthrinses on plaque regrowth and salivary bacterial counts. *J Clin Periodontol.* 1997; 24:603-9.
 17. Frascella J, Gilbert R, Fernandez P: Odor reduction potential of a chlorine dioxide mouthrinse. *J Clin Dent.* 1998;9:39-42.
 18. Grootveld M, Silwood CJ, Gill D, Lynch E: Evidence for the microbicidal activity of a chlorine dioxide-containing oral rinse formulation in vivo. *J Clin Dent.* 2001;12:67-70
 19. Shetty NJ, David .K, Kamala D. N. Shenoy R. Comparative study of a stabilized 0.1 % chlorine dioxide with 0.2% chlorhexidine mouthrinse in inhibiting the formation of volatile sulphur compounds (VSC). *INDIAN JOURNAL OF APPLIED RESEARCH.* 2013; 3 (12) :424-27
 20. Frascella J, Gilbert RD, Fernandez P, Hendler J. Efficacy of a chlorine dioxide- containing mouthrinse in oral malodor. *Compend Contin Educ Dent.* 2000 ;21(3):241-4, 246, 248
 21. Addy M, Willis L, Moran J. Effect of toothpaste rinses compared with clorhexidine on plaque formation during a 4-day period. *J Clin Periodontol.* 1983; 10(1):89- 99
 22. Silness J, Loe H. periodontal disease in pregnancy. II. Correlation between oral hygiene and periodontal condition. *Acta OdontologicaScandinavica.* 1964;22:121–135
 23. Loe H. The gingival index, the plaque index and the retention index systems. *J Periodontol.* 1967;38 (suppl.): 610
 24. Jones CG. Chlorhexidine: is it still the gold standard? *Periodontol.* 2000;15: 55- 62
 25. Yadav SR, Kini VV, Padhye A. Inhibition of Tongue Coat and Dental Plaque Formation by Stabilized Chlorine Dioxide Vs Chlorhexidine Mouthrinse: A Randomized, Triple Blinded Study. *J Clin Diagn Res.* 2015;9(9):69-74
 26. Bonacorsi C, Raddi MS, Carlos IZ. Cytotoxicity of chlorhexidine digluconate to murine macrophages and its effect on hydrogen peroxide and nitric oxide induction. *Braz J Med Biol Res.* 2004;37(2):207-12.
 27. Rajendiran M, Trivedi HM, Chen D, Gajendrareddy P, Chen L. Recent Development of Active Ingredients in Mouthwashes and Toothpastes for Periodontal Diseases. *Molecules.* 2021;26(7):2001.
 28. Colombo AP, Haffajee AD, Dewhirst FE, Paster BJ, Smith CM, Cugini MA *et al.* Clinical and microbiological features of refractory periodontitis subjects. *J Clin Periodontol.* 1998;25(2):169-80.
 29. Siddeshappa ST, Bhatnagar S, Yeltiwar RK, Parvez H, Singh A, Banchhor S. Comparative evaluation of antiplaque and antigingivitis effects of an herbal and chlorine dioxide mouthwashes: A clinicomicrobiological study. *Indian J Dent Res.* 2018;29:34-40
 30. Paraskevas S, Rosema NA, Versteeg P, Van der Velden U, Van der Weijden GA. Chlorine dioxide and chlorhexidine mouthrinses compared in a 3-day plaque accumulation model. *J Periodontol.* 2008;79(8):1395-400.
 31. Goultshin J, Green J, Machtei E, Stabholz A, Brayer L, Schwartz Z *et al.* Use of a metastabilizedchlorous acid/chlorine dioxide formulation as a mouthrinse for plaque reduction. *Isr J Dent Sci.* 1989;2(3):142-7.
 32. Yeturu SK, Acharya S, Urala AS, Pentapati KC. Effect of Aloe vera, chlorine dioxide, and chlorhexidine mouth rinses on plaque and gingivitis: A randomized controlled trial. *J Oral BiolCraniofac Res.* 2016;6(1):54-58.
 33. Murakami S, Mealey BL, Mariotti A, Chapple ILC. Dental plaque-induced gingival conditions. *J Clin Periodontol.* 2018;45(20):17–27.