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Evaluation of zinc as an adjunct in chlorhexidine containing toothpaste on gingival and plaque index

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Original Article

Abstract

BACKGROUND AND AIM: Bacterial plaque is the uppermost element in periodontal diseases. Chlorhexidine (CHX) is one of the utmost influential materials in chemical plaque control and ORTHOKIN is a toothpaste claimed to encompass CHX. Although there are various studies on efficacy of different types of CHX formulation in toothpaste, no literature has focused on the anti-plaque effects of toothpaste with CHX when zinc acetate is introduced in to chemical formula. Therefore, in the present study, we compared Crest ANTI-Cavity toothpaste with KIN gingival and ORTHOKIN toothpastes that contained CHX.

METHODS: This controlled clinical trial study was conducted on 30 patients with gingivitis. To compare the anti-plaque activity and bleeding on probing (BOP) index of the toothpastes, the average BOP and plaque index percent was recorded 14-day post-brushing. BOP index and plaque index were measured by an experienced dentist blind to the study and were recorded at pre-scaling, post-scaling and post-brushing for each group. Analysis of variance and paired t-test was used to analyze the data.

RESULTS: The average BOP in the 3rd meeting for the ORTHOKIN, Crest ANTI-Cavity and KIN gingival toothpastes was 10.54%, 12.15% and 10.60%, and the plaque index in the 3rd meeting was 32.22%, 50.35% and 27.80%, respectively. In these 3 groups, BOP did not have a reduction while the plaque index significantly differed between ORTHOKIN and KIN gingival compared to Crest ANTI-Cavity ($P < 0.05$).

CONCLUSION: These results showed that the reduction of gingival inflammation in CHX contained toothpastes was the same as the toothpaste without CHX. The addition of zinc had no effect on the effectiveness of CHX.

KEYWORDS: Fluoride; Toothpaste; Chlorhexidine; Dental Plaque; Zinc

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In human, the utmost prevalent infectious diseases of oral cavity such as periodontal inflammation, caries, and gingivitis are caused by dental plaque.[1] Dental plaque, containing more than 500 bacterial species, is a complex biofilm that accumulates on the surface of the teeth and is the uppermost element in periodontal diseases.[2] Adequate self-performed mechanical plaque control is an important means to improve periodontal health. Because of the well-known limitations of the mechanical plaque control methods such as difficult access to distal aspect of third upper molar or interproximal surfaces and difficulty to perform these methods in aged patients with hand mobility limitation and dexterity, chemical materials are used as supplements.[3] The addition of antimicrobial/antiplaque chemical for preparing the toothpaste has gained much attention to maintain dental health and

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enhance the efficacy of self-performed mechanical tooth-cleaning.[4]

Toothpastes are formulated by different active agents that are antimicrobial in nature, to provide a therapeutic effect to control plaque and microorganisms accumulation that cause periodontal disease. It is well established that antibacterial toothpastes and mouth rinses are effective in decreasing tooth surface plaque.[5] Enzymes, amine alcohols, natural products, triclosan, bisbiguanides [chlorhexidine (CHX)], quaternary ammonium compounds [cetylpyridinium chloride (CPC) and different metal salts (zinc salts, stannous fluoride, and stannous fluoride with amine fluoride) are active agents that have been included in toothpastes.[6]

There are large varieties of toothpastes for different purposes such as caries and gingivitis prevention, anti-calculus, dentin hypersensitivity prevention and tooth whitening, with a wide range of active and non-active ingredients. CHX is a cationic antiseptic with action against a few lipophilic viruses, a wide spectrum of bacteria including gram negative and gram positive bacteria and dermatophytes. A significant reduction of its antiplaque potential may be observed when it is formulated into toothpaste.[7] Owing to inactivation of CHX by anionic ingredients, formulation of a toothpaste including CHX is a challenging task.[8] Numerous studies have been conducted to evaluate the efficacy of toothpastes containing CHX. A systematic review in 2012 showed the effectiveness of CHX toothpaste in reduction of bleeding index and plaque index in patients with gingivitis for a 4-week period while there was not any substantial decrease in bleeding index and plaque index for CHX dentifrice.[9]

Although various studies were conducted to evaluate the efficacy of different types of CHX formulation in toothpaste, no study has been carried out to consider the anti-plaque effects of toothpaste with CHX when zinc acetate is combined in to chemical formula. Allegedly in this toothpaste, combination of CHX and zinc shows and enhanced antimicrobial activity compared to any one of these substances alone. It can be stated that the antimicrobial efficacy of chemical agents in a toothpaste could be lowered or inactivated when mixed with other ingredients. The main goal of the present work was to investigate and compare the antibacterial and anti-plaque activity of a toothpaste without CHX with dentifrice with CHX or a toothpaste containing CHX and zinc acetate.

Methods

The Ethics Committee of The Faculty of Dental School, Kerman University of Medical Sciences, Kerman, Iran, approved the study (ethical code: K/91/378, IRCT: IRCT2016101330289N1). Written informed consent was obtained from all patients.

This prospective, controlled clinical trial was conducted on 30 patients (13 men and 17 women) with gingivitis who referred to Periodontology Department of Dental Clinic of Kerman University of Medical Sciences. The patients were randomly (block randomization) divided into three groups (each group containing 10 subjects), in which anti-plaque activity of three toothpastes including one without CHX (Crest ANTI-Cavity, Procter & Gamble, Germany), one with CHX (KIN gingival, McCabes Pharmacy, Spain), and one containing CHX and zinc acetate (ORTHOKIN, McCabes Pharmacy, Spain) was investigated.

Inclusion criteria were patients with gingivitis that had a minimum of 24 natural permanent teeth with gingival index II [defined as moderate inflammation, redness, edema and glazing, bleeding on probing (BOP)]. Exclusion criteria were smoking, dental prosthesis or orthodontic devices, taking antibiotics or anti-inflammatory drugs and having any systemic disease.

At the start point, all participants underwent oral examination through which clinical indices including BOP and dental plaque index were recorded and oral health

Table 1. Bleeding on probing (BOP) index and standard deviation of three toothpastes

Toothpastes/BOP index	Pre-scaling	Post-scaling	After treatment
ORTHOKIN (mean ± SD)	30.54 ± 15.94	24.80 ± 12.64	10.54 ± 5.86
Crest (mean ± SD)	34.97 ± 8.35	23.77 ± 10.92	12.15 ± 4.54
KIN gingival (mean ± SD)	40.81 ± 13.04	23.60 ± 15.13	10.60 ± 8.63

SD: Standard deviation; BOP: Bleeding on probing

was given. Clinical examination of the patients was carried out by an experienced dentist who was blind to the treatment groups. Subsequently, scaling and root planning (SRP) was performed with Gracey Curettes (Hu-Friedy, Chicago, IL) and an ultrasonic scaler (PS, miniPiezon, EMS Piezon Systems, Nyon, Switzerland). During the 14-day study, subjects were asked to brush twice per day with their assigned dentifrice using a standard manual toothbrush (Oral-B P35 Indicator) for three minutes. At day 14, the subjects were examined for BOP, plaque index and stain index.

Data analyses were done using the SPSS software (version 20, IBM Corporation, Armonk, NY, USA) package. Standard deviation (SD) of all data was ± 1. After performing Shapiro-Wilk normality test to ensure the normality of pairwise differences, the mean values of data were calculated and statistical significance was determined with ANOVA to compare the effect of anti-plaque activity of three toothpastes. P-value < 0.05 was considered significant. Intra-group differences were analyzed using repeated measure ANOVA.

Results

The average age of the patients was 29.5 years (18-43), and the majority (56.6%) was women. The mean ± SD BOP values for ORTHOKIN group were 30.54 ± 15.94, 24.80 ± 12.64 and 10.54 ± 5.86 percent when measured pre-scaling, post-scaling and post treatment (at day 14), respectively. The recorded value of the BOP index for any three toothpastes at each time is demonstrated in table 1. BOP index was reduced at post-scaling as well as 14-day post-treatment in three toothpaste groups. The lowest mean percent of BOP index was seen with ORTHOKIN toothpaste compared to KIN gingival and Crest toothpaste groups. However, there was no significant difference in BOP index between the three groups of toothpastes (P > 0.050). In all three groups, brushing resulted in significant decrease in BOP index compared to pre- (P = 0.003) and post-scaling (P = 0.010).

At day 14, the mean plaque index values for KIN gingival, Crest and ORTHOKIN gingival were 32.22 ± 13.24, 50.35 ± 9.41, and 27.80 ± 10.61 percent, respectively (Table 2). Plaque index was reduced at post-scaling as well as 14-day post-treatment in three toothpaste groups. The smallest amount of plaques belonged to the ORTHOKIN group compared to KIN gingival and Crest groups.

Nonetheless, this difference in plaque index of the three toothpastes was negligible and insignificant (P > 0.050). In the ORTHOKIN and KIN gingival, brushing resulted in significant decrease in plaque index compared to pre- (P = 0.010) and post-scaling (P = 0.030). Crest toothpaste resulted in non-significant decrease in plaque index compared to pre- and post-scaling (P > 0.050).

Discussion

Claims of plaque and BOP control benefits

Table 2. Plaque index of three toothpastes

Toothpastes/plaque index	Pre-scaling	Post-scaling	After treatment
ORTHOKIN (mean ± SD)	77.50 ± 12.08	54.08 ± 11.03	27.80 ± 10.61
Crest (mean ± SD)	80.75 ± 11.40	55.48 ± 7.45	50.35 ± 9.41
KIN gingival (mean ± SD)	76.88 ± 13.50	49.91 ± 11.74	32.22 ± 13.42

SD: Standard deviation

are common among marketed toothpastes, but comparative in vivo clinical testing is infrequent. The primary aim of this clinical study was to investigate and compare the anti-plaque activity and BOP control of a toothpaste without CHX (Crest) with toothpastes containing CHX (KIN gingival) or CHX in combination with zinc acetate (ORTHOKIN). To compare the anti-activity plaque and BOP of the toothpastes, the average BOP and plaque index percent was calculated for each patient at 14-day post-brushing. BOP index and plaque index were measured by an experienced dentist blind to the study and recorded at pre-scaling, post-scaling and post-brushing for each group.

This study demonstrated a difference in plaque inhibitory performance by the three dentifrices. KIN gingival dentifrice inhibited the rate of plaque formation at 14-day post-brushing to a greater degree than that of Crest (as negative control) and lower than that of ORTHOKIN (containing zinc acetate). Albeit this diversity of plaque formation inhibition between the three toothpaste groups was negligible and insignificant. Various studies using different toothpastes have failed to show significant differences between the efficacy of the test and control toothpastes, although gingival index and plaque index were reduced compared with baseline values.[10,11] ORTHOKIN dentifrice inhibited the rate of plaque formation at 14-day post-brushing to a greater degree than those of KIN gingival and Crest. This might be due to tooth brushing with zinc citrate formulation that was shown to result in significant reductions in oral bacteria from all of the intraoral locations.[12] However, the results of plaque index of ORTHOKIN toothpaste showed a little and inconsequential decrease at 14-day post-brushing compared to KIN gingival and Crest toothpastes. CHX is a cationic antiseptic with action against a wide spectrum of bacteria. However, a significant reduction of its antiplaque potential may be observed when it is formulated into toothpaste and formulating a toothpaste containing CHX have also difficulties. Possibly the main reason for no significant reduction in plaque index in 3 toothpastes could be the interaction between CHX and anionic componenets.[7] It has been demonstrated that toothpastes containing fluorides and other antimicrobials including triclosan and zinc citrate are more effective on plaque index and gingival bleeding.[5] Junevicius et al. have shown that the "Blend-A-Med Complete 7 Extra fresh" toothpaste containing zinc nitrate had more antimicrobial effect compared to silver and gold dentrifrice.[13]

There was significant decrease in plaque index of KIN gingival and ORTHOKIN toothpastes at 14-day post-brushing compared to pre- and post-scaling. While there was no significant decrease in plaque index of Crest at 14-day post-brushing compared to pre- and post-scaling. After pellicle formation on fresh tooth surface following brushing, different population of microorganisms adhere to the polysaccharides matrix of pellicle and dental plaque is formed.[2,14] It has been shown that CHX as an ingredient of dentifrices is able to reduce the number of anaerobic supragingival plaques.[15] CHX is widely accepted to be one of the gold standard chemical inhibitors of plaques.[9] It has been illustrated that CHX has greater instant anti-pathogenic outcome and in vivo durability effect than other mouthwashes used as topical agents in mouth and is one of the most useful and impressive antimicrobial agents for plaque control.[16] Because of the binding properties of the CHX molecule, its effect sustains in the mucosal surface and on teeth and progressively results in a broad bactericidal and bacteriostatic spectrum of action after 8 hours.[9] In addition, CHX has a high substantivity of up to 12 hour within the oral cavity.[17] The patients were asked to brush twice per day. The twice daily application of a toothpaste formulation containing CHX as main ingredient has been demonstrated to have statistically significant effectiveness in reducing gingival inflammation over a 3-month period.[18,19] Bellamy et al. reported that toothpaste containing stannous fluoride is significantly more effective in alleviating plaque formation than Lacalut Aktive toothpaste containing CHX.[20] There are discrepancies in results on efficacy of toothpastes containing CHX. The induce of innate and unplanned factors on the anti-pathogenic behavior of CHX or the substantivity of CHX after performing routine daily activities, such as eating, swallow, or mastication was demonstrated.[17] This may explain the possible reason of this discrepancy.

The data on BOP index illustrated that the mean percent of BOP in KIN gingival was lower than ORTHOKIN and greater than Crest. However, no statistically significant differences in BOP index were found between the three toothpaste groups.

In a clinical study which was based on home use lasting for 6 months, both CHX alone and CHX/fluoride formulations were more effective than placebo in reducing plaques, gingival inflammation and bleeding.[21] Comparable clinical results were reported by others concerning the effectiveness of CHX in toothpaste formulations.[14,15] In agreement with our results, Wara-aswapati et al. reported that three toothpaste containing antiplaque and anti-inflammatory agents can reduce gingival bleeding index and plaque index, albeit nonsignificant.[3]

Regardless of the type of toothpaste, our results showed that scaling and root planning is effective in alleviating plaque formation and BOP (Table 1). However, no obvious difference was found in the average amount of plaque index and BOP between pre- and post-scaling in any of the three groups.

Conclusion

In conclusion, CHX and zinc in ORTHOKIN toothpaste had a greater but non-significant anti-plaque and anti-gingival bleeding effect than KIN gingival and Crest toothpastes containing CHX alone or without CHX, respectively. More studies are needed to further determine that the combination of CHX and zinc can enhance antimicrobial activity of any one of these substances alone. Toothpastes containing CHX alone and in combination with zinc can reduce plaque index and BOP when comparing pre- and post-scaling.

Conflict of Interests

Authors have no conflict of interest.

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