ORIGINAL RESEARCH

Desensitizing Efficacy of a Herbal Toothpaste: A Clinical Study

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Abstract

Aim: This double-blinded randomized parallel-group comparison study aimed to investigate the efficacy of an herbal desensitizing toothpaste (test group) compared to a 5% potassium nitrate toothpaste (control group) and a base toothpaste (benchmark group), with respect to dentine hypersensitivity.

Materials and methods: Ninety healthy participants were arbitrarily allotted into three groups. All subjects received instructions on oral hygiene using a toothbrush with these toothpastes for a 4-week period. The subjects were evaluated at baseline, week 2, and week 4. During the visits, two hypersensitive teeth were assessed using two validated stimulus tests: a tactile test and an airblast test. Data on the percentage of positive responses to the tactile stimulus and visual analog scale (VAS) scores for air stimulation were analyzed.

Results: The mean airblast VAS score and percentage of positive responses to the tactile stimulus after using the test and control toothpastes were significantly reduced compared with the benchmark. At week 4, the airblast VAS score and percentage of positive responses to the tactile stimulus decreased significantly in the test and control groups ($p < 0.01$), whereas the scores in the benchmark group decreased slightly.

Conclusion: After 4 weeks of use, the herbal desensitizing toothpaste significantly diminished dentine hypersensitivity to the same extent as did the synthetic desensitizing toothpaste.

Clinical significance: An herbal desensitizing toothpaste can reduce dentine hypersensitivity, supporting its usefulness in clinical practice.

Keywords: Clinical trial, Dentine hypersensitivity, Herbal toothpaste, Potassium nitrate.

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Introduction

Dentine hypersensitivity is well defined as a common unpleasant pain arising from dentine exposed to a variety of stimuli, which cannot be attributed to any forms of dental pathology.[1] The reported prevalence of dentine hypersensitivity varies from 3 to 57%.[2–4] Some risk indicators have been identified as contributing factors, e.g., abrasive toothpaste, gingival recession, and post periodontal treatment status.[5] The mechanism of dentine hypersensitivity is described with the hydrodynamic theory by Brännström.[6] The movement of dentinal tubule contents by increasing outward fluid flow causes pressure change across the dentine, which results in A-delta fiber distortion via a mechanoreceptor action.[7] The preventive management strategy for hypersensitivity should aim to minimize dentine exposure, for example, through proper brushing techniques, unaggressive periodontal instrumentation, and limiting the frequency of acidic beverage consumption. Desensitizing toothpaste has been suggested as a home care application to relieve the pain from hypersensitivity. The mode of action can be either nerve stabilization or tubular occlusion. Synthetic active components such as strontium chloride or sodium fluoride can interact with dentine and cause dentine precipitation.[8] Toothpaste that contains potassium salts has a depolarizing effect on electrical nerve conduction along nerve fibers, causing dentine to be less excitable by stimuli.[9]

This project aimed to examine the efficacy of an herbal desensitizing toothpaste on dentine hypersensitivity with 4 weeks of home use compared to the efficacy of a 5% potassium nitrate toothpaste and a base toothpaste not containing these active agents.

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Materials and Methods

Study Design and Population

The protocol for the human study was approved by the Ethical Committee of the Research Institute of Rangsit University (Project number RSEC 2/2559). The study was carried out at the College of Dental Medicine, Rangsit University, Pathum Thani, Thailand. The subjects were required to have at least twenty permanent teeth with a hypersensitive area on the facial or lingual surfaces of the teeth (incisors, cuspids, bicuspids, first and second molars with exposed cervical dentine) with a minimum of two teeth showing a painful response elicited by both a dental explorer and an airblast. Moreover, the subjects had to (1) have good periodontal health (no probing depth exceeding 4 mm and no bleeding on probing); (2) have received nonsurgical periodontal treatment longer than

8 weeks; (3) have normal overall health; (4) be in the age range of 20–65 years; (5) provide informed consent. Exclusion criteria were (1) teeth with dental caries or extensive restoration (involving more than 50% of the tooth structure), which might have an abnormal pulpal response; (2) destructive periodontal diseases; (3) plaque score higher than 40% of the total tooth surfaces; (4) tooth mobility greater than grade I; (5) orthodontic treatment within 12 weeks; (6) abutment teeth for a fixed or removable partial denture; (7) periodontal surgery in the preceding 12 weeks; (8) vital tooth whitening within the previous 12 weeks; (9) ongoing treatment with antimicrobials and/or anti-inflammatory medication; (10) current desensitizing therapy; (11) pregnancy or lactation; (12) smoking or alcohol abuse; (13) a history of an allergic reaction to toothpaste.

Interventions

The study was a double-blinded randomized parallel-group comparison between the following three toothpastes: (1) herbal desensitizing toothpaste containing the following active ingredients: little ironweed, Java tea, mangosteen peel, whole *Hydrocotyle* plant, *Clinacanthus nutans*, cuttlefish bone powder, and extracts of orange jessamine leaf and toothbrush tree (Twin Lotus Co., Ltd, Bangkok, Thailand) (test group) (2) desensitizing toothpaste containing 5% potassium nitrate and 0.76% sodium monofluorophosphate (Sensodyne Fresh Mint®, Glaxo-SmithKline (Thailand), Ltd, Bangkok, Thailand) (control group) (3) base toothpaste containing sorbitol, glycerin, calcium carbonate, and sodium lauryl sulfide, with no added fluoride (benchmark group).

The subjects were arbitrarily allotted into one of three groups. All subjects received a nonsurgical periodontal treatment and oral hygiene instruction by using a soft-bristle toothbrush (Colgate®) with one of the aforementioned toothpastes at least 4 minutes and dental floss (Sensodyne®) twice daily for a 4-week period of study.

Clinical Examination

All participants were evaluated at baseline, 2 weeks, and 4 weeks (end of the follow-up). At each visit, only the teeth found to be hypersensitive at baseline were evaluated. During the visits, two hypersensitive teeth were assessed using the tactile test and airblast test. The teeth were isolated with cotton rolls, and stimuli were applied to each tooth. Stimuli tests were performed according to previously published methodology.[10,11]

Tactile Test

A dental explorer (EXD11-12 Hu-Friedy, USA) was passed across the tooth's facial area, perpendicular to its long axis in the mesiodistal direction for 10 seconds, at an approximated constant force. The subjects were asked to record their sensitivity response by using the following scale: 0, did not respond and 1, responded.

Airblast Test

A blast of air was projected onto the tooth for 1 second from a 10 mm distance using a standard 3-in-1 dental unit syringe at 45–60 psi at a temperature of 17–21°C. All subjects were requested to record their perception using a visual analog scale (VAS) score on a 10 cm line with two ends (0 = no sensitivity, 10 = intolerable sensitivity).

Statistical Analysis

The Wilcoxon signed-rank test was utilized to determine significant differences between the means within the group at different visits. The Kruskal–Wallis test was used to compare the mean hypersensitivity scores after using different toothpaste among the three comparison groups. In addition, the Mann–Whitney *U* test was used to determine significant differences between the means when the Kruskal–Wallis test result was significant. The significance level was set at $p < 0.05$.

Data analysis was achieved using Statistical Package for the Social Sciences 18.0 for Windows (SPSS, Inc., Chicago, IL).

Results

A total of 90 qualified subjects agreed to join and were thus randomized (30 in the test group; 31 in the control group; 29 in the benchmark group). The mean age (SD) of subjects was 45.7 (11.5) years, and the majority were female (65.5%). The mean age, gender, and baseline sensitivity are shown in Table 1 and were not different across groups.

The comparison groups had similar mean tactile and airblast VAS scores at baseline ($p > 0.05$). At 2 weeks, both scores were reduced, but there was no statistically significant difference among the three groups. However, there was a significant reduction in the positive response percentage and airblast VAS score ($p < 0.01$) at week 4 (Figs 1 and 2).

The percentage of positive responses to the tactile stimulus among the three comparison groups is shown in Figure 1. The positive percentages were similar between the groups at the beginning of the study. The positive response percentages in all groups were reduced in week 2, but there was no significant difference among the groups. In the test group, the percentage decreased from 83.3% at baseline to 46.7% in week 2 and then to 18.3% in week 4. The reduction pattern was similar to that of the control group, in which the percentage decreased from 85.5% at baseline to 53.2% in week 2 and 19.4% at the end of the study. At week 4, there was a statistically significant percentage reduction for both the control and test groups compared to the benchmark group ($p < 0.01$). There was also no overall percentage difference between the test and control groups at any time point of the study. In contrast, there was a slight change in the percentage reduction for the benchmark group, with a percentage of 81.0% at baseline, 55.2% at week 2, and 48.3% at the end of the study.

The changes in VAS scores for the air stimulus are shown in Figure 2. The scores were similar among the groups at baseline. In the test group, the mean airblast VAS score diminished rapidly from 6.20 (3.84–8.56) at baseline to 4.33 (2.12–6.54) at week 2 and 2.73 (0.40–5.06) at week 4. The pattern was identical in the control group, with a score of 6.58 (4.11–9.05) at baseline to 4.44 (2.12–6.76) at week 2 and 2.98 (0.83–5.13) at week 4. A reduction was also

Table 1: Characteristics of the subjects: age, sex, and baseline response to stimuli

	Test group (n = 30)	*Control group (n = 31)*	*Benchmark group (n = 29)*
Age (years) (mean ± SD)	42.0 ± 11.2	45.6 ± 11.9	49.7 ± 10.2
Female:male *n* (%)	18:12 (60:40)	22:9 (71:29)	19:10 (65.5:34.5)
Baseline percentage of positive responses to a tactile stimulus (%)	83.3†	85.5†	81.0†
Baseline airblast VAS scores (mean ± SD)	6.20 ± 2.36*	6.58 ± 2.47*	5.79 ± 2.29*

†,*No statistical significance among the comparison groups ($p = 0.183$)

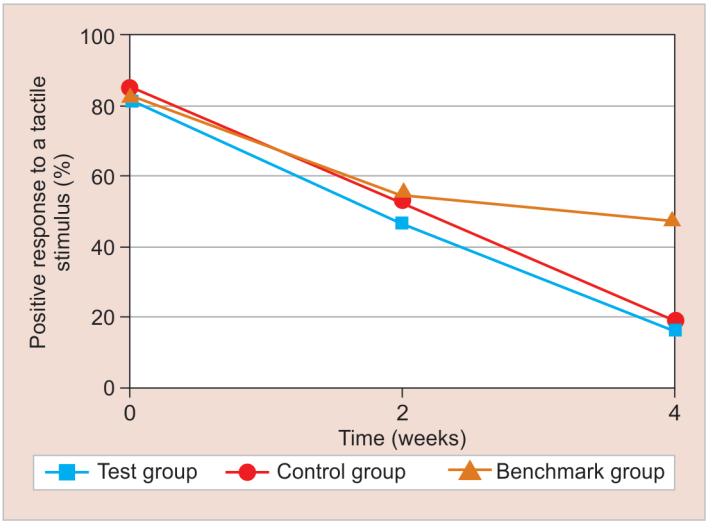

Fig. 1: Percentage of positive responses to a tactile stimulus at baseline, week 2, and week 4 among the three comparison groups

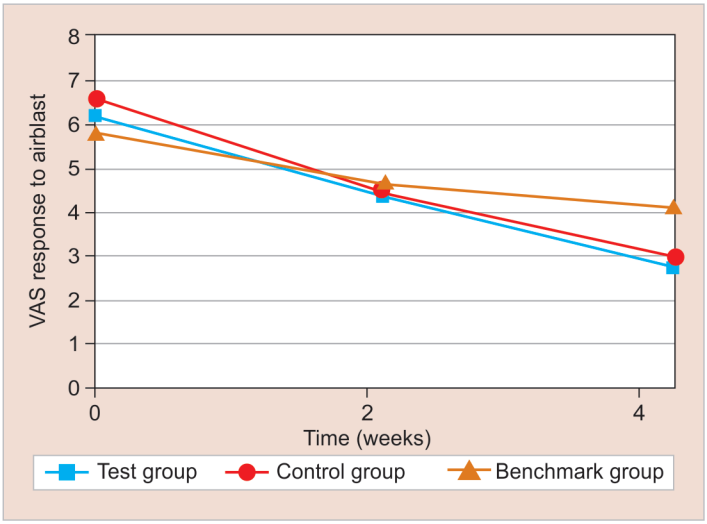

Fig. 2: Visual analog scale scores for dentine hypersensitivity to an airblast stimulus at baseline, week 2, and week 4 among three comparison groups

observed in the benchmark group, but this change was slight, from 5.79 (3.50–8.08) to 4.64 (2.10–7.18) at week 2 and 4.14 (1.54–6.74) at the end of study. The difference between these three comparison groups was statistically significant ($p < 0.01$) in week 4. The Mann–Whitney *U* test revealed that VAS score reduction was superior in both the test and control groups compared to the benchmark group ($p < 0.05$). In addition, there was no difference in the mean VAS score between the test and control groups at any time point.

Discussion

The current approach for dentine hypersensitivity has been aimed at two basic doctrines. First, according to the hydrodynamic theory based on the change in fluid flow in dentinal tubules,[6] it can be suggested that if the dentinal tubules were occluded, hydraulic conductance would be decreased. The second theory is that blocking the pulpal nerve response might lessen interdental nerve excitability by elevating the concentration of local extracellular potassium ions and causing depolarization of the pulpal sensory nerves, thereby interrupting the transmission of pain stimuli.[12] Consistent with the data from the preexisting literature, we found that the 5% potassium nitrate toothpaste was able to essentially lower dentine hypersensitivity for subjects experiencing pain due to sensitivity.[13,14] Several studies have shown that desensitizing toothpaste containing potassium nitrates provide effective nerve desensitization to dentine hypersensitivity.[13,15,16] The meta-analysis also reported evidence supporting the use of potassium-containing desensitizing toothpaste for dentine hypersensitivity.[17] Moreover, sodium fluoride may be indirectly beneficial because it is a chemical agent that protects against acid erosion by promoting remineralization.[18] These findings were all supported by the overall substantial reduction in the mean airblast VAS score and the lower percentage of a positive response to the tactile stimuli (Figs 1 and 2) after using the control toothpaste compared to the corresponding results from home care use of the benchmark product. Interestingly, at week 4, the VAS score in response to the air stimulus and the percentage of a positive response to the tactile stimulus declined the utmost in the test group, while the results in the benchmark

group decreased marginally. At the end of the study, the results obtained from the subjects who used the herbal toothpaste were similar to those obtained from the potassium nitrate-containing toothpaste users.

Plant and herbal research have impacted oral healthcare over two decades. There is a trend for greater heterogeneity of targeted dental conditions, mostly oral mucositis, periodontal and peri-implant diseases, and dental caries. Topical application rather than systemic use predominates in the dental scope, as toothpaste, mouth rinses, oral patches, and gels have been the most commonly examined in various pharmaceutical forms.[19] Most herbal toothpaste has antiplaque and anti-inflammatory effects.[20–22] However, there are few reports that show the effects of herbal products in the reduction of dentine permeability.[23,24] There are a limited number of studies regarding the reduction of hypersensitivity by herbal toothpaste. To the best of our knowledge, this is the first study to assess the desensitizing efficacy of herbal toothpaste. The herbal desensitizing toothpaste that was used in the present study containing the following active ingredients: little ironweed, Java tea, mangosteen peel, whole *Hydrocotyle* plant, *Clinacanthus nutans*, cuttlefish bone powder, and extracts of orange jasmine leaf and toothbrush tree. Little ironweed (*Vernonia cinerea*) and Java tea (*Orthosiphon aristatus*) have been studied and found to contain potassium nitrate, which might provide a nerve stabilization effect.[25,26]

A further promising reason for the reduction in dentine hypersensitivity experienced by the participants using the Thai herbal toothpaste is that the larger particle size of the herbal toothpaste may occlude dentinal tubules. A crystalline precipitate was observed on the defined surface, and there was no statistically significant difference between the herbal toothpaste and the potassium nitrate-containing toothpaste with regard to dentine permeability after brushing or citric acid immersion, as observed in a scanning electron microscope study.[24] Most of the components of Twin Lotus toothpaste are derived from natural products such as mangosteen peel, toothbrush tree, orange jessamine leaf, whole *Hydrocotyle* plant, and *Clinacanthus nutans*. These ingredients' granules might occlude dentinal tubules and be resistant to solubilization in the oral environment. This might lead to a reduction in fluid flow through dentinal tubules.

Another result of the present study is that the desensitizing efficacy in the test and control groups did not show a difference compared to that in the benchmark group at 2 weeks of study. However, at week 4, both the control and test groups showed desensitization properties that were superior to those of the benchmark group (Figs 1 and 2). There was also no overall difference between the test and control groups at any time point of the study. This is consistent with the previous analysis that claimed that the weakness of a desensitizing toothpaste is the slow onset of the effect, i.e., a lengthy period is necessary to observe the desensitizing efficacy of the toothpaste.[17] This information should be given to patients who experience dentine hypersensitivity before suggesting the home care application of desensitizing toothpaste. Moreover, the use of a desensitizing toothpaste might be recommended after the patient has experienced an instant effect from in-office treatment to maintain and increase the desensitizing effect. However, the long-term desensitizing effect of herbal toothpaste should also be investigated. Another study limitation is the sample size. Since the data in each group were not normally distributed, further research should employ both larger sample size and a longer follow-up period.

Conclusion

This study documented that after 4 weeks of use, herbal desensitizing toothpaste significantly diminished dentine hypersensitivity to the same extent as did a synthetic desensitizing toothpaste.

Clinical Significance

An herbal desensitizing toothpaste can reduce dentine hypersensitivity, supporting its usefulness in clinical practice.

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