Toothpaste containing sodium bicarbonate, sodium fluoride, and potassium nitrate for dentine hypersensitivity with periodontal inflammation

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Abstract. Dentine hypersensitivity is commonly found in patients with periodontal inflammation, typically caused by a disease process that has exposed the root surface. Use of toothpaste while tooth brushing has been proven to be effective in removing plaque as a major cause of inflammation. This study was performed to analyze the role of tooth brushing with toothpaste containing sodium bicarbonate, sodium fluoride, and potassium nitrate in the treatment of dentine hypersensitivity with periodontal inflammation. Experimental clinical trial data were compared between groups. Both groups showed decreased levels of sensitivity and inflammation. Compared with controls, patients in the treatment group showed a greater decrease in sensitivity.

1. Introduction
Gingiva usually circles the cervical plane of the tooth under the crown. Inflammation may expose dentin and cementum, though the effects may remain hidden [1,2]. Inflammation of periodontal can be defined as pathological process that involve the periodontal tissues. Most of periodontal inflammations are caused by bacterial infection on dental plaque or calculus [3]. Hypersensitivity of dentin mostly found in patient with chronic inflammation of periodontal, whereas the surface of tooth was exposed as part of pathological process [4,5]. The study by Chabanski et al showed that 72.5%–98% patients with periodontal inflammation if they got the stimulant such as water, air, or scratches on cervical of their tooth would experience some hypersensitivity of dentin [6]. Hypersensitivity of dentin is a pain initiates by gingival recession or exposure of dentin and cementum. Sharp or short pain which was elicited from dentin hypersensitivity could be caused by chemical, thermal, or osmotic stimulant and pathological damage [7]. Dentin may undergo demineralization on pH 6.5 and the chance for mineralization is small [8,9]. Dentin hypersensitivity commonly was started by loss of gingival margin [10,11]. Exposure of root surface could get worse by acid from bacteria that could open the dentinal tubuli [12,13]. Education on effective means of controlling plaque levels would improve periodontal health [14]. Tools were used to mechanical plaque control are tooth brush, dental floss, interdental brush, and pocket irrigation [4]. Chemically is toothpaste. Few studies have shown that the use of toothpaste containing sodium bicarbonate, sodium fluoride, and potassium nitrate is statistically proven to decreasing plaque, sensitivity, and gingivitis [15]. Many treatments are available done to remove hypersensitivity of dentin, but patient complaint to tooth sensitivity is often seen in dental
The use of toothpaste containing of sodium bicarbonate, sodium fluoride, and potassium nitrate was found effective. Otherwise, Klimek et al study showed that without proper tooth brushing instructions from operator, the results of an investigation to use toothpaste for sensitive teeth showed no effective result [16].

2. Methods
The study protocol was approved by Dental Research Ethics Committee, Faculty of Dentistry, Universitas Indonesia. This study used 49 teeth from 8 (eight) subjects. The subjects experienced some periodontal inflammation, gingival recession, and tooth hypersensitivity on premolar teeth, but not in sensitive toothpaste therapy or had gone through desensitization therapy and voluntary participated and also had signed the informed-consent were included in the study. Exclusion criteria were caries, abrasion, crowding, cracked enamel, or restoration; systemic diseases such as diabetes mellitus, bulimia, bruxism, and clenching; and pregnant woman.

Subjects were examined for the presence of plaque, calculus, and/or gingival bleeding. Level of dental hygiene was recorded. Cotton swabs were used to remove saliva from the cervical margins of teeth. Teeth were then stimulated with air for 3 s with a 3-way syringe. A cotton pellet that had been soaked in cold water for 3 s was then applied to scratches created for the purposes of investigation. Break after stimulus range was 1 minute. Subjects were asked to sign on along the VAS line based on the level of pain intensity on stimulus’ were given. Scoring was done to know the progress of therapy, then initial therapy was given to the subjects such as scaling. Then, subjects were given tooth brush and toothpaste containing sodium bicarbonate, potassium nitrate, and sodium fluoride. All study participants received instructions on proper tooth brushing with use of Stillman’s method and without using any toothpaste. Subjects were evaluated again after 2 (two) weeks. Data were analyzed by Wilcoxon test (non-parametric). For non-parametric data, scores were compared between groups with the Mann–Whitney test.

3. Results
Study was done on February 2014 at the Teaching Dental Hospital, Faculty of Dentistry, Universitas Indonesia, and 49 teeth of subjects were examined. Each of subject complained dentin hypersensitivity and experienced periodontal inflammation on mandibular and maxillary first or second premolar. Normality test by Shapiro–Wilk test on on Plaque Index, Calculus Index, Oral Hygiene Index, and Papillary Bleeding Index showed p < 0.05 which means the data distribution were not normal. Normality test by Shapiro–Wilk test on on Visual Analog Score by 3 (three) stimulus showed p < 0.05 which means the data distribution were not normal. The Mann–Whitney test was performed when data were not normally distributed.

| Table 1. Mean, standard deviation, and wilcoxon test between periodontal inflammation on group whose use toothpaste and the one who use no toothpaste before and after 2 (two) weeks |
|------------------|--------|----------------------|-------------------------------|------------------|
| Periodontal Inflammation | N     | Mean ± SD Before | Mean ± SD After | p     |
| Plaque Index       | 24    | 1.82 ± 0.51        | 0.17 ± 0.24                | 0.00  |
| With Toothpaste    | 25    | 1.60 ± 0.41        | 0.80 ± 0.54                | 0.00  |
| Without Toothpaste | 24    | 1.40 ± 0.59        | 0.24 ± 0.24                | 0.00  |
| Calculus Index     | 25    | 1.56 ± 0.77        | 0.37 ± 0.42                | 0.00  |
| With Toothpaste    | 24    | 3.22 ± 0.92        | 0.41 ± 0.31                | 0.00  |
| Without Toothpaste | 25    | 3.16 ± 0.85        | 1.17 ± 0.88                | 0.00  |
| Oral Hygiene Index | 24    | 1.29 ± 0.33        | 0.29 ± 0.25                | 0.00  |
| With Toothpaste    | 25    | 1.24 ± 0.25        | 0.86 ± 0.40                | 0.00  |
| Without Toothpaste | 24    | 1.00 ± 0.33        | 0.32 ± 0.24                | 0.00  |
| Papillary Bleeding Index | 25    | 1.10 ± 0.85        | 0.34 ± 0.27                | 0.00  |

Wilcoxon test; p < 0.05 (significant difference); N = Total number of subjects
Results of the Wilcoxon test in Table 1 revealed a significant difference between periodontal inflammation with and without use of toothpaste ($p < 0.05$). Level of periodontal inflammation in subjects with dental hypersensitivity decreased after teeth were brushed with toothpaste which contained of sodium bicarbonate, sodium fluoride, and potassium nitrate.

**Table 2.** Mean, standard deviation, and wilcoxon test of visual analog score between first and last stimulus on group whose use toothpaste and the one who use no toothpaste before and after 2 (two) weeks

| Visual Analog Score | N  | Before Mean ± SD | After Mean ±SD | p       |
|---------------------|----|------------------|----------------|---------|
| Air Spray           | 24 | 2.06 ± 0.70      | 0.25 ± 0.26    | 0.00    |
|                     | 25 | 2.96 ± 0.78      | 2.56 ± 0.68    | 0.00    |
| Cold Water          | 24 | 1.96 ± 1.09      | 0.17 ± 0.24    | 0.00    |
|                     | 25 | 2.72 ± 1.18      | 2.36 ± 1.01    | 0.01    |
| Scratches           | 24 | 1.04 ± 0.85      | 0.17 ± 0.24    | 0.00    |
|                     | 25 | 1.64 ± 0.80      | 1.26 ± 0.91    | 0.00    |

Wilcoxon test; $p < 0.05$ (significant difference)

The results of Wilcoxon test in Table 2 showed that there was significant difference ($p < 0.05$). Level of sensitivity of patient with dental hypersensitivity with periodontal inflammation decreased after teeth were brushed with toothpaste which was contained of sodium bicarbonate, sodium fluoride, and potassium nitrate.

**Table 3.** Mean, standard deviation, and mann–whitney test of decreasing of visual analog score between first and last stimulanl on group whose use toothpaste and the one who use no toothpaste before and after 2 (two) week

| Visual Analog Score | With Toothpaste Mean ± SD | Without Toothpaste Mean ±SD | p     |
|---------------------|---------------------------|----------------------------|-------|
| Air Spray           | 1.81 ± 0.92               | 0.39 ± 0.47                | 0.00  |
| Cold Water          | 1.79 ± 1.11               | 0.38 ± 0.66                | 0.00  |
| Scratches           | 0.88 ± 0.66               | 0.46 ± 0.41                | 0.02  |

Mann–Whitney Test; $p < 0.05$ significant difference

The results of Mann–Whitney Test in Table 3 showed that dental hypersensitivity of the subjects that used toothpaste were decreased. Teeth were brushed with toothpaste which contained of sodium bicarbonate, sodium fluoride, and potassium nitrate can remove dental hypersensitivity of patient with periodontal inflammation.

4. **Discussion**

In this study, both the groups were given initial therapy such as scaling and education on how to brush the teeth properly with Stillman’s method. This was a proof that plaque removal was helpful to heal the periodontal inflammation. These results were same as the study by Grenstein and Dwijartini who showed that scaling and using tooth brush were sufficient to decrease papillary bleeding index, reduce inflammation and gingival bleeding, and remove pathogenic microorganism in periodontal tissues. [17-20] The group which used toothpaste containing sodium bicarbonate, sodium fluoride, and potassium nitrate showed decrease in periodontal inflammation. It is proven that sodium fluoride and
sodium bicarbonate had antibacterial and buffering properties, so it could change environment of bacteria [18,19].

Statistical analysis showed that the level of sensitivity decreased in both the groups, but the group which used toothpaste showed more decrease. This proves that sodium fluoride could remove acid products of bacteria which are one of causal factors of dental hypersensitivity [21-23]. Kawasaki etc study showed that controlling biofilm by brushing teeth and rising the mouth with chlorhexidine decreased the size of dentinal tubuli orifices by up to 20% [23,24]. Potassium nitrate served as a desensitizing agent in toothpaste, blocking neuronal transmission of pain messages [11,21,22].

Decrease in sensitivity level accompanied by decrease in periodontal inflammation without toothpaste was in line with the theory which said that tooth brushing could increase capillary circulation of gingiva, increase keratinization of oral epithelium and sulcus epithelium and dense bundle of collagen connective tissues so the surface of root of teeth which was exposed could be closed and complaint of dental hypersensitivity was decreasing [25,26]. Mechanical tooth brushing, besides it could enhance fibroblast activity so it could proliferate in a week, but also enhance the collagen synthesize in 5 (lima) weeks [25,27]. These results were similar to the study that showed improvement in group without toothpaste took longer time than the one with toothpaste.

5. Conclusion
Visual Analog Scores decreased in the group that used toothpaste containing sodium bicarbonate, sodium fluoride, and potassium nitrate, those levels remained higher than those seen in the control group. Periodontal inflammation decreased after tooth brushing with toothpaste which contained sodium bicarbonate, sodium fluoride, and potassium nitrate. There was a decreasing of Visual Analog Score through giving of stimulus such as air spray, cold water, and scratch after tooth brushing with toothpaste which contained of sodium bicarbonate, sodium fluoride, and potassium nitrate.

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