Evaluation of a Sonic Toothbrush on the Reduction of Clinical Parameters, Interleukin-1, MMP-8 and Periodontal Pathogens in Incipient to Moderate Periodontitis

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ABSTRACT

Evaluation of a Sonic Toothbrush on the Reduction of Clinical Parameters, Interleukin-1, MMP-8 and Periodontal Pathogens in Incipient to Moderate Periodontitis

Daily plaque removal with a toothbrush is an important component of most oral hygiene programs to prevent and treat periodontal diseases. The Sonicare® toothbrush utilizes solid-state electronics to create sonic-frequency bristle movement with 520 brush strokes per second. This rapid bristle movement, in addition to its scrubbing plaque-removing activity, creates dynamic activities in surrounding fluids. It has been suggested that these fluid forces lift and disperse plaque bacteria from tooth surfaces about 2-3 mm beyond the physical reach of the bristles. The aim of this study was to evaluate the effectiveness of the sonic toothbrush duration of 12 weeks on the reduction of the clinical parameters, Interleukin-1, MMP-8 quantitatively and Periodontal Pathogens in moderate periodontitis

A 12-week, single-blind clinical trial was employed. Eighty two subjects, ages 25-55 years, were selected. Subjects with plaque index (PI) of >0.5, gingival index (GI) of >1.0 were randomly assigned to use either the manual or the Sonicare® Elite toothbrush, instructed in its use, and asked to brush each morning and evening for 2 minutes. Plaque index, gingival index, percentage of sites which bled on probing, pocket depth, loss of attachment level, Interleukin-1, MMP-8 and four Periodontal Pathogens (*Actinomyces viscosus*(AV), *Porphyromonas gingivalis*(PG), *Streptococcus sanguis*(SS), *Tannerela forsythensis*(TF)) in a subgingival plaque sample from 16S rRNA test were assessed at baseline and 1, 12 weeks from the selected teeth. Plaque score and gingival inflammatory score (GI) were taken at baseline and 1, 4, 12weeks using Silness & löe gingival index, Löe & Silness plaque

index, respectively. Gingival bleeding was assessed by the bleeding tendency score, presence or absence of bleeding on probing (BOP).

The results demonstrate that both the Sonicare® elite brush and manual brush were significantly reduced all of the clinical parameters. However, statistics indicated Sonicare® was more effective than the manual brush in plaque and gingival Index scores reduction, respectively ($p < 0.001$). Reduction of BOP in the Sonicare® group (76.73%) was greater than manual group (44.57%). Reduction of Probing pocket depths compared to baseline were reduced in the Sonicare® group and the manual groups 18.55% and 14.81%, respectively. Clinical attachment level were significantly improved compared to baseline in the Sonicare® groups (25.24%) and the manual groups (16.94%) ($p < 0.001$). Concentration of IL-1ß and MMP-8 were decreased compared to baseline in both groups. AV, PG and TF in subgingival plaque samples did not show significantly decreased 12 weeks than the baseline both in sonicare® and manual groups. SS showed significantly decreased 12 weeks than the baseline in Sonicare® but were not significantly reduced than baseline in manual group.

In conclusion, the tested Sonicare® toothbrush was more effective than the manual brush in removal plague and reduction of gingival inflammation.

Key Words : Sonic toothbrush, plaque, bleeding, pocket, IL-1, MMP-8, realtime-PCR, periodontal pathogens

Evaluation of a Sonic Toothbrush on the Reduction of Clinical Parameters, Interleukin-1, MMP-8 and Periodontal Pathogens in Incipient to Moderate Periodontitis

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Ⅰ. Introduction

Daily plaque removal with a toothbrush is an important component of most oral hygiene programs to prevent and treat periodontal diseases. Although it has been reported that both manual and electric toothbrushes are effective in removing supragingival plaque and reducing clinical signs of gingival inflammation, several recent studies report that electric toothbrushes show superiority to manual brushes in removing supragingival plaque(Tritten and Armitage, 1996).

The Sonicare® toothbrush utilizes solid-state electronics to create sonic-frequency bristle movement with 520 brush strokes per second. This rapid bristle movement, in addition to its scrubbing plaque-removing activity, creates dynamic activities in surrounding fluids. It has been suggested that these fluid forces lift and disperse plaque bacteria from tooth surfaces about 2-3 mm beyond the physical reach of the bristles(Hope and Wilson, 2003). Furthermore, in vitro experiments have shown that low-amplitude acoustic energy, such as that generated by the Sonicare® brush, has structural and metabolic effects on oral bacteria, which may retard their ability to form plaque by disturbing bacterial adherence properties(Tritten CB 1996, Wu-Yuan CD 1994). Increased levels of bacterial pathogens common in periodontal pockets are known to be associated with an elevated biochemical inflammatory response that promotes bone resorption. Understanding the process of periodontal pathogenesis in terms of the biochemical pathway prompted by greater than normal levels of bacteria and mitigating the subsequent effects is a primary component of periodontitis therapy.

The most potent pro-inflammatory cytokine stimulating bone resorption is interleukin-1(IL-1)(Page RC, 1976, Tonetti 1994). IL-1 is a pleiotropic cytokine

having multiple biological activities including stimulation of osteoclast recruitment and activation. IL-1 also stimulates fibroblast production of matrix metalloproteinases (MMPs) important for the degradation of non-mineralized extracellular tissue. Several studies have reported increased levels of inflammatory mediators, such as IL-1 and prostaglandin E_2 (PGE_2), in gingival crevicular fluids (GCFs) from diseased sites exhibiting periodontal bone loss when compared with healthy sites. Furthermore, GCF from diseased sites has been shown to stimulate bone resorption in vitro to a higher degree than GCF from healthy sites. One important factor responsible for this bone resorbing activity seems to be IL-1.

Matrix metalloproteinases (MMPs) are enzymes activated by IL-1 and are involved in tissue destruction and regeneration(Page RC, 1976). A complex cascade involving both host and microbial-derived proteinases mediates extracellular matrix degradation during periodontal disease. In this regard, the host-derived MMPs are thought to play a key role. Enhanced activity of these enzymes is a consequence of microbial induced inflammation in the periodontal tissues. Polymorphonuclear leukocyte(PMN)-derived MMPs(MMP-8 and MMP-9) are the main proteinases related to tissue destruction and

remodeling events in periodontal diseases(Page and Kornman, 1997).

Traditional clinical measurements such as assessments of probing pocket depth, attachment level, gingival inflammation and microbial plaque yield only historic information about periodontal status. By directly analyzing the changes in the levels of MMPs and IL-1 in GCF, we can associate parameters of inflammation with clinical parameters of tissue destruction. Among several methods that have been applied to detect periodonto-pathogenic microorganisms, nucleic acid-based methods using DNA probes can give insight on changes in bacterial counts in the periodontal pocket. (Haffajee AD, 2001)

The purpose of this study was to assess of the effects of the Sonicare® toothbrush on clinical parameters (Probing Pocket Depth (PPD), Plaque index (PI), Gingival index (GI), Bleeding on probing (BOP), Clinical attachment level (CAL)), IL-1ß, MMP-8 and reduction of four Periodontal Pathogens (*Actinomyces viscosus*(AV), *Porphyromonas gingivalis*(PG), *Streptococcus sanguis*(SS), *Tannerela forsythensis*(TF)), testing 16S rRNA at 3 sites of selected teeth on moderate chronic periodontitis, following baseline, 1, 4 and 12 weeks of toothbrush use

Ⅱ. Materials and Methods

II. 1. Subjects

The initial study population consisted of 93 volunteers who were recruited form the dental clinic patients of Dental Hospital, University of Yonsei, Seoul. Subjects ranged in age from 25-55 years with incipient to moderate periodontitis. 34 subjects were randomized to receive standard of care at-home oral hygiene using a manual toothbrush for enrolled control and completed the experiment 30 subjects (Age;38.0±9.7). 59 subjects were randomized to receive the test treatment with at-home oral hygiene use of the Sonicare® Elite power toothbrush for enrolled experiment and completed 52 subjects (Age; 40.9±8.8)(Table. 1). Subjects have moderate periodontitis with mean gingival index (Löe & Silness 1963) of at least 1 and mean plaque index (Löe & Silness 1963) of at least 0.5 on the all teeth but no probing depths deeper than 6 mm; no previous periodontal therapy except for routine dental prophylactic cleaning.

Table 1. Demographics of subjects

Characteristics	Manual group	Sonicare® group
Total Subjects	30	52
Males	14	25
Females	16	27
Mean age(yrs)	38.0±9.7	40.9±8.8
Age range(yrs)	25-55	25-55
Smoking / Non-smoking	4 / 26	9 / 43

II. 2. Examination protocols

II. 2.1 Clinical Assessment

Total 12 investigators did not be blinded to the brush assignments of each group, performed the clinical measurements. At the baseline examination visit, Patients were randomized by having Manual brush (Butler #311 Multi-tufted Manual Toothbrush) (control group) and Sonicare® Elite powerbrush (experimental group). Patients were then given oral hygiene instructions. A total 93 patients, 34 manual group and 59 Sonicare® group started the study. 30 control group and 52 experimental group were completed

Table 2. Subjects visit summery

Visit 1	Screening/Enrollment/Baseline: obtain informed consent, health history, screening intraoral examination to qualify subject (PI, GI, PPD, BOP, CAL), test site selection, IL-1, MMP-8, 16S rDNA samples, scaling, cleaning, randomization, instruction
Visit 2	Week 1: intraoral examination (PI, GI, PPD, BOP, CAL), IL-1, MMP-8, 16S rDNA samples, compliance, safety
Visit 3	Week 4: intraoral examination (PI, GI, PPD, BOP, CAL), compliance (issue new MTB or Sonicare brush head), safety
Visit 4	Week 8: compliance (issue new MTB or Sonicare brush head), safety
Visit 5	Week 12: intraoral examination (PI, GI, PPD, BOP, CAL), IL-1, MMP-8, 16S rDNA samples

Patients were examined at baseline and at 1, 4 and 12weeks thereafter (Table 2). In the Patient, gingival inflammation was clinically assessed at 6 site(mesiobuccal,

buccal, distobuccal, mesiolingual, lingual, distolingual) on the all teeth using the gingival index (GI) (Löe & Silness 1963), the plaque index (PI) (Löe & Silness 1963) and the bleeding on probing (BOP) was recorded as either present or absent. For both the GI and BOP assessments, a North Carolina Probe (Hu-Friedy Mfg. Inc., Chicago, IL; USA) was used.

At baseline, 1-week, 4-week and 12-week visits, probing depths and clinical attachment levels were measured on all teeth in the mouth (excluding third molars) at 6 sites per tooth. A North Carolina Probe was aligned parallel to the long axis of the tooth and gently inserted to the base of the gingival crevice until resistance was felt. Probing depths and clinical attachment levels were measured to the nearest millimeter from the gingival margin and cemento-emamel junction(CEJ), respectively. Gingival recession, if present, was recorded as the distance from the CEJ to the gingival margin.

II. 2. 2 IL-1ß and MMP-8 sampling and preparation

Gingival crevicular fluid samples at 3 sites with gingival index of at least 1 and plaque index of at least 0.5, probing depths 4- 6 mm per subject in experimental group and control group to measure were collected at baseline, 1-week and 12-week.

On the test sites, parameters involved in tissue inflammation and destruction will be assessed by laboratory measurements of MMP-8 and IL-1 in the GCF. In order to detect IL-1ß and MMP-8 in human GCF(gingival crevicular fluid), we collect GCF with paperpoints, soak them in Hank's buffered salt solution (HBSS) of 0.5% FBS in 1mL tubes and keep them frozen at -20°C. The samples are analyzed by using Quantikine® kit (R&D systems), which is for the quantitative determination of IL-1ß, human active and pro-Matrix Metalloproteinase (total MMP-8) concentrations

Finally, we use Microplate Manager™(version 5.2 ; ELIZA reader ; BMS®) to detect optical density under 450nm of each of the prepared sample and calculate the results to find out the concentrations.

II. 2.3 TagMan Real-time PCR

Subgingival plaque samples from 82 adult patients with generalized chronic moderate periodontitis were collected. Samples were obtained from the 3 selected periodontal pocket with gingival index of at least 1 and plaque index of at least 0.5, probing depths 4 - 6 mm of the dentition by using the sterile curette. The samples were pooled in 1.5 ml Reduced Transport Fluid (RTF). Upon arrival samples were vortexed for 2 min and stored at -80℃. From plaque samples 200㎕ was used for automated DNA extraction and purification with the QIAamp DNA Mini

Kit(QIAGEN Inc.). After isolation DNA was eluted in 200 $\mu\ell$ elution buffer.

Table 3 shows the sequences of the primers/probe sets. The 16s rRNA sequence of the pathogens were selected form the taxonomy database of the National Center for Biotechnology Information. Selected primers and probes were checked by blast search for homology with unrelated sequences, NCBI.

Table 3. Primers and fluorogenic probes for the specific detection of the pathogens

Bacteria	Sequence	(5'->3')
T. forsythensis	Forward	GGG TGA GTA ACG CGT ATG TAA CCT
	Reverse	ACC CAT CCG CAA CCA ATA AA
	Probe	FAM-CCC GCA ACA GAG GGA TAA CCC GG-TAMRA
P. gingivalis	Forward	GCG CTC AAC GTT CAG CC
	Reverse	CAC GAA TTC CGC CTG C
	Probe	FAM-CAC TGA ACT CAA GCC CGG CAG TTT CAA-TAMRA
A. viscosus	Forward	GCA GAT ATC AGG AAG AAC AC
	Reverse	GAC TAC CAG GGT ATC TAA TCC T
	Probe	FAM-CTA CTG ACG CTG AGG AGC GAA AGC-TAMRA
S. sanguis	Forward	GGA TTT ATT GGG CGT AAA GC
	Reverse	TCT GCA CTC AAG TTA AAC AG
	Probe	FAM-GAG CGC AGG CGG TAA GAT AAG TCT G-TAMRA

Platinum® Quantitative PCR SuperMix-UDG with ROX (Invitrogen®) and primers and probes and DNA samples for SDS Comperndium 7700 Sequence detection system (ABI) were used. The volume of each PCR mixture was 45㎕. (25㎕ for the Platinum® Quantitative PCR SuperMix-UDG with ROX master mixture and 1㎕ of extracted DNA stored in Qiagen AE buffer. The optimal volume of the forward and the reverse primers and the probe in the PCR volume were 1㎕. The cycling parameters (cycling was performed with the SDS Compendium 7700 Sequence detection system (ABI)) consisted of 45 cycles : 50℃ for 2 min, 95℃ for 2 min95℃, 45 cycles of 95℃ 15 seconds and 65℃ for 45 seconds.

II. 3. Oral hygiene instructions

At the baseline visit, the subjects were assigned to a study group(manual or sonic), and were given oral hygiene instructions for a period of 10 min by a dental assistant for a period of 15 min by a dentist. The same dentist provided instruction to all of the subjects in the trial.

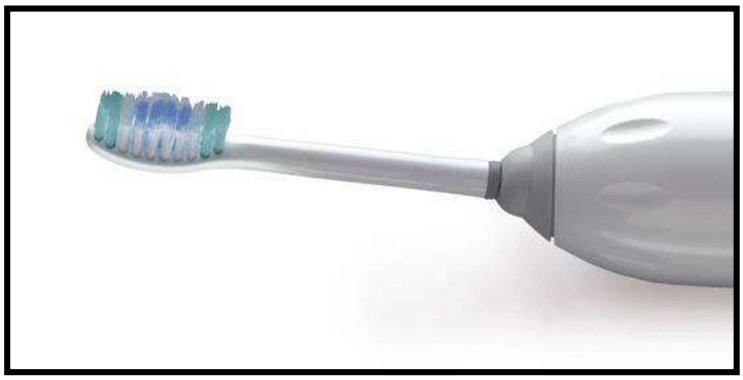
II. 3. 1 Manual tooth brushing group(Control group)

Each subject in the manual group received a Butler® #311 Multi-tufted Manual Toothbrush with 3 rows of soft nylon bristles (J.O Butler Co., Chicago, IL; USA). The subjects were individually instructed in the modified Bass toothbrushing technique (Bass 1954).

II. 3. 2 Sonic toothbrushing group(experimental group)

Subjects were given a sonic toothbrush (Sonicare® Elite powerbrush). The soft nylon bristles of this brush are scalloped to facilitate interproximal access by the longer bristle tufts(Fig. 1). Written and oral instructions were given to the patients according to manufacturer's recommendations. Subjects were instructed to position the brush so that the bristles were perpendicular to, and lightly touched, the teeth and gingiva. Brushing was done by a slow horizontal back-and-forth movement along the teeth and gingiva.

Figure 1. Sonicare Elite® power toothbrush



Between baseline and the 12-week visit, all subjects were instructed to perform oral hygiene twice daily(on arising and before bedtime) with their assigned brush using the same brand of toothpaste (2080 toothpaste®, Aekyung Co., ROK)

II. 4. Statistical analysis

Within each group, means and standard deviations(S.D.) were calculated for each subject for all clinical measurements and assessments. A mean PD, CAL, Silness & Löe plaque index (PI), Löe & Silness gingival index(GI) score were evaluated. BOP was dichotomixed as present or absent and expressed as the percentage of total of total sites in each subject that bled after probing with a controlled-force probe. The

effects of the brushes in reducing baseline values of the PI, GI, PD, CAL, BOP at 1 weeks, 4 weeks and 12 weeks were assessed using the Wilcoxon signed ranks test. Differences between experimental and control group were tested by unpaired T-test. P values <0.05 were considered significant.

MMP-8, IL-1 levels and subgingival periodontal pathogen levels(PG, TF, SS, AV), testing 16S rDNA in 4 bacterial species at 3 sites prospectively identified at Baseline, following 1 and 12 weeks of toothbrush use. Differences between experimental and control group were tested by unpaired T-test. P values <0.05 were considered significant.

Ⅲ. Results

A total of 82 subjects, 52 in the experimental group and 30 in the control group, came to all 5 study visits. 11 subjects, 7 in the experimental group and 4 in the control group did not return for the final examination and were therefore excluded from the data analysis. The distribution of subjects by age, gender and smoking in each group was comparable. The two groups were not significantly different in their average age (control group mean=38.0, standard deviation 9.7 years; experimental group mean=40.9, standard deviation 8.8 years). There were 14 men and 16 women in the control group, and 25 men and 25 women in the experimental group. The two groups were not significantly different in smoking/non-smoking. No other adverse effects were noted by the examiner in either of the groups or reported by any of the subjects.

III. 1. Probing depth, clinical attachment level

Because each patient in the study population had an overall clinical diagnosis of "incipient to moderate periodontitis", they had no probing depths deeper than 6 mm and little or moderate clinical attachment loss or gingival recession. At the baseline visit, subject means for probing depths for both toothbrush groups were similar (control=3.72mm±0.68; experimental=3.51mm±0.43), as were the clinical attachment level measurements (control=4.16mm±1.05; experimental=3.60mm±0.64). Throughout the 12-week study period, there were statistically significant changes in both group of patients (Table 4). Reduction of Probing pocket depths were significantly reduced compared to baseline values in both the experimental group (18.55%) and the l group (14.81%) ($p < 0.001$). Clinical attachment level were significantly improved compared to baseline in both the experimental group (25.24%) and the control group (16.94%) ($p < 0.001$).

Table 4. Clinical Measurements of the 2 groups at each visits(mm)

Group	Baseline	1 Week	4 Week	12 Week	Change(%)
Probing Depth					
experimental group	3.72±0.68	3.30±0.66†	3.25±0.73†	3.03±0.66†	18.55
control group	3.51±0.43	3.21±0.37†	3.11±0.45†	2.99±0.37†	14.81
Clinical Attachment level					
experimental group	4.16±1.05	3.54±0.89†	3.30±0.81†	3.11±0.83†	25.24
control group	3.60±0.64	3.24±0.38†	3.11±0.45†	2.99±0.37†	16.94

+ : statistically significant from control at $p<0.05$ (unpaired T-test)

*: statistically significant from baseline at $p<0.05$ (Wilcoxon signed ranks test)

III. 2. Efficacy of plaque removal

At baseline, gingival inflammation assessed by the Plaque Index was comparable in the two groups (Table 5). Throughout the study both toothbrush groups showed sustained statistically significant reductions from baseline values ($p<0.05$). Experimental group was statistically superior to the control group in Plaque Index scores reduction, respectively ($p <0.001$)（Table 5).

Table 5. Mean plaque index of the 2 groups at each visits

	Plaque index (PI)			
	Baseline	1 week	4 week	12 week
experimental group	1.38±0.33	0.70±0.42^{+*}	0.72±0.38^{+*}	0.64±0.37^{+*}
control group	1.45±0.31	1.18±0.32*	1.15±0.26*	1.12±0.37*

+ : statistically significant from control at $p<0.05$ (unpaired T-test)

*: statistically significant from baseline at $p<0.05$ (Wilcoxon signed ranks test)

III. 3. Assessments of gingival inflammation

III. 3.1. Qualitative (Clinical) assessments of gingival inflammation

At baseline, gingival inflammation assessed by the Gingival Index was comparable in the two groups. Throughout the study, both toothbrush groups showed statistcally significant reductions from baseline values ($p<0.05$). Experimental group was statistically superior to control group in gingival Index scores reduction ($p <0.001$) (Table 6).

Table 6. Mean gingival index of the 2 groups at each visits

	Gingival index (GI)			
	Baseline	1 week	4 week	12 week
experimental group	1.33±0.29	0.67±0.44^{+*}	0.63±0.38^{+*}	0.65±0.40^{+*}
control group	1.45±0.28	1.20±0.32*	1.17±0.25*	1.14±0.40*

+ : statistically significant from control at $p<0.05$ (unpaired T-test)

*: statistically significant from baseline at $p<0.05$ (Wilcoxon signed ranks test)

Bleeding on probing was comparable in the two groups. Throughout the study both toothbrush groups showed sustained statistically significant reductions from baseline values ($p<0.05$) in BOP. The reduction of BOP in the experimental group (76.73%) was significantly greater than control group (44.57%) (Table 7).

Table 7. Mean bleeding on probing of the 2 groups at each visits(%)

	Bleeding on probing		
	Baseline	12 Week	Change(%)
experimental group	81.73±33.28	19.02±21.59^{+*}	76.73
control group	84.37±29.44	46.77±33.89*	44.57

+ : statistically significant from manual at $p<0.05$ (unpaired T-test)

*: statistically significant from baseline at $p<0.05$ (Wilcoxon signed ranks test)

III. 3.2. Quantitative (laboratory) assessments of gingival inflammation

As alternative, potentially more sensitive and less subjective, means to assess gingival inflammation, two laboratory tests were also done on samples of gingival crevicular fluid (GCF) taken from selected sites. These two tests, measurement of IL-1 and MMP-8 levels in GCF samples, have previously been shown to have a high correlation with gingival inflammation (Page RC 1976, Tonetti 1994).

Measurements of both IL-1 levels and MMP-8 levels were subjected to relatively high degrees of variability (note the standard deviations for these assessments in Table 8). Concentration of IL-1ß and MMP-8 were decreased compared to baseline in both groups.

However there were no statistically significant reductions in either IL-1 levels and MMP-8 levels over the entire study period (Table 8).

Table 8. Quantitative assessments of gingival inflammation by visit in 2 groups (pg/mL)

Parameter and Group	Baseline	1 Week	12 Week	% Change
IL-1				
experimental group	167.6±110.1	157.8±112.3	147.3±130.2	12.11
control group	135.5±111.1	109.3±110.5	91.4±84.0	32.55
MMP-8				
experimental group	20.9±14.4	17.7±14.3	14.6±12.1	30.14
control group	27.7±20.7	N/A	15.8±12.3	42.96

+ : statistically significant from control at $p<0.05$ (unpaired T-test)

*: statistically significant from baseline at $p<0.05$ (Wilcoxon signed ranks test)

4. TagMan Real-time PCR

AV, PG and TF in subgingival plaque samples from 16S rDNA were significantly decreased at 12 weeks when compared with the baseline both in Sonicare® and manual groups with no significant differences between the groups. SS in subgingival plaque samples from 16S rDNA test significantly decreased at 12 weeks when compared with the baseline in experimental group but were not significantly reduced when compared with the baseline in control group (Table 9).

Table 9. Real time PCR CT values of the pathogens

	CT value		
	Baseline	1 week	12 weeks
A. viscosus			
Experimental	22.7±1.88	23.9±1.62†,‡	23.2±2.25
Control	23.7±1.99	23.5±1.82	24.4±2.46
P. gingivalis,			
Experimental	23.7±4.21	25.7±4.50†	24.8±5.29†
Control	23.9±3.73	26.5±4.70†	27.4±5.51†
***S. sanguis*.**			
Experimental	36.9±8.06	37.3±7.63	36.3±7.81
Control	35.9±8.37	35.7±8.77	35.7±8.61
T..forsythensis			
Experimental	25.6±3.03	27.8±3.74†	26.7±3.90†
Control	25.6±2.49	28.9±4.17†	28.3±3.84†

† Significantly greater reduction than baseline,. $p < 0.05$

‡ Significance between the experimental and control groups. $p < 0.05$

Ⅳ. Discussion

The results of this clinical trial in moderate periodontitis demonstrate that both a manual brush and a new sonic toothbrush(Sonicare Elite® power toothbrush) are capable of removing supragingival plaque and reducing signs of gingival inflammation. Although both devices were effective, the sonic brush was statistically superior in removing supragingival plaque from the dentition taken as a whole. The results of this study comfirm the findings of Tritten and Armitage(1996) who also compared the plaque-removing effectiveness of the Sonicare® toothbrush with a traditional manual brush. Our findings are also in general agreement with other investigations that compared the effectiveness of manual brushes with a counter-rotary brush (Baab & Johnson 1989, Killoy et al 1989, Khocht et al 1992), a reciprocating device with 4 brush heads (Khocht et al. 1992), and a circular brush with a rotating and oscillating brush head (Ainamo et al 1997, van der Weijden et al. 1993).

Not all studies that have compared manual with electric toothbrushes have compared manual with electric toothbrushes have shown a device-dependent difference(Elliott 1963, Glass 1968, Rainy et al 1964, Smith et al 1964, Boyd RL et al 1989). However, the devices used in these studies had very different designs and modes of operation than any of the electric brushes that have been shown to be superior to manual toothbrushes in the removal of plaque. It is also likely that study length affects the outcome of toothbrushing studies. For example, van der Weijden et al.(1994) reported that an oscillating/rotating electric brush was not significantly superior to a manual brush in either plaque removal or gingivitis reduction at 1and 2 months, but was superior after 5 and 8 months of use.

One of the therapeutic goal of plaque removal is the reduction of gingival inflammation. The result of qualitative (clinical) assessments of gingival inflammation, in the population studied, control group and experimental group both resulted in statistically significant reductions($p<0.05$) in gingival inflammation as assessed by the Gingival Index. Throughout the study both toothbrush groups showed sustained statistically significant reductions from baseline values($p<0.05$) in BOP.

However, in this short-term study no device-specific statistical differences were noted between the two types of brushes in their ability to reduce gingival inflammation.

In quantitative (laboratory) assessments of gingival inflammation, with the manual or sonic brushes, statistically significant reductions in the IL-1 levels and MMP-8 levels did not occur. With both brushes, however, notable reductions in the IL-1 levels and MMP-8 levels were observed. Nevertheless, analysis of data from these laboratory measurements of gingival inflammation by repeated measures ANOVA across all time intervals did not show device-dependent differences. This finding could be due to the wide standard deviations associated with measurements of the IL-1 levels and MMP-8 levels. The possible explanation for the failure to demonstrate marked differences between the manual and sonic brushes in their ability to reduce gingival inflammation is the lack of precision of available methods for measuring gingival inflammation. We had hoped that inclusion of the IL-1 levels and MMP-8 levels analyses would add some precision to the assessments of gingival inflammation. However, the high test-to-test variability of the IL-1 levels and MMP-8 levels data demonstrates that further technical improvements in such assays are desirable

In microbiological analysis, AV, PG and TF in subgingival plaque samples from 16S rDNA test significantly decreased at 12 weeks when compared with the baseline both in sonicare® and manual groups, with no significant differerences between the groups. And SS in subgingival plaque samples from 16S rDNA test showed significant decrease in 12 weeks than the baseline in experimental group but were not significantly reduced than baseline in control group. The possible explanation for the failure to demonstrate marked differences between the manual and sonic brushes in their ability to reduce gingival inflammation is the lack of precision of available methods for collecting subgingival plaque samples and laboratory analysis.

Based on the results of this clinical trial, it can be concluded that in the population studied, the Sonicare® toothbrush is a safe and effective device for removing supragingival plaque and gingival inflammation. Similar statistically significant reductions in qualitative assessments of gingival inflammation were observed in both the sonic and manual groups over the 3-month study. However, the sonic brush was superior to the manual brush in removal of plaque, and reduction of gingival inflammation.

Ⅴ. Conclusion

The Aim of this study were to assess of the effects of the Sonic toothbrush on clinical parameters, the reduction of inflammation factor (IL-1ß and MMP-8) and the reduction of 4 bacterial species (PG, TF, SS, AV) on incipient to moderate chronic periodontitis, following 1, 4 and 12 weeks of toothbrush use.

Based on the results of this clinical trial, it can be concluded that in the population studied, the sonic toothbrush is a safe and effective device for removing supragingival plaque and gingival inflammation. Similar statistically significant reductions in qualitative assessments of gingival inflammation were observed in both the sonic and manual groups over the 3-month study.

In conclusion, the tested Sonic toothbrush was more effective than the manual brush in removal plague and reduction of gingival inflammation

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국문요약

성인성 치주염 환자에서 초음파 전동칫솔 사용에 따른 임상지수, Interleuin-1, MMP-8, 치주병인균 등의 감소에 대한 평가

지속적인 칫솔질을 이용한 치태조절은 치주질환의 예방과 치료의 구강위생방법의 중요한 요소이다. 초음파 전동칫솔(Sonicare® Elite toothbrush)은 초당 520회의 진동을 생성하여, 이 초음파 진동은 치태제거와 더불어 주변 액체에 와류를 형성한다. 이 와류의 역동적인 힘은 칫솔모에서 2-3mm거리의 치아표면까지 치태세균을 탈락시키고 제거하는데 관여하는것으로 보고되고 있다. 이 연구의 목적은 12주간 성인성 치주염 환자에서 초음파 전동칫솔 사용에 따른 임상지수, Interleukin-1, MMP-8, 치주병인균의 감소에 대한 평가를 하고자 함이다.

12주간 단일 맹검법으로 시행하였다. 25-55세의 82명이 실험대상자로 선정되었다. 치태지수가 0.5이상, 치은지수가 1.0이상인 성인성 치주염 환자로 한정하였다. 무작위로 초음파 전동칫솔과 일반 칫솔을 제공하고 통법의 칫솔질 교육을 시행하였다. 치태지수, 치은지수, 탐침시 출혈율, 치주낭 깊이, 치주 부착 소실은 0주, 1주, 4주, 12주에 평가하였다. Interleukin-1, MMP-8의 치은열구액 표본 채취와 4종의 치주병인균(*Actinomyces viscosus*(AV), *Porphyromonas gingivalis*(PG), *Streptococcus sanguis*(SS), *Tannerela forsythensis*(TF))의 16S r DNA 검사를 위한 치은연하치태 채취는 0주, 1주, 12주에 시행되었다.

초음파 전동칫솔군과 일반 칫솔군에서 모든 임상지수가 감소되었다. 그러나 치태지수와 치은지수에서 초음파 전동칫솔군이 일반 칫솔군에 비해 유의성있는 감소를 보였다($P<0.001$). 탐침시 출혈 감소율은 초음파 전동칫솔군이 76.73%로 일반 칫솔군 44.57%보다 현저히 높았다. 치주낭 깊이는 초음파 전동칫솔군이 18.55%, 일반 칫솔군이 16.94% 감소하였다. 치주 부착소실은 초음파 전동칫솔군이 25.24%, 일반 칫솔군이 16.94%로 감소하였다($p<0.001$). Interleukin-1,

MMP-8 농도는 두 군 모두에서 감소하였다. 치은연하치태표본의 치주병인균 AV, PG, TF의 유의성 있는 감소는 보이지 않았다. 치주병인균 SS는 초음파 전동칫솔군에서 유의성있는 감소를 보였으나, 일반 칫솔군에서는 유의성이 존재하지 않았다.

결론적으로 초음파 전동칫솔이 일반 칫솔보다 치태 제거와 치은 염증 감소에 더욱 효과적이다.

핵심되는 말 : 성인성 치주염, 치태, 초음파 전동칫솔, 치은지수, 치태지수, IL-1, MMP-8, realtime-PCR, 치주병인균