Gingivitis Reduction Effects by Using Dentifrice Containing Green Tea Extract, Sodium Monofluorophosphate, and Calcium Carbonate

Ji-Youn Kim¹, Mi-Sol Park¹, Jung-Eun Park², Seung-Sook Yang¹, Min-Jeong Kim¹, Sun-Ae Mok¹, Hye-Ji Kim¹,2, Chan-Ho Kim³, Ki-Jung Kim³, Ja-Won Cho¹,2,4

Departments of ¹Oral Health and ²Dental Hygiene, College of Health Science, Dankook University, Cheonan, ³HBD Division, Amorepacific R&D Center, Yongin, ⁴Department of Preventive Dentistry, College of Dentistry, Dankook University, Cheonan, Korea

Objective: This study was carried out to investigate the effect of dentifrice containing green tea extract, sodium monofluorophosphate and calcium carbonate on dental plaque and gingivitis by periodic measurements.

Methods: Oral examination items were measured by papillary marginal attached (PMA) index, Talbott’s gingival index, patient hygiene performance (PHP) index, and Turesky’s plaque index.

Results: PMA index showed statistically significant difference in the control group (p < 0.05). Talbott’s gingival index measurements showed statistically significant differences in the control group from 8 weeks after the start of the study (p < 0.05). As a result of PHP index measurement, statistically significant differences were observed in the experimental group from the control group after 4 weeks (p < 0.01). And Turesky’s plaque index measurement, statistically significant differences were observed in the experimental group from the control group after 4 weeks (p < 0.01).

Conclusion: These results suggest that dentifrice with green tea extract, sodium monofluorophosphate and calcium carbonate can be effective in reducing gingivitis and dental plaque.

Keywords: calcium carbonate, catechin, dentifrices, fluorides, gingivitis

Introduction

The greatest desire that man has longed for is health. Health is an important factor for people to live, and everybody strives to keep them alive. As economic growth and people’s level increased, interest in health and quality of life also increased. Therefore, it cannot be explained by excluding oral health, which is the most important element of health [1].

Dental plaque is a membrane attached to the tooth surface. It is a host-dependent biofilm, and is a group of microorganisms, which is a main component of bacteria, and is composed of various bacteria [2]. Dental plaque is a typical cause of gingivitis, and gingivitis is inflammation that is limited to the upper part of the alveolar bone, and may cause symptoms such as redness, swelling, and bleeding. The physical method...
to remove dental plaque, which is the cause of gingivitis, is brushing. Brushing is a method of using a toothbrush and a dentifrice, and a toothbrush and a dentifrice are oral appliances. The form of a dentifrice is divided into liquid, powder, cream, and solid dentifrice. The main ingredients of the most commonly used cream type dentifrice are an abrasive, detergent, binder, wetting agent. Various ingredients such as flavors, coloring agents, sweeteners, fluorine, water, and preventive therapeutic agents may be added to the dentifrice [3,4].

Recently, a dentifrice has been developed in the basic role and used for prevention and treatment, and studies for decreasing oral diseases according to dental plaque have been actively carried out by combining various additives [5].

Among them, catechin, a major component of green tea extract, is a polyphenolic natural compound, and its main forms are (+)-catechin, (−)-epicatechingallate, (−)-epicatechin, (−)-epigallocatechin and -gallate and so on. These ingredients have various effects on antimicrobial, antioxidant, anticancer and anti-aging effects on the caries [6]. Fluorine used in a dentifrice uses several types of fluoride. Sodium fluoride, and tin fluoride are used and among which sodium monofluorophosphate (SMFP) is suitable as an abrasive. If SMFP is added, free fluoride ion (F⁻) acts on the hydroxyapatite and the action of fluoride phosphorus ion (FPO₃⁻²) in combination with hydroxyapatite in the dentin can prevent caries [7,8]. SMFP can reduce the time available for binding to calcium by the salivary phosphatases of saliva, thereby increasing the calcium and fluoride ions. And calcium carbonate acts as an abrasive, and calcium is secreted to play a remineralization role and adsorption of fluorine [9]. Yoo et al. [10] measured the physiologically active compound in the dentifrice containing a green tea. The natural compound containing green tea was extracted with methanol, diluted 5 times with water, and the content of physiologically active substance was observed for 1 month. As a result, 66% of the compound was decomposed for 1 month. Fan et al. [11] randomly assigned the experimenter to use one of the three toothpastes for two years. Three-hundred and twenty-eight were brushing with calcium carbonate-based toothpaste that contained nothing, 341 with 1.14% SMFP silica toothpaste, and 329 with 1.14% SMFP calcium carbonate toothpaste twice daily. As a result, it was found that experimenters using 1.14% SMFP silica toothpaste and 1.14% SMFP calcium carbonate toothpaste were more effective in dental caries than the ones using non-carbonated toothpaste. Therefore, this study was carried out to investigate the effect of dentifrice containing green tea extract, SMFP and calcium carbonate on dental plaque and gingivitis by periodic measurements.

### Materials and Methods

1. Subject

1) Study subjects

In this study, the subjects of the study agreed to participate in the study and signed the written consent of the adult subjects aged from 20 years old to under 50 years old. They should brush their teeth more than twice a day regularly. The number of remaining teeth without cervical caries or restorations was more than 24, and 60 healthy individuals with mild-moderate gingivitis were selected (Table 1).

2) Study subjects dentifrice

The study dentifrice was conducted with two types of dentifrice: an experimental dentifrice and a control dentifrice. The experimental dentifrice used was green tea extract, SMFP and calcium carbonate as the main ingredients, and the control dentifrice used dentifrice except the main ingredient in the experimental dentifrice (Table 2).

2. Method

1) Approved by institutional review board (IRB)

This study was approved by Dankook University IRB (approval no. DKU 2017-01-009 and DKU 2017-03-024).

2) Assignment of study subjects

This study assessed the suitability of volunteers who signed

### Table 1. Sex and age distribution of subjects

<table>
<thead>
<tr>
<th>Sex</th>
<th>Age (yr)</th>
<th>Total</th>
<th>20s</th>
<th>30s</th>
<th>40s</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>60</td>
<td>30</td>
<td>22</td>
<td>8</td>
</tr>
<tr>
<td>Male</td>
<td></td>
<td>21</td>
<td>10</td>
<td>9</td>
<td>2</td>
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<tr>
<td>Female</td>
<td></td>
<td>39</td>
<td>20</td>
<td>13</td>
<td>6</td>
</tr>
</tbody>
</table>

### Table 2. Ingredients and content of dentifrice

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>E</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Green tea extract (%)</td>
<td>0.04</td>
<td>0</td>
</tr>
<tr>
<td>Sodium monofluorophosphate (%)</td>
<td>0.76</td>
<td>0</td>
</tr>
<tr>
<td>Calcium carbonate (%)</td>
<td>10.0</td>
<td>0</td>
</tr>
<tr>
<td>Formulation component (%)</td>
<td>Appropriate amount</td>
<td>Appropriate amount</td>
</tr>
</tbody>
</table>

E: experimental dentifrice for experimental group, C: control dentifrice for control group.
the study agreement through a parallel, randomized, double-blind, and control study for 16 weeks. The subjects were randomly assigned to the experimental group and the control group according to the registered order so that the subjects, and were distributed by 30 persons per group.

3) How to use a dentifrice training
After training all subjects with the method of rotation, the brushing method, three times a day for 3 minutes, using the rotation method, the applicable dentifrice was used for 16 weeks. The experimental group was given the experimental dentifrice and the control group was given the control dentifrice.

4) Oral examination
Subjects underwent oral examinations six times before, one week, two weeks, four weeks, eight weeks, and sixteen weeks after use. Oral examination items were measured by papillary marginal attached (PMA) index, Talbott’s gingival index, patient hygiene performance (PHP) index, and Turesky’s plaque index.

(1) Gingival index
① PMA index: PMA index was measured on the anterior teeth.
② Talbott’s gingival index: According to the gingivitis rating index, six areas were measured by dividing the buccal and lingual marginal gingiva surrounding the teeth into mesial, distal, and central gingivitis, respectively. The individual gingivitis index is obtained by dividing the total of the measurements for each site by the number of teeth to be examined. The target tooth were #16, #11, #26, #31, #36, and #46 teeth.

5) Data analysis
The results of this study were analyzed using the IBM SPSS Statistics ver. 24.0 (IBM Corp., Armonk, NY, USA) statistical program. The comparison between the groups was analyzed by 2-sample t-test and the intra-group were analyzed by paired t-test.

Results

1. Changes in gingivitis index
The results of gingivitis test are shown in Table 3 and Table 4. PMA index was 2.67±2.92 at 16 weeks in the experimental group and 4.93±4.23 in the control group. There was statistically significant difference between the experimental group and the control group after 16 weeks (p<0.05). In the experimental group, there was a significant PMA index decrease at 1 week after the experiment (p<0.01). In Talbott’s gingival index results, there was statistically significant difference between the experimental group and the control group at 8 weeks (3.16±2.38 in the experimental group and 5.28±3.44 in the control group), and statistically significant difference was found between the experimental group and the control group.
Table 5. Changes of PHP index

<table>
<thead>
<tr>
<th>Group</th>
<th>Base</th>
<th>After 1 week</th>
<th>After 2 weeks</th>
<th>After 4 weeks</th>
<th>After 8 weeks</th>
<th>After 16 weeks</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>2.26±0.68</td>
<td>2.21±0.73</td>
<td>2.13±0.58</td>
<td>2.34±0.56</td>
<td>2.28±0.43</td>
<td>2.15±0.75</td>
</tr>
<tr>
<td>E</td>
<td>1.73±0.92</td>
<td>1.78±0.94</td>
<td>1.79±0.88</td>
<td>1.51±0.73*</td>
<td>1.25±0.67**</td>
<td>1.31±0.75**</td>
</tr>
<tr>
<td>p-value</td>
<td>0.015</td>
<td>0.054</td>
<td>0.531</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

Values are presented as mean±standard deviation. PHP: patient hygiene performance, C: control group, E: experimental group. p-value by 2-sample t-test. *p<0.05 by paired t-test between base and after. **p<0.01 by paired t-test between base and after.

Table 6. Changes of Turesky plaque index

<table>
<thead>
<tr>
<th>Group</th>
<th>Base</th>
<th>After 1 week</th>
<th>After 2 weeks</th>
<th>After 4 weeks</th>
<th>After 8 weeks</th>
<th>After 16 weeks</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>1.17±0.68</td>
<td>1.14±0.65</td>
<td>1.17±0.69</td>
<td>1.18±0.48</td>
<td>1.22±0.47</td>
<td>1.17±0.64</td>
</tr>
<tr>
<td>E</td>
<td>1.05±0.88</td>
<td>1.01±0.69</td>
<td>0.87±0.65**</td>
<td>0.75±0.53**</td>
<td>0.70±0.51**</td>
<td>0.71±0.51*</td>
</tr>
<tr>
<td>p-value</td>
<td>0.546</td>
<td>0.449</td>
<td>0.087</td>
<td>0.002</td>
<td>&lt;0.001</td>
<td>0.003</td>
</tr>
</tbody>
</table>

Values are presented as mean±standard deviation. C: control group, E: experimental group. p-value by 2-sample t-test. *p<0.05 by paired t-test between base and after. **p<0.01 by paired t-test between base and after.

Discussion

To prevent oral disease, dental plaque made of various bacteria and microorganisms should be kept on the surface of teeth. Dental plaque has gathered various bacterial causes of oral diseases. To remove dental plaque that causes oral disease, brushing is a physical removal method. It is not enough to remove dental plaque attached to the tooth surface by brushing, so the role of dentifrice, an oral product, is needed. Recently, dentifrice has been increasingly attracting interest, so not only the removal of dentifrice, but also preventive efficacy and therapeutic agents have been developed. And various combined with other additives, studies on dental plaque have been conducted to reduce oral diseases [12-14]. Lee et al. [15] reported that green tea extract, CHMC-2032, was not cytotoxic at low temperatures. The green tea extract, CHMC-2032, was found to be more effective than the extract of cassia obtusifolia in inhibiting growth of periodontal disease-causing bacteria. Sarin et al. [16] provided a mouthwash for the control group and a mouthwash containing 2% green tea for the experimental group and rinsed twice a day. It was confirmed that dental plaque and gingivitis were reduced in a mouthwash containing 2% green tea. Bae et al. [17] showed that gingivitis was decreased after 2 weeks when gargle containing sodium fluoride, cetylpyridinium chloride green tea extract and pine leaf extract was used at 0, 2, 4, and 6 weeks, respectively.

In addition, dentifrice, which contains the western wasabi extract of various components, had an inhibitory effect on dental plaque index and gingivitis index. Dentifrice with baking soda had an inhibitory effect on gingivitis in 65% dentifrice alone. Dentifrice containing willow has been reported to reduce dental plaque and gingivitis [18-20].

Maruyama et al. [21] reported that green tea extract inhibited the growth of periodontal bacteria when catechin of green tea was added to toothpaste. As a result of using green tea extract, the decrease of PMA index was statistically sig-
nificant after 1 week of use (p<0.01), consistent with Maruyama’s study.

Kim et al. [22] found that the use of dentifrice with SMFP and sodium bicarbonate resulted in stable fluoride ion concentration and relatively low tooth abrasion, which is safe for the tooth and effective for removal of dental plaque. In this study, the use of SMFP dentifrice resulted in a statistically significant difference between the effects of PHP index reduction after 4 weeks of use (p<0.05).

Moon et al. [23] reported that periodontal disease and dental plaque index decreased in dentifrice combined with triclosan. In this study, the plaque index reduction effect was significantly decreased in the experimental group from the second week after the experiment (p<0.05).

In summary, as a result of using the green tea extract, SMFP and calcium carbonate dentifrice, gingivitis and dental plaque decreased. Therefore, the use of green tea extract, SMFP and calcium carbonate dentifrice may be effective for patients with severe gingivitis and dental plaque. It is necessary to use dentifrice according to the oral diseases and characteristics of each individual and it is necessary to develop a multifaceted dentifrice using various natural medicines or anti-inflammatory medicines to prevent dental caries and periodontal disease.

Conclusion

In order to confirm the reduction of gingivitis and dental plaque of dentifrice containing green tea extract, SMFP and calcium carbonate as main ingredients. We used the dentifrice for 16 weeks in a total of 60 subjects, 30 in the experimental dentifrice including all component and 30 in the control dentifrice. As a result of measuring gingivitis and dental plaque, the following conclusions were obtained.

1. After 16 weeks, PMA index showed statistically significant difference in the control group (p<0.05). In the experimental group, there was a significant decrease in the PMA index from 1 week after the experiment to before the experiment (p<0.01).

2. Talbott’s gingival index measurements showed statistically significant differences in the control group from 8 weeks after the start of the study (p<0.01). In the experimental group, there was a significant decrease in the gingival index from 1 week after the experiment to before the experiment (p<0.01).

3. As a result of PHP index measurement, statistically significant differences were observed in the experimental group from the control group after 4 weeks (p<0.001). The experimental group showed a significant decrease in the PHP index from 4 weeks after the experiment to before the experiment (p<0.05).

4. As a result of Turesky’s plaque index measurement, statistically significant differences were observed in the experimental group from the control group after 4 weeks (p<0.01). The experimental group showed a significant decrease in the plaque index from 4 weeks after the experiment to before the experiment (p<0.05).

These results suggest that dentifrice with green tea extract, SMFP and calcium carbonate can be effective in reducing gingivitis and dental plaque.

Conflict of Interest

No potential conflict of interest relevant to this article was reported.

References

12. Jeong HY, Kim YS, Jeong MA. Variations of oral cavity environ-
ment according to sodium lauryl sulfate concentration of toothpaste. Korea Content Assoc 2010;10:240-8.