

A Clinical Study on the Dental and Tongue Plaque Removal Effect by Use of 360° Round Toothbrush with Soft Bristle

Jin-Sil Kim¹, Kyu-Hwan Lee², Seung-Chul Shin³, Jee-Hyun Lim⁴

¹Department of Oral Health, Graduate School, Dankook University, Cheonan, ²Health Promotion Center, Seoul National University Bundang Hospital, Seongnam, ³Department of Preventive Dentistry, College of Dentistry, Dankook University, Cheonan, ⁴Department of Dental Hygiene, Taegu Science University, Daegu, Korea

Objective: In order to prove the effect of removing the plaque attached on the tooth surface and the dorsum of the tongue of dental patients equipped with orthodontic appliance, a clinical trial was conducted.

Methods: Sixty adult volunteers who were equipped with a fixed type of orthodontic appliance participated in this study and they were divided into two groups: experimental group who were supplied with 360° round toothbrushes and control group who were provided with V shaped concave type bristle plane toothbrushes as routine type toothbrushes for the patients equipped with the orthodontic appliance. Simplified patient hygiene performance (S-PHP) index and tongue plaque index were measured 4 times: before this experiment, a week later, and 2 and 4 weeks later after this experiment, and the data were collected and compared between the experimental group and the control as time goes by.


Results: S-PHP index and tongue plaque index decreased in experimental group after 2 and 4 weeks later, but this result wasn't significantly meaningful between experimental group and the control ($p < 0.01$). It revealed decreasing tendency of S-PHP and tongue plaque index in experimental group as time goes by ($p < 0.05$).

Conclusion: It was recommended to use 360° round head toothbrushes with a proper instruction for cleaning tooth surface and appliance in order to remove the dental plaque and tongue plaque effectively.

Keywords: toothbrush, oral health, orthodontic appliance, dental plaque

Corresponding author **Kyu-Hwan Lee**

Health Promotion Center, Seoul National University Bundang Hospital, 82 Gumi-ro 173beon-gil, Bundang-gu, Seongnam 13620, Korea. Tel: +82-31-787-2420, Fax: +82-31-787-4014, E-mail: recovery@hanmail.net

 <https://orcid.org/0000-0002-0918-8711>

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Introduction

The aim of the tooth brushing is to clean teeth in order to prevent dental caries and periodontal disease by removing dental plaque on the tooth surface or tongue plaque on the dorsum of the tongue [1]. Tooth brushing can eliminate the oral environmental factors that cause oral diseases as well as decrease the oral micro-organism factors through proper tooth-brushing [2]. In general, it has been well known that the best way and the general method for cleaning oral cavity to get rid of dental plaque

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on tooth surface and tongue are to brush with the manual toothbrush by mechanically or physically cleansing the oral cavity [3].

In recent years, orthodontic treatment has been popular by developing a fixed type of oral orthodontic appliance, but it has a problem. It is difficult to care oral hygiene because of its complicated structure on the tooth surface and oral diseases, such as dental caries and periodontal disease [4].

It has been reported that the incidence rate of demineralization on the tooth surface of orthodontic appliance dental patients was from 2% to 97%, which is variable because of difficulty in removing plaque on the tooth surface and a fixed type of orthodontic appliance [5]. In general, the plaque control of orthodontic appliance dental patients has been done by using V shaped concave type of bristle plane through horizontally scrubbing the bracket and wire at the labial surface of anterior teeth with it [6]. A lot of studies on plaque control for patients equipped with orthodontic appliance have been conducted by using electric short vibratory action toothbrushes in recent years [7,8]. In this study, it will be introducing an effect of removing plaque attached on tooth surface and tongue by using a newly designed and developed toothbrush, which has 360° round head with soft bristle for a fixed type of orthodontic appliance of dental patients and by comparing the traditional V shaped orthodontic toothbrush with 360° round head with soft bristle in the control group equipped with fixed type of orthodontic appliance.

Materials and Methods

1. Materials

A 360° round head toothbrush (LUX 360 Molar; One Star



Figure 1. A 360° rotating head toothbrush.

International Co., Incheon, Korea) was used for experimental group as shown in Figure 1, and V shaped concave type of the bristle plane toothbrush for a routine type toothbrush of orthodontic dental patients (VIVATEC Functional; One Star International Co.) was supplied to the control group as shown in Figure 2.

2. Subjects

Sixty adult volunteers were equipped with the fixed type of orthodontic appliance, agreed by writing their signature, and participated in this study. They were divided into two groups: 30 for experimental and the other 30 for the control group. A 360° round head toothbrushes were given to the experimental group and V shaped concave type bristle plane toothbrushes for orthodontic appliance dental patient were supplied to the control group. Tooth-brushing instruction was delivered to each group with a proper method in order to eliminate dental plaque and tongue plaque with each toothbrush, and all the participants had practical exercise. All of them were allowed to use each toothbrush for a month, and they were asked to join 4 oral examinations; the first was conducted before the experiment and the others were conducted 1, 2, and 4 weeks later after the experiment respectively.

3. Method

This study obtained Institutional Review Board (IRB) as approval from the committee of Research Ethics in Dankook University (IRB NO: DKU 201707007-UE 001).

The experimental group used 360° round toothbrushes (LUX 360 Molar; One Star International Co.) and the control group used V shaped concave type of bristle plane for routine ortho-



Figure 2. V shaped concave type toothbrush.

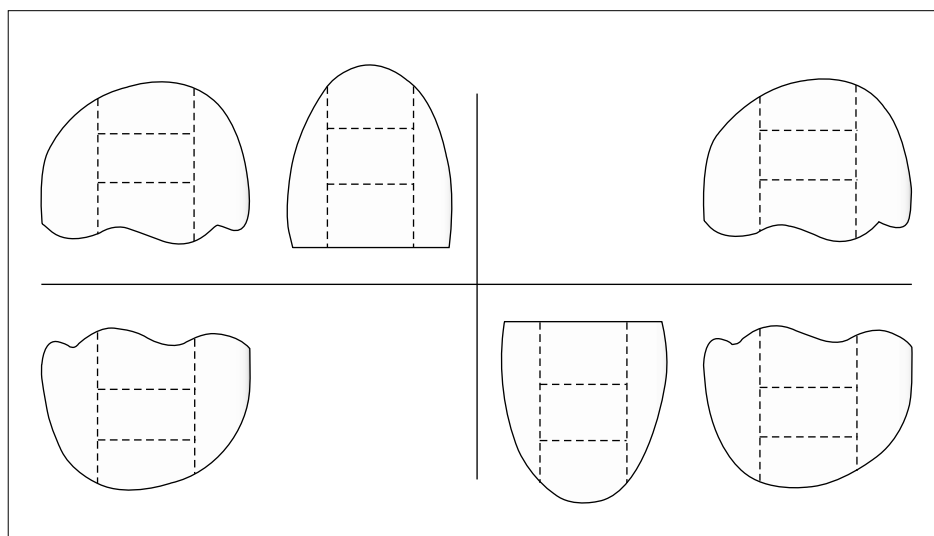


Figure 3 Sector division for simplified patient hygiene performance index.

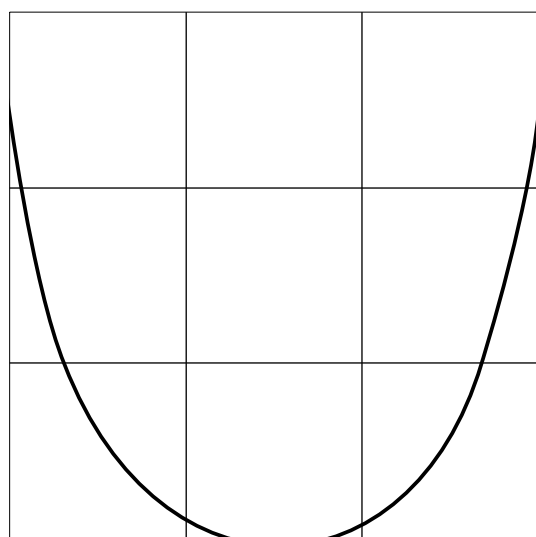


Figure 4. Sector division for tongue plaque.

dontic appliance of dental patients (VIVATEC Functional; One Star International Co.). The same dentifrice was supplied to both groups. It contains a minimum abrasives (Sensodyne Original; Glaxo Smith Kline Co., London, UK).

Tooth-brushing instruction for proper use of 360° round head soft bristle toothbrush was provided with the experimental group one by one with practical training. They were allowed to clean tooth surface and the proximal area with the toothbrushes and required to clean the bracket and wire on the appliance. For the control group, V shaped concave bristle plane routine toothbrushes for orthodontic appliance dental patients were supplied, and then the instruction about how to brush teeth around appliance and gingival area was demonstrated with short vibratory action after horizontal scrub on the labial surface.

Simplified patient hygiene performance (S-PHP) index and tongue plaque index were measured by a trained dentist and dental hygienist a week before the experiment, a week, 2 weeks and 4 weeks later after the experiment.

The standard of S-PHP index was used as a means of examining the buccal surface of 2 upper first molars, labial surface of upper and lower anterior Incisor and lingual surface of 2 lower first molars by dividing 5 sectors in one tooth surface into mesial, distal, incisal, cervical, and central areas in order to examine the plaque existence in all areas to rate one point after applying the disclosing solution on the tooth surface and then, mouth was washed off. So it will be estimated from a minimum 0 point to a maximum 5 points according to score at one tooth surface shown in Figure 3.

Tongue plaque index was estimated according to tongue plaque existence check by dividing the dorsum of the tongue with totally 9 sectors by dividing 3 sectors horizontally and 3 for vertical sections. In case of any tongue plaque existence at any sectors, 1 point was given to the sector. One person can get from a minimum 0 point to a maximum 9 points as shown in Figure 4.

To compare the differences over time between the experimental group and the control group, a repeated measure ANOVA analysis was performed. All analyses used the IBM SPSS ver. 19.0 statistical program (IBM Co., Armonk, NY, USA).

Results

1. The comparison of S-PHP and the tongue plaque index before the experiment

There was no significant difference on S-PHP index and

tongue index between in experimental group and the control ($p>0.05$) before the experiment as shown in Table 1.

2. The change of S-PHP index according to time flow both in experimental and the control group

It turned out that before the experiment, S-PHP index was 3.10 ± 0.34 in the experimental group and it was 3.22 ± 0.29 in the control ($p>0.05$), but it turned out to be 2.94 ± 0.40 in the experimental group and 3.23 ± 0.34 in the control 2 weeks later after the experiment. Also, it was found that 4 weeks later after the experiment, the index was 2.63 ± 0.41 in the experimental group and that of the control group was 3.27 ± 0.31 respectively. There was statistically meaningful difference between the two groups ($p<0.01$).

As time goes by, the changes of S-PHP index were found statistically different: before the experiment, a week later, 2 weeks and 4 weeks later after the experiment ($p<0.01$) as shown in Table 2 and Figure 5.

3. The change of tongue plaque index according to time flow both in experimental and the control group

It was found that tongue plaque index was 3.73 ± 0.69 in the experiment group and 3.73 ± 0.87 in the control group respectively a week after the experiment. Also, the index was 3.20 ± 0.61 and 3.80 ± 0.71 in the control group and the experimental group respectively 2 weeks later after the experiment.

Table 1. The comparison of S-PHP index and the tongue plaque index before experiment

Group	S-PHP index	Tongue plaque index
Exp	3.19 ± 0.34	4.43 ± 0.86
Con	3.21 ± 0.40	3.67 ± 0.84
p-value ^a	0.86	0.057

Values are presented as mean \pm standard deviation. S-PHP: simplified patient hygiene performance, Exp: experiment group, Con: control group. ^ap-value estimated by Independent two-sample t-test.

Table 2. Changes of S-PHP index between each group and according to the time passing

Group	Before	1 week	2 weeks	4 weeks	Repeated measure ANOVA	
					Between time	Between group
Exp (n=30)	3.19 ± 0.34	3.10 ± 0.34	2.94 ± 0.40	2.63 ± 0.41	0.00**	0.00**
Con (n=30)	3.21 ± 0.40	3.22 ± 0.29	3.23 ± 0.34	3.27 ± 0.31		

Values are presented as mean \pm standard deviation. S-PHP: simplified patient hygiene performance, Exp: experiment group, Con: control group.

** $p<0.01$ by repeated measure ANOVA test.

In addition, after four weeks of the experiment, the experimental group showed 2.13 ± 0.78 and 3.73 ± 0.58 in the control group. Therefore, there was significantly meaningful difference between the two groups ($p<0.05$). There was also significant difference in tongue plaque index as time goes by: before the experiment, a week later, 2 weeks, and 4 weeks later after the experiment ($p<0.01$) as shown in Table 3 and Figure 6.

Discussion

It is well known that plaque removal activities would be very hard for patients who are equipped with fixed type of the orthodontic appliance by using the general method of tooth-brushing because of the plaque deposition on the tooth surface as well as on the inside areas of the orthodontic appliance such as a bracket or wire [9]. The demineralization on the tooth surface due to a long time adherence on the orthodontic appliance and hard cleansing can be one of the problems, and it might sometimes lead to medical disputes. So, dental plaque should be eliminated by cleansing mouth of orthodontic dental patients who have some difficulties in caring oral hygiene [10].

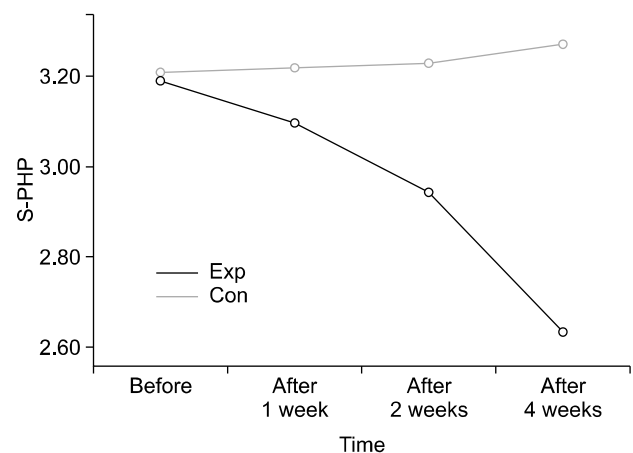
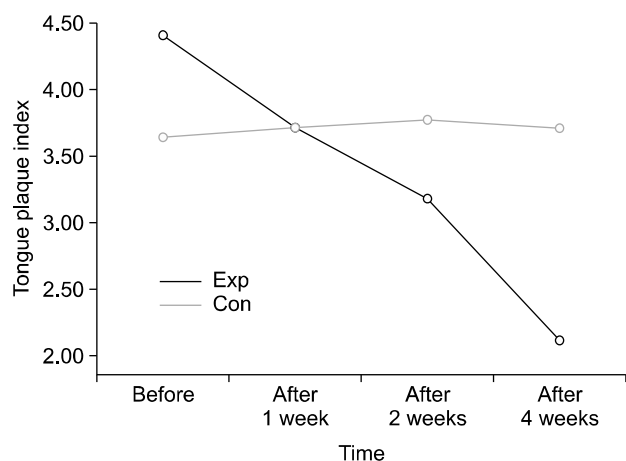


Figure 5. The interaction between the time and group for simplified patient hygiene performance index (S-PHP). Con: control group, Exp: experiment group.

Table 3. Changes of the tongue plaque index between each group and according to the time passing

Group	Before	1 week	2 weeks	4 weeks	Repeated measure ANOVA	
					Between time	Between group
Exp (n = 30)	4.43 ± 0.86	3.73 ± 0.69	3.20 ± 0.61	2.13 ± 0.78	0.00**	0.03*
Con (n = 30)	3.67 ± 0.84	3.73 ± 0.87	3.80 ± 0.71	3.73 ± 0.58		

Values are presented as mean ± standard deviation. Exp: experiment group, Con: control group. * $p < 0.05$, ** $p < 0.01$ by repeated measure ANOVA test.

**Figure 6.** The interaction level between the time and the group for tongue plaque index. Con: control group, Exp: experiment group.

A large number of studies have been completed to introduce better oral hygiene care methods for patients equipped with orthodontic appliance. However, most of the studies focus on the oral hygiene care by using electric toothbrushes or newly developed toothbrushes using sound wave, not manual toothbrushes for orthodontic dental patients. According to previously completed studies, there was one that said that there was no difference in the dental plaque removal effect between using electric toothbrushes and manual ones [11]. So, this study shows that the plaque removal effect by using the newly designed and developed toothbrush, 360° round shaped head toothbrush, is much more effective economically for this manual toothbrush [12]. In general, V shaped concave type of the bristle plane toothbrush has been recommended for dental patients who are equipped with a fixed typed orthodontic appliance. It might be effective to clean the tooth surface and appliance rather than to use a flat type of the bristle plane toothbrush with short vibratory movement on the bracket and around wire and gingival sulcus after horizontally scrubbing along the alignment of the wired dentition. However, it is difficult to give short vibration at each area on teeth, and it is also required to use interdental brushes at the proximal areas and around the wire. Now, 360° round head with soft bristled toothbrush has been newly developed and pro-

duced for easy access to the inside areas on the orthodontic appliance without using interdental brushes.

The data shows that the plaque removal effect was more effective in the experimental group who used 360° round head toothbrushes and took an instruction about proper use of them with practical exercises than the control group who used V shaped concave form of bristle plane toothbrushes as routine orthodontic toothbrushes. In terms of removing dental plaque and tongue plaque, there was statistically meaningful difference between the experimental group and the control ($p < 0.01$).

Choi [13] reported that the newly designed and developed toothbrush was more effective for removing dental plaque from the tooth surface by using the soft bristle toothbrush than by using the routine V shaped orthodontic toothbrush. That was similar with the result of this study and it was recommended to use the soft bristled toothbrush for effective removal of dental plaque or tongue plaque. So, the conclusion is that the newly developed 360° round head with soft bristled toothbrush is recommended to use for dental patients equipped with a fixed type orthodontic appliance in order to care oral hygiene effectively.

Since the limitation of this study is that the experiment period is only 4 weeks along with tooth-brushing instruction for proper use, further studies should be needed to prove the effect of removing plaque by using the newly developed toothbrush.

Conclusion

The authors have conducted the clinical trial with 60 volunteers who are equipped with a fixed type of the orthodontic appliance in order to investigate a plaque removal effect by using the newly designed and developed toothbrush, supplying 360° round head toothbrushes with the experimental group and V shaped concave type of the bristle plane toothbrushes with the control group. The subjects were also given a proper instruction about proper tooth-brushing with each toothbrush. S-PHP index and tongue plaque index were measured, before the experiment, a week, 2 and 4 weeks later after the experiment and the data were compared between both groups as time went by. The processed data were as following:

1. S-PHP decreased more in the experimental group and it is statistically meaningful between the two groups ($p<0.01$). Also, this result is statistically meaningful in each group ($p<0.01$).

2. Tongue plaque index turned out to more decrease in the experimental group than in the control, and it was statistically meaningful ($p<0.01$). In addition, the index in each group varied depending on the amount of the time the subject spent using the newly developed toothbrush ($p<0.05$).

3. It was recommended to use 360° round head toothbrush along with an instruction about proper tooth-brushing and a proper method for dental patients equipped with a fixed type of orthodontic appliance in order to remove dental plaque and tongue plaque effectively.

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