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# Comparison of 0.1% Chlorine Dioxide With 0.2% Chlorhexidine on Dental Plaque, Gingivitis, Stain and Taste Perception among Young Adults – A Randomized Controlled Trial

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## Abstract

**Background:** Previously, researches has been done on the clinical efficacy of 0.1% chlorine dioxide (ClO2) on malodour and periodontal parameters. The present study was done to compare the effect of 0.1% ClO2 mouthwash with 0.2% Chlorhexidine mouthwash on plaque reduction, gingivitis , staining and taste alteration.

**Aim** : Evaluating the effectiveness of 0.1% chlorine dioxide and 0.2% chlorhexidine mouthrinses on plaque, gingivitis, staining and taste perception among young adults.

**Materials and methods:** A randomized controlled, double blind study was conducted among subjects aged 18-25 years. A total sample of 60 participants were equally divided into 2 groups. Group 1: using 0.1% chlorine dioxide and Group 2 : using 0.2% Chlorhexidine mouthwash. Plaque , gingivitis, staining and taste perception was examined after 21 days follow–up.

**Result:** The mean difference in reduction in plaque score after 21 days in Chlorine Dioxide group was found to be 0.64 (± 0.43), whereas in Chlorhexidine it was found to be 0.82(± 0.04). Similarly, the gingival score for after 21 days in chlorine dioxide reduced to 0.31 (± 0.15); whereas in chlorhexidine it was reduced to 0.66 (± 0.29). The plaque score and gingival score between the groups after 21 days was found to be statistically non-significant (p = 0.154 and 0.409 respectively). The stain index of both the groups (Chlorine Dioxide and Chlorhexidine) was found to be statistically significant on follow-up ( p = 0.000) and

the taste perception was found to be better in chlorine dioxide .

**Conclusion:** Though Chlorhexidine has similar effects on periodontal parameters but the taste alteration makes it a lesser favourable choice by the subjects. Therefore, Chlorine dioxide can be considered as a more favourable alternative as it overcame all the side- effects of chlorhexidine mouthwash.

**Keywords:** 0.1% Chlorine Dioxide Mouthwash, 0.2% Chlorhexidine Mouthwash, Periodontal Parameters, Taste Perception, Staining Index.

**Introduction**

Plaque is known as the initiating factor of gingivitis when in contact with gingival tissues. Therefore, plaque control represents the cornerstone of good oral hygiene practice.[1] Despite the availability various mechanical oral hygiene devices, even the most meticulous patient cannot always completely remove all plaque.[2] Therefore, chemical plaque control agents such as mouthwashes have been advocated to prevent dental plaque and gingivitis having maximum efficacy & minimum side effects. Though, Chlorhexidine is considered as one of the best mouthwash for inhibition of plaque accumulation and gingivitis, yet staining and taste alteration makes it a lesser favourable choice. Whereas, Chlorine dioxide mouthwashes exhibit the properties of a more favourable mouthwash overcoming the side effects of Chlorhexidine.

Therefore this study was conducted to compare the effectiveness of 0.1% chlorine dioxide and 0.2% chlorhexidine on periodontal parameters , staining tendency and taste alteration among young adults.

**Methodology**

A randomized controlled, double blind study was conducted among subjects aged 18-25 years. Subjects with more than 16 functional teeth present and not having any systemic or oral disease were included in the study. Subjects under any medication; pregnant and lactating women, having multiple restorations or gross dental caries with pulpal involvement; using tobacco in any form; with functional, removable or orthodontic appliances; allergic to Chlorhexidine or Chlorine Dioxide mouthwashes were excluded from the study. After conducting a pilot study on 10 patients , 5 in each group, sample size was estimated to be 60 with a significance level of 5%, and a power of 80%. Clinical examination was done to access the plaque accumulation and gingivitis by a single trained and calibrated examiner and the kappa value for intra-reliability was found to be 0.85.

Total samples of 60 subjects those fulfilled the inclusion and exclusion criteria and signed informed consent after being explained about the study procedure were recruited in study. Ethical approval was taken from the Institutional Ethical Review Board (IERB) before the commencement of the study. ( Ref. No. :- KDCRC/IERB/09/2019/03).

Eligible subjects were randomly allocated equally into 2 groups i.e., 30 subjects in each group. Allocation was done using the computer generated list of random numbers to ensure the random allocation of the subjects into 2 groups : Group 1 using 0.1% of Chlorine Dioxide and Group 2 using 0.2% Chlorhexidine. Allocation concealment was done by the investigator who was not involved in clinical examination and the samples were revealed after the completion of the study. After thorough examination for plaque and gingivitis all the subjects received oral prophylaxis and oral hygiene instructions prior to the distribution of mouthwashes. In order to maintain the standardization the subjects were provided identical tooth brushes and toothpaste.

After an interval of 7 days baseline data was recorded after achieving optimal gingival health to standardize the gingival baseline conditions. Subjects were constantly reminded about the rinsing using telephonic remainders.

Plaque accumulation was accessed using Silness and Loe[3] plaque index and Gingival index using Loe and Silness[4] and Modified Lobene index[5] was used to examine the staining at baseline and at follow-up and a 5 item questionnaire was used to examine the taste perception of the subjects only at follow- up.

**Statistical Analysis**

The data collected was subjected for statistical analysis using SPSS 19.0. The comparison between the chlorhexidine and the chlorine dioxide group was done using Independent T – test. Whereas the comparison within the groups was done using Paired T- test. The Chi-square test was used to analyse data of the questionnaire regarding the taste perception.

**Results**

TABLE 1 - COMPARISON OF MEAN PLAQUE ; GINGIVAL AND STAINING SCORE BETWEEN BASELINE AND AFTER 21 DAYS IN CHLORINE DIOXIDE AND CHLORHEXIDINE GROUPS

| INDEX SCORES | DURATION | CHLORINE DIOXIDE | CHLORHEXIDINE | p - VALUE |
|---|---|---|---|---|
| PLAQUE | BASELINE | 1.48 (± 0.69) | 1.86 (± 0.55) | **0.021** |
| | 21 DAYS | 0.84 (± 0.26) | 1.04(± 0.51) | 0.154 |
| GINGIVAL | BASELINE | 0.85 (± 0.34) | 1.30 (± 0.58) | **0.003** |
| | 21 DAYS | 0.54 (± 0.19) | 0.64 (± 0.29) | 0.409 |
| STAIN | BASELINE | 0.00 | 0.00 | **0.000** |
| | 21 DAYS | 0.00 | 1.12 (± 0.37) | **0.000** |

*INDEPENDENT T-TEST , p< 0.05

TABLE 1 (A) - COMPARISON ON MEAN PLAQUE SCORE, GINGIVAL SCORE AND STAIN INDEX WITHIN 0.1% CHLORINE DIOXIDE GROUP AT BASELINE AND 21 DAYS

| INDEX | DURATION | MEAN SCORE (S.D) | p- VALUE |
|---|---|---|---|
| PLAQUE | BASELINE | 1.48 (± 0.69) | **0.000** |
| | 21 DAYS | 0.84 (±0.56) | |
| GINGIVAL | BASELINE | 0.85 (±0.54) | **0.000** |
| | 21 DAYS | 0.54 (±0.39) | |
| STAIN | BASELINE | 0.00 | **0.000** |
| | 21 DAYS | 0.00 | |

*PAIRED SAMPLE T- TEST

TABLE 1 (B) -COMPARISON ON MEAN PLAQUE SCORE, GINGIVAL SCORE AND STAIN INDEX WITHIN 0.2% CHLORHEXIDINE GROUP AT BASELINE AND 21 DAYS

| INDEX | DURATION | MEAN SCORE (S.D) | p- VALUE |
|---|---|---|---|
| PLAQUE | BASELINE | 1.86 (± 0.55) | **0.000** |
| | 21 DAYS | 1.04 (±0.51) | |
| GINGIVAL | BASELINE | 1.30 (±0.58) | **0.000** |
| | 21 DAYS | 0.64 (±0.49) | |
| STAIN | BASELINE | 0.56 (±0.27) | **0.000** |
| | 21 DAYS | 1.12 (±0.36) | |

*PAIRED SAMPLE T- TEST

TABLE 2- QUESTIONNAIRE RESPONSES (MEAN ± SD) DETERMINED BY VAS

| | | CHLORHEXIDINE | CHLORINE DIOXIDE | P- VALUE |
|---|---|---|---|---|
| TASTE OF THE PRODUCT | GOOD | 16.67% (5) | 96.67% (29) | 0.000 |
| | NORMAL | 23.33% (7) | 3.33% (1) | |
| | BAD | 60% (18) | 0% (0) | |
| DURATION OF TASTE | LONG | 73.33% (22) | 13.33% (4) | 0.000 |
| | SHORT | 26.67% (8) | 86.67% (26) | |
| AFFECT ON TASTE | GOOD | 23.33% (7) | 70% (21) | 0.000 |
| | BAD | 76.67% (23) | 30% (9) | |
| CONVINENCE | CONVINENT | 60% (18) | 13.33% (26) | 0.020 |
| | NON- CONVINENT | 40% (12) | 86.67% (4) | |
| RINSING TIME | LONG | 80% (24) | 26.67% (8) | 0.000 |
| | SHORT | 20% (6) | 73.33% (22) | |

*CHI – SQUARE TEST , p <0.05

Out of total 60 participants 34 were Male and 26 were Female with the mean age and SD of 22.82 ( ± 2.30) years. As shown in Table 1, the mean value of plaque score in Chlorine Dioxide group after 21 days was found to be 0.84 (± 0.26), whereas in Chlorhexidine the mean value was found to be 1.04(± 0.51) after 21 days. Similarly, the gingival score for chlorine dioxide reduced to 0.54 (± 0.19) after 21 days; whereas in chlorhexidine it was reduced to 0.64 (± 0.29) after 21 days. The plaque score and gingival score between the groups after 21 days was found to be statistically non-significant (p = 0.154 and 0.409 respectively). The stain index of both the groups (Chlorine Dioxide and Chlorhexidine) was found to be statistically significant on follow-up ( p = 0.000). As shown in Table 2 ; the results of taste perception rating included questions on: the taste perception, duration of taste , alteration in taste perception, convenience in using and duration of rinsing time which was found to be statistically significant in both the groups (p = 0.000).

**Discussion**

This study evaluated the efficacy of 0.2% Chlorhexidine & 0.1% Chlorine Dioxide mouth rinses on reduction of plaque, gingivitis and staining tendency along with the taste perception over a period of 21 days among subjects aged 18-25 years . Although the reduction in mean plaque score and gingival score was found to be more in chlorine dioxide in comparison with chlorhexidine, but this was found to be statistically non- significant . Chlorine Dioxide shows enhanced ability to reduce colony forming units (CFUs) as the sodium chloride ions (stabilized chlorine oxide) obliterate the microbiota via oxygenation and neutralized its toxins.[12] The chlorine dioxide mouthwash leads to the disruption of transport of nutrients across the cell membrane of micro-organisms leading to the inhibition of growth of the microorganisms.[13] It

further, oxidatively consumes and inactivates salivary biomolecules, thereby, exerting its antimicrobial effect. Chlorine dioxide based products also destroy the volatile sulphide compounds, which further leads to the reduction of gingival inflammation.[14] This result was in accordance with the previous study conducted by Paraskevas et al (2008),[6] Neetha et al (2013,)[7] Yeturu et al (2015).[8]

On the basis of staining index, Chlorhexidine was found to have produced stains after using for 21 days. The etiology of extrinsic tooth discolorations due to CHX rinsing is not fully understood. Non-enzymatic browning reactions (Maillard reactions) and formation of pigmented metal (Fe, Sn) sulfides hypotheses is not supported by direct and conclusive in vivo evidence. However, clinical and laboratory studies provided strong evidence that staining is caused by interaction or precipitation of dietary chromogens with locally adsorbed CXH the main possible mechanism of extrinsic tooth stain is the reaction products of food and beverage, where aldehydes and ketones, natural constituents of various foods, may react with CHX forming colored products on hydroxyapatite. However, a discoloring capacity of CHX combined with tea, red wine and coffee has been demonstrated both in vivo and in vitro. Whereas chlorine dioxide had no staining side effect.[15]

On the basis of taste perception , 0.2% Chlorhexidine, a bis-biguanide antiseptic, produces a profound and lengthy alteration of the salty & bitter taste. Previous studies have shown that CHX severely impairs identification of taste stimuli that require appreciation of salty and bitter taste qualities by reducing paracellular ion movement (Frank *et al.*, 2001)[9]. Whereas , chlorine dioxide does not exhibit any taste perception changes. (Paraskevas Et al 2008)[6] which is in favour of our results. Even though the exact mechanism of inhibition of salty taste is unclear; but chlorhexidine may block ion channels in taste receptor cell membranes (Breslin and Tharp, 2001)[10] but Gent J.F. et al (2002)[11] demonstrated that chlorhexidine severely impairs identification of NaCl, KCl and quinine-HCl, taste stimuli that require appreciation of salty and bitter taste qualities.

**Conclusion**

Although ,the efficacy of chlorhexidine in plaque reduction was found to be equally effective; but the fact that CHX rinsing can cause a number of local side-effects including extrinsic staining and taste disturbance cannot be neglected.

Whereas Chlorine Dioxide plays equally significant role in plaque reduction and gingivitis along with a better taste perception and no staining, making it a more favourable mouthwash preferred by the subjects. Therefore, we can conclude that Chlorine Dioxide mouth rinse can be a better recommendation for patients.

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