

Caries management by the oral biofilm care method: A randomized controlled trial.

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Abstract

Background: Dental caries is one of the most common oral diseases in children and adolescents. Dental plaque management is important in preventing dental caries.

Objectives: This study was conducted in order to compare the effects of general brushing and Polishing using a rubber cup (POL), and Toothpick Method (TPM), which are essential for the prevention of dental caries.

Materials and Methods: The collected data were repeated measures ANOVA test was used to compare the influencing factors of dental caries by time, according to the three groups of general brushing, POL and TPM.

Results: The TPM was an effective method for the removal of oral biofilm and the reattachment rate of oral biofilm on the interdental surface ($F=10.438$, $p<0.000$). POL was an effective method for the removal of oral biofilm and the re-attachment rate of oral biofilm on a smooth surface ($F=10.438$, $p<0.000$) and an occlusal surface ($F=1.925$, $p=0.117$). POL was an effective method for the removal of oral biofilm and the reattachment rate of oral biofilm on the O'Leary index ($F=13.146$, $p<0.000$) and occlusal surface ($F=3.409$, $p=0.014$). Dental hygienists should avoid any reckless implementation of the increased preventive measures.

Conclusions: In order to prevent dental caries, a more specialized and effective oral care method should be implemented according to the dental plane while taking into consideration the oral condition of the patient.

Keywords: Biofilms, Dental caries, Tooth brushing methods, Prevention, Oral health.

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Introduction

Dental caries is a pandemic disease, and it is at the ninth place in South Korea's medical expenses in 2016. Furthermore, the surrounding dental pulp and periapical tissue disease, which is at the fifth place, is also a disease caused by severe dental caries that can be classified as a secondary disease of dental caries [1]. The dental caries require early management because they consume processed foods such as snacks and drinks as snacks in childhood and adolescence, while tooth brushing is not well performed [2]. South Korea recommends a rotation method that is relatively good at brushing the smooth surfaces of the teeth and is highly practical. Therefore, there are many caries on interdental surfaces where toothbrushes do not touch and occlusal surfaces that are difficult to manage due to morphological factors in teeth [3]. In particular, since dentin enamel junction lesions on the interdental surface have slow progression to dental caries even after 2-3 years have passed, and the lesions involving up to half of the outer side of the dentin can be re-mineralized, prophylactic treatment and careful observation are necessary [4].

In order to prevent dental caries, oral biofilm care is essential, which is a host-dependent biofilm, and the main constituent is the microbial group [5]. The acid produced by these bacteria causes dental caries by demineralization in the tooth structure; therefore, efforts should be made in order to lower the acid production capacity of Mutans streptococci, which is known to be involved in dental caries induction [6]. Alban's test is widely used as a method to confirm the acid production ability because the pH of the organic acid produced by bacteria can be visually observed by coloring through the indicator [7]. Therefore, this test method should be used and efforts should be made to remove the oral biofilm and prevent the reattachment of the oral biofilm for lowering the acid production ability of bacteria and preventing dental caries.

Oral biofilm care is divided into self-care and expert care, and it is difficult to manage all tooth surfaces by brushing, which is self-care. For this reason, dentists have recently been conducting expert oral biofilm care to solve these difficulties for the patients. Expert oral biofilm care methods mainly include Professional Mechanical Tooth Cleaning (PMTC) and Toothpick Method (TPM) (Figure 1).

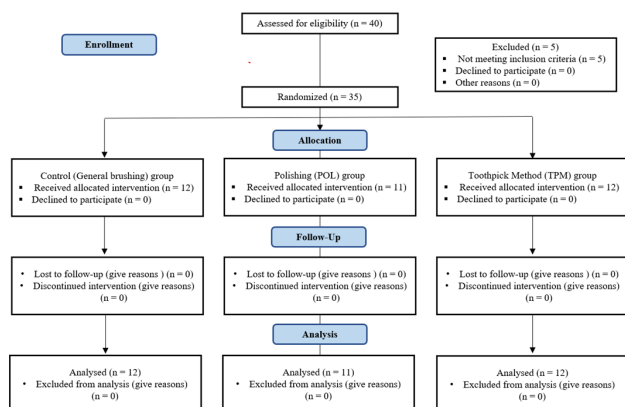


Figure 1. Participants flow.

PMTTC uses rubber cups and EVA-tip, and TPM uses two rows of V-shaped toothbrushes, all of which are efficient for interdental surface and sub gingival oral biofilm care [8]. TPM, which is widely used in dental clinics, has been reported to be superior in oral biofilm removal as it has the gingival massage effect, as well as in the interdental area [9].

POL has been reported to cause enamel damage due to the use of a coarse abrasive, and it is recommended to be performed selectively only when necessary [10]. Therefore, it is important to compare the two methods by examining their effects on oral biofilm removal according to the tooth area by dividing the teeth into interdental surface, smooth surface, and occlusal surface.

It is also necessary to compare the degree of reattachment of oral biofilm and the degree of activity of bacteria with time intervals for general brushing, POL and TPM due to the persistent and rapid production of oral biofilm. There have been various reports on post-treatment care with polishing [11-14], but there have been no studies conducted by time after dividing the teeth into interdental surface, smooth surface, and occlusal surface. This study aimed to investigate the degree of oral biofilm attachment and activity of bacteria by time by performing self-care (general brushing) and expert care (POL and TPM) after dividing all teeth by tooth surface and using the outcomes as fundamental data for a more subdivided dental care.

Materials and Methods

Participants

Among the patients who visited the preventive care office of a dental clinic in Busan from September 2018 to December

2018, 35 patients, who voluntarily agreed to participate in the study, were selected as subjects. The sample size calculated by using G* power 3.1.9.2 ver was 16, and the study was reviewed by the research ethics review committee of S University (IRB No. 1041449-201801-HR-002). Only the subjects with a healthy oral condition in they were selected, excluding those who were having systemic diseases or taking medications that could affect the results of the study, those who were wearing orthodontic appliance, and those who smoke and drink alcohol. The subjects were restricted to those who were 22 years old (female) with good oral care habits and whose Decayed Teeth (DT) and Filled Teeth (FT) were "0".

The reason for limiting the age of the study subjects is that their teeth surfaces should be healthy. If there are caries and fillings on the teeth, it can have an important effect on the three methods of biofilm care. Therefore, the study subjects were limited to those with DT and FT of "0". Accordingly, the required minimal sample size for the present study was 16 participants. Of 40 athletes recruited, 35 were eligible, 35 agreed to participate, and 11 or 12 were randomly assigned to each group. At baseline, there were no imbalances in the characteristics of the three groups. The participants flow is presented in Figure 1. The experimental group consisted of 11 subjects for whom POL applied and 12 subjects for whom TPM was applied. The control was 12 subjects for whom general brushing was applied.

Study flowchart

Baseline measures Influence factor of dental caries (activity of bacteria, rate of oral biofilm, O'Leary index, Alban's test) before biofilm care. Since then, control group has performed general brushing, and POL group has polished with rubber cup of teeth. TPM group has brushing with 2 rows of brushes in tooth brush. The secondary measurement was taken again after removing biofilm according to the three methods. Since bacteria are attached to lectin, a protein in carbohydrate structure, within two hours as a byproduct of food, the surveyor took a third measurement five hours later to check whether preventive measures were sustainable [15]. The subject ate the same diet provided by the surveyor between the second and third measurements, and took the third measurement after drinking 1 cup of bottled water. All these procedures were carried out by a dental hygienist who had more than 10 years of experience, and efforts were made to minimize the difference of the measurement (Table 1).

Group ^a	Control (N=12)	POL (N=11)	TPM (N=12)
Baseline	Influence factor of dental caries		
Baseline	1) Activity of bacteria; 2) Rate of oral biofilm; 3) O'Leary index; 4) Alban's test		
Treatment	General brushing	Polishing using a rubber cup	Toothpick method
2nd measurement	Influence factor of tooth caries		

After treatment	1) Activity of bacteria; 2) Rate of oral biofilm; 3) O'Leary index; 4) Alban's test
After 5 hours	Same diet, 1 cup of water after meals
3rd measurement	Influence factor of dental caries
After 5 hours	1) Activity of bacteria; 2) Rate of oral biofilm; 3) O'Leary index; 4) Alban's test

Table 1. Research Method. ^a Control: General brushing; POL: Polishing using a rubber cup; TPM: Toothpick method.

Activity of bacteria

All teeth were divided into interdental surface, occlusal surface, buccal surface, and lingual surface, and bacteria were collected by reciprocating the tooth surface twice with sterilized #11 and #12 explorers. For the interdental surface, mesial and distal surfaces were combined, and for the smooth surface, buccal and lingual surfaces were combined. For the occlusal surface, bacteria were collected by reciprocating twice along the sphere. A microscope (BA310, Motic, Hong Kong, and Asia) was used at 400 magnifications.

Bacteria were recorded for more than 10 seconds and images recorded to check the activity of Mutans streptococci among the bacteria were analyzed. In order to improve the objectivity of the reading, one preventive dental resident and one preventive dental hygienist prepared the decision criteria and each of them made an individual assessment. When the errors were severe, the results were adjusted by reassessment. After the assessment, the agreement rate was 96% between the investigators.

Rate of oral biofilm

All teeth were divided into interdental, occlusal, buccal and lingual surfaces in order to investigate the degree of oral biofilm attachment. For the interdental surface, mesial and distal surfaces were combined, and for the smooth surface, buccal and lingual surfaces were combined. The rate of oral biofilm was expressed as a percentage by dividing the sum of the number of surfaces with biofilm attached by the number of teeth surfaces.

O'Leary index

O'Leary index [16] is useful for quantitatively measuring oral hygiene and is reliable and reproducible. It is easy to grasp the patient's oral hygiene. The tooth surface is divided into occlusal surface, buccal and lingual surface, mesial and distal surface. If the surface of each tooth has a biofilm attachment,

mark it as 0 if there is no 1 point. The higher score, the worse oral condition.

Alban's test

Alban's test [17] is a test method used in order to check the acid production ability in oral cavity by measuring the degree of occurrence of bacteria in the saliva and oral biofilm by colorimetric method. Since it is easy, it is widely used in dental clinical practice. A 6.5 g of Snyder test agar (Difcotm, Snyder test agar, USA) was added to 100 ml of distilled water and heated to dissolve completely. Then, 5 ml was dispensed to the test tube for sterilization, and the subjects were guided to spit directly on a sterilized medium to the extent that non-irritating saliva thinly covers it. After that, it was incubated in the incubator (HiTEC, Model DS-63 source, Yamato scientific Co., LTD, and TOKYO, JAPAN) and scored from 0 to 4 according to the color change of the medium by observing every 24 hours. A higher score means a higher caries activity.

Data analysis

Collected data were analyzed by using a statistical analysis software SPSS. For the comparison of the influential factors of dental caries by time according to each group, repeated measures ANOVA test was conducted. The test results of within-subjects effects were verified by using multivariate tests if the sphericity assumption was not satisfied through Mauchly's test of sphericity. If the sphericity assumption was satisfied, the results were confirmed by tests of within-subjects effects. The test results of between-subjects effects were checked with the tests of between-subjects effects, and the significance level to make a decision for statistical significance was set at 0.05.

Results

Demographic characteristics

All of the subjects are 22-year-old women who do not smoke or drink. She is a healthy person who has no systemic diseases and does not take medicine (Table 2).

Demographic characteristics		N (%)
Gender	Male	0 (0.0)
	Female	35 (100.0)
Smoking status	Yes	0 (0.0)
	No	35 (100.0)

Alcohol intake	Yes	0 (0.0)
	No	35 (100.0)
Systemic diseases	Yes	0 (0.0)
	No	35 (100.0)
Taking medicine	Yes	0 (0.0)
	No	35 (100.0)
Age		22

Table 2. Demographic characteristics by frequency analysis.

Changes in the activity of bacteria by time according to three groups

In regard to the changes in the activity of interdental surface bacteria for the three measurement time points of the three groups, there was a significant difference among the three groups ($F=454.020$, $p<0.001$) and according to the measurement time ($F=396.882$, $p<0.001$). In the effects considering the group and measurement time simultaneously, a significant difference was shown ($F=18.029$, $p<0.001$). In regard to the changes in the activity of smooth surface bacteria for the three measurement time points of the three groups,

there was a significant difference among the three groups ($F=57.203$, $p<0.001$) and according to the measurement time ($F=314,920$, $p<0.001$).

In the effects considering the group and measurement time simultaneously, a significant difference was shown ($F=34,417$, $p<0.001$). In regard to the changes in the activity of occlusal surface bacteria for three measurement time points of the three groups, there was a significant difference among the three groups ($F=252.525$, $p<0.001$) and according to the measurement time ($F=524.123$, $p<0.001$). In the effects considering the group and measurement time simultaneously, a significant difference was shown ($F=14.455$, $p<0.001$) (Table 3).

Group ^a		Mean \pm SD			Source	F	p*
		Baseline	After treat	After 5 h			
Control (N=12)	Interdental	81.83 \pm 8.08	76.50 \pm 1.45	85.25 \pm 1.96	Interdental surface		
Control (N=12)	Smooth	81.92 \pm 6.65	68.42 \pm 5.29	71.42 \pm 3.58	Group	454.02	0
Control (N=12)	Occlusal	32.50 \pm 3.80	19.08 \pm 1.83	68.17 \pm 2.29	Time	396.882	0
POL (N=11)	Interdental	83.91 \pm 8.89	28.64 \pm 2.11	35.36 \pm 2.69	Group*Time	18.029	0
POL (N=11)	Smooth	81.00 \pm 6.19	28.09 \pm 3.25	51.73 \pm 4.49	Smooth surface		
POL (N=11)	Occlusal	32.82 \pm 5.36	9.64 \pm 1.43	23.64 \pm 5.87	Group	57,203	0
TPM (N=12)	Interdental	83.00 \pm 8.32	27.00 \pm 2.17	39.00 \pm 7.07	Time	3,14,920	0
TPM (N=12)	Smooth	80.58 \pm 5.45	41.92 \pm 9.36	62.00 \pm 10.89	Group*Time	34,417	0
TPM (N=12)	Occlusal	31.75 \pm 5.82	10.67 \pm 1.61	23.58 \pm 6.22	Occlusal surface		
Total (N=35)	Interdental	82.89 \pm 8.22	44.49 \pm 23.55	53.71 \pm 23.58	Group	252.525	0
Total (N=35)	Smooth	81.17 \pm 5.96	46.66 \pm 18.08	62.00 \pm 10.67	Time	524.123	0
Total (N=35)	Occlusal	32.34 \pm 4.93	13.23 \pm 4.59	38.89 \pm 22.02	Group*Time	14.455	0

Table 3. Activity bacteria according to groups,^aControl: General brushing; POL: Polishing using a rubber cup; TPM: Toothpick method; *: By repeated measures ANOVA test.

Changes in the rate of biofilm by time according to three groups

In regard to the changes in the rate of interdental surface biofilm for the three measurement time points of the three groups, there was a significant difference among the three groups ($F=3329.564$, $p<0.001$) and according to the

measurement time ($F=545.907$, $p<0.001$). In the effects considering the group and measurement time simultaneously, a significant difference was shown ($F=10.438$, $p<0.001$). In regard to the changes in the rate of smooth surface biofilm for the three measurement time points of the three groups, there was a significant difference among the three groups ($F=19.171$, $p<0.001$) and according to the measurement time ($F=73.518$, $p<0.001$).

In the effects considering the group and measurement time simultaneously, there was no significant difference ($F=2.299$,

p=0.068). In regard to the changes in the rate of occlusal surface biofilm for the three measurement time points of the three groups, there was a significant difference among the three groups (F=4.215, p=0.024) and according to the measurement

time (F=9.375, p<0.001). In the effects considering the group and measurement time simultaneously, there was no significant difference (F=1.925, p=0.117) (Table 4).

Group ^a		Mean ± SD			Source	F	p*
		Baseline	After treat	After 5 h			
Control (N=12)	Interdental	85.50 ± 13.09	35.50 ± 11.74	41.50 ± 7.00	Interdental surface		
Control (N=12)	Smooth	42.08 ± 18.24	39.92 ± 10.84	22.58 ± 10.55	Group	3329.564	0
Control (N=12)	Occlusal	7.67 ± 2.67	6.92 ± 3.58	6.92 ± 4.06	Time	545.907	0
POL (N=11)	Interdental	84.36 ± 11.37	25.91 ± 5.17	27.45 ± 7.35	Group*Time	10.438	0
POL (N=11)	Smooth	40.91 ± 14.36	17.09 ± 9.33	3.64 ± 1.91	Smooth surface		
POL (N=11)	Occlusal	7.73 ± 1.56	3.27 ± 2.01	3.36 ± 2.84	Group	19.171	0
TPM (N=12)	Interdental	85.33 ± 10.59	32.83 ± 5.65	12.50 ± 5.23	Time	73.518	0
TPM (N=12)	Smooth	41.25 ± 14.35	19.75 ± 7.68	10.58 ± 1.68	Group*Time	2.299	0.068
TPM (N=12)	Occlusal	7.83 ± 1.85	5.75 ± 2.01	6.08 ± 4.38	Occlusal surface		
Total (N=35)	Interdental	85.09 ± 11.40	31.57 ± 8.89	27.14 ± 13.75	Group	4.215	0.024
Total (N=35)	Smooth	41.43 ± 15.33	25.83 ± 13.80	12.51 ± 10.03	Time	9.375	0
Total (N=35)	Occlusal	7.74 ± 2.03	5.37 ± 2.01	5.51 ± 4.03	Group*Time	1.925	0.117

Table 4. Rate of biofilm according to groups.^aControl: General brushing; POL: Polishing using a rubber cup; TPM: Toothpick method; *:By repeated measures ANOVA test.

Changes in O’Leary index by time according to three groups

In regard to the changes in O’Leary index for the three measurement time points of the three groups, there was a

significant difference among the three groups (F=7.186, p=0.003) and according to the measurement time (F=167.836, p<0.001). In the effects considering the group and measurement time simultaneously, there was a significant difference (F=13.146, p<0.001) (Table 5).

Group ^a	Mean ± SD			Source	F	p*
	Baseline	After treat	After 5 h			
Control (N=12)	56.17 ± 23.49	17.08 ± 3.15	51.42 ± 4.64	Group	7.187	0.003
				Time	167.836	0
				Group*Time	13.146	0
POL (N=11)	56.64 ± 15.69	22.36 ± 5.71	18.73 ± 4.29	Group	7.187	0.003
				time	167.836	0
				Group*Time	13.146	0
TPM (N=12)	56.58 ± 17.17	17.50 ± 4.87	22.58 ± 5.49	Group	7.187	0.003
				time	167.836	0
				Group*Time	13.146	0
Total (N=35)	56.46 ± 18.61	18.89 ± 5.12	31.26 ± 15.59	Group	7.187	0.003
				time	167.836	0
				Group*Time	13.146	0

Table 5. O’Leary index according to groups.^aControl: General brushing; POL: Polishing using a rubber cup; TPM: Toothpick method; *:By repeated measures ANOVA test.

Changes in Alban's test by time according to three groups

In regard to the changes in Alban's test for the three measurement time points of the three groups, there was a

significant difference among the three groups ($F=9.742$, $p<0.001$) and according to the measurement time ($F=22.552$, $p<0.001$). In the effects considering the group and measurement time simultaneously, there was a significant difference ($F=3.409$, $p=0.014$) (Table 6).

Group ^a	Mean \pm SD			Source	F	p*
	Baseline	After treat	After 5 h			
Control (N=12)	2.17 \pm 0.72	1.50 \pm 0.52	2.33 \pm 0.65			
POL (N=11)	2.00 \pm 0.63	0.55 \pm 0.52	1.00 \pm 0.63	Group	9.742	0
TPM (N=12)	2.00 \pm 0.60	1.33 \pm 0.65	1.75 \pm 0.87	Time	22.552	0
Total (N=35)	2.06 \pm 0.64	1.14 \pm 0.69	1.71 \pm 0.89	Group*Time	3.409	0.014

Table 6. Alban's test according to groups. ^aControl: General brushing; POL: Polishing using a rubber cup; TPM: Toothpick method. *: By repeated measures ANOVA test.

Discussion

Oral disease is a chronic disease that is difficult to recover from once it occurs. Among them, dental caries occur from childhood and adolescence, and in the case of Korea, the trend is continuously decreasing, but it is still higher than that of OECD countries [18]. Dental caries is induced by bacterial acid production, and it is important to remove the oral biofilm, which is composed of bacterial colonies. Brushing is generally used to remove oral biofilm; however, perfect care is difficult to achieve. For this reason, oral biofilm expert care methods, POL and TPM were performed by subdividing the tooth surface in order to compare their effects.

The result of examining the activity of bacteria and the rate of oral biofilm on the interdental surface of teeth showed that POL and TPM were more effective than general brushing. After 5 hours, POL was more effective for activity of bacteria, but TPM was effective for the adhesion rate of oral biofilm. These results suggest that TPM had a more positive effect on the removal and reattachment of interdental surface biofilm due to the easy insertion of the bristles, while there is difficulty in reaching the interdental surface during polishing via the rubber cup. These results seem to be the same as the studies on the positive effects of TPM in the interdental surface. This is consistent with several studies where the positive effect of TPM on motility sub gingival bacterial motility in the biofilm has been reported because the 2-row brush can be readily inserted between the proximal surfaces.

The result of examining the activity of bacteria and the rate of oral biofilm on the smooth surface of teeth showed that POL and TPM were more effective than general brushing. After 5 hours, both the activity of the bacteria and the rate of oral biofilm were effective. This seems to be due to the rubber cup

being relatively easy for reaching the smooth surface of the buccal and lingual surfaces of the teeth than the interdental surface during POL. Moreover, as the area of the smooth surface is larger, POL is more effective in removing and reducing the reattachment rate of the oral biofilm.

The result of examining the activity of bacteria and the rate of oral biofilm on the occlusal surface of teeth showed that POL and TPM were more effective than general brushing. After 5 hours, there was no significant difference between POL and TPM. It is difficult to remove oral biofilm on the occlusal surface differently from the other areas due to fissures, pits, etc. Although the public interest in oral care is increasing, the actual rate of preventive treatment is very low at about 0.72%. Therefore, POL and TPM are recommended for the vulnerable occlusal surface in order to prevent occlusal dental caries.

Appropriate oral hygiene management is necessary in order to reduce the O'Leary index to 10% or less. In the present study, it decreased similarly in the three groups immediately after the treatment, but after 5 hours, it increased after general brushing and TPM, and decreased after POL, thereby showing that POL is more effective. Alban's test to confirm the acid production ability of bacteria showed that it decreased in all three groups immediately after the treatment, but the degree of reduction was the largest in POL.

After 5 hours, it increased in all three groups, but the degree of increase was the smallest in POL, thereby showing that POL is most effective. For the interdental surface care, TPM was more effective, for the smooth and occlusal surface care, POL was more effective, and for the overall O'Leary index and Alban's test, POL was more effective. However, polishing using rubber cup recommends selective implementation due to damage to the enamel [10]. Therefore, it is necessary to efficiently implement polishing, which is performed indiscriminately after the recent scaling, to suit the dental surface. In recent years, as the interest of the public in oral health has been increasing,

dental clinics are expanding the implementation of preventive treatment.

Therefore, it is necessary to plan the preventive treatment while taking into consideration the oral health condition of the patient, and to establish a detailed preventive treatment plan according to the patient's tooth surface. There is a need for in-depth studies to make more specialized and detailed comparisons for the performance of various preventive measures. The limitation of this study is that the number of subjects is small and cannot represent the whole, and that age and oral condition are limited. Therefore, further studies will need to expand and study subjects. In addition, more in-depth comparative studies on the factors affecting dental caries are deemed necessary. Despite these limitations, this study will be the basic research for the utilization of more specialized oral care, which compares the effects of general brushing and POL and TPM by subdividing the tooth surface.

Conclusions

Through this study, the biofilm care of the adjacent face of the tooth was effective in TPM, and the smooth and occlusal surface of the biofilm care was effective in POL. Therefore, in order to prevent dental caries in childhood and adolescence, dental hygienists should implement a more professional and effective oral care method according to the dental surface in consideration of the patient's oral condition.

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Conflict of interest

The authors report no conflicts of interest related to this study. The author does not have any financial interest in the companies whose materials are included in the article.

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