

A Prospective Clinical Study to Evaluate the Effect of Manual and Power Toothbrushes on Pre-existing Gingival Recessions

Christof E. Dörfer, DDS, PhD; Daniela Joerss, DDS;
Diana Wolff, DDS



Abstract

Aim: To evaluate gingival recession changes after six months of brushing with an oscillating-rotating power toothbrush (PT) or an ADA reference manual toothbrush (MT).

Methods and Materials: Healthy subjects with pre-existing recession were assigned to brush with either a PT (n=55) or an ADA reference MT (n=54) according to a prospective randomized, controlled, single-blind, parallel group design. Participants were asked to brush their teeth twice daily for two minutes each with the same fluoride toothpaste. Clinical attachment loss and probing pocket depths (PPDs) were measured at six sites per tooth to the nearest mm by one calibrated examiner at baseline and after six months. Gingival recession was calculated as the differences between clinical attachment loss and PPDs overall and separately at individual sites.

Results: As compared with baseline, overall recession at six months was reduced from 2.35 ± 0.35 mm to 1.98 ± 0.55 mm ($p < 0.001$) in the PT group and from 2.26 ± 0.31 mm to 1.90 ± 0.45 mm ($p < 0.001$) in the MT group. The data showed 40% (power) and 38% (manual) of all recession sites improved by at least 0.5 mm while 51% and 54% remained unchanged. Eight percent and 7% recessions increased over time. Differences between groups were not statistically significant at either timepoint.

Conclusion: Both the PT and the MT significantly reduced pre-existing gingival recession after six months of brushing. This may have been due to improved brushing technique (i.e., Hawthorne effect).

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Clinical Significance: Based on these six-month data, concern that power tooth brushing results in a higher risk for gingival recession is not warranted.

Keywords: Oscillating-rotating power toothbrush, gingival recession, Hawthorne effect

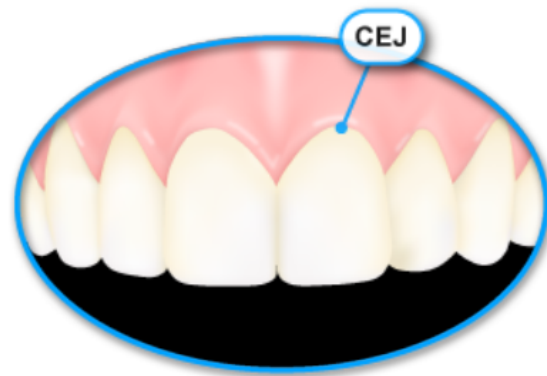
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Introduction

Gingival recession is marked by the apical displacement of the gingival margin away from the cemento-enamel junction (CEJ). This leads to root exposure, which is esthetically unattractive and may result in hypersensitivity and root caries. While the cause of gingival recession is not fully established, it is clear the etiology is multifactorial.¹ Research indicates recession is associated with aging² and is more common in women than men.³ In addition, a variety of anatomical, pathological, and physiological factors have been implicated in the etiology.¹

The most controversial issue is the possible role of tooth brushing in promoting gingival recession.⁴ Tooth brushing has been shown to result in gingival abrasions, but it is not known how such abrasions may relate to gingival recession.⁵ There is some circumstantial evidence tooth brushing could be a causative factor in the development of gingival recession.^{6,7} However, one influential review of the evidence concludes “it is only with ‘under, over or abusive use [of tooth brushing] when combined with erosion that significant harm may be thus caused.’”⁵ A very recent systematic review states “data to support or refute the association between tooth brushing and gingival recession are inconclusive.”⁴

As researchers attempt to clarify this relationship, it is important to consider any differential effects of power and manual tooth brushing on gingival recession. Power toothbrushes (PTs) with a rotating-oscillating and pulsating action have been shown to provide significant advantages for oral health (specifically plaque removal and reduction of gingivitis) over manual toothbrushes (MTs) in long- and short-term studies.^{8,9} These systematic reviews found no evidence PTs with oscillating-rotating action cause any more abrasion of soft tissue (gingivae, lips, tongue, inner surface of



cheeks, etc.) than manual brushing. A number of other studies support this general conclusion,^{10,11} and one reports power brushing results in fewer abrasions than manual brushing.¹²

While there is no established connection between gingival abrasions and gingival recession, it is nevertheless possible the use of devices with a higher plaque removing capacity could be associated with a higher risk of gingival recession. Three long-term controlled clinical trials have compared powered with manual tooth brushing for changes in gingival health. Neither a rotary electric brush,¹³ nor a counter-rotational electric brush,¹⁴ nor an oscillating-rotating PT¹⁵ resulted in differences in gingival recession compared with manual tooth brushing. However, both the Boyd et al.¹³ and the Wilson et al.¹⁴ studies used small numbers of subjects (40 and 32, respectively), and no studies examined pre-existing recessions. As sites with existing recessions are known to be more susceptible to further recessions,⁶ the aim of the present long-term, prospective, randomized, controlled clinical study was to examine the influence of tooth brushing with an oscillating-rotating PT and a manual reference toothbrush on subjects with pre-

existing recessions. Within-group comparisons of gingival recession facilitate the evaluation of the progress of recession, while between-group comparisons test the null hypothesis that oscillating-rotating PT users and MT users show no differences in the progress of recession.

Methods and Materials

Subjects and Study Design

This was a single center, randomized, examiner-blind, parallel group study to compare the effects of power brushing, using an Oral-B ProfessionalCare® 7000 Model D17U power brush (The Procter & Gamble Company, Cincinnati, OH, USA), with manual brushing, using an American Dental Association reference flat trim brush, on oral tissues (Figure 1). This study assessed the results after six months of twice daily brushing. All subjects used a standard sodium fluoride dentifrice (Blend-a-Med®; The Procter & Gamble Company, Cincinnati, OH, USA).

The study protocol was approved by the Independent International Freiburg Ethics Committee before the start of the study, and subjects gave written informed consent before participating in any study procedures.

Subjects from the general population were considered for the study according to the study inclusion and exclusion criteria (Table 1). All dental professionals and dental students were excluded from participation to avoid bias. Participants had to exhibit at least two sites with gingival recession of at least 2 mm at baseline to qualify for participation in the study. Qualifying subjects were consecutively included.

Subjects who qualified to participate in the study according to the inclusion and exclusion criteria

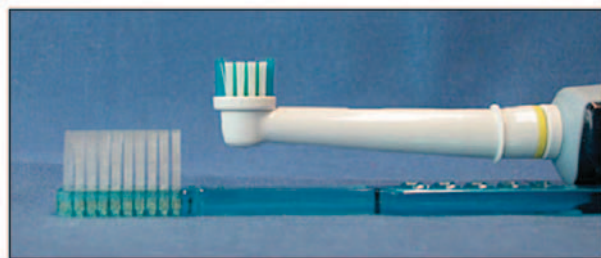


Figure 1. Oral-B ProfessionalCare 7000 toothbrush and ADA reference MT.



had their first study visit (Visit 1; baseline) during which subjects received oral assessments of the soft and hard tissues, followed by clinical measurements by the same examiner (DW) who was blinded to the assigned treatment. The examiner had been calibrated for intra-examiner reproducibility. The clinical recession measurements were carried out at six sites per tooth and comprised periodontal measurements of pocket depth, attachment levels, and gingival recession. The sites were mesiobuccal, centrobuccal, distobuccal, mesiolingual, centrolingual, and distolingual. Plaque and gingival health were assessed next but the data were not analyzed in this study.

Periodontal pocket depth (PPD) at every site was measured to the nearest mm using a periodontal probe marked at each mm (PCPUNC15, Hu-Friedy, Chicago, IL, USA), averaging upward if the margin of the gingiva was between markings. For proximal surfaces, the probe was held at 45° to the long axis of the tooth to prevent overestimations of pocket depth at the interproximal spaces. The clinical attachment level (CAL) at every site was measured as the sum of (i) the distance between the CEJ to the margin of the gingiva and (ii) the PPD. The CAL was scored as negative if the margin of the gingiva was above the CEJ and positive if the margin of the gingiva was below the CEJ. If the CEJ was covered by a crown or cervical restoration, the measurement was taken from the most apical margin of the restoration. Gingival recession at every site was calculated as the difference between CAL and PPD.

Subjects were stratified based on mean gingival recession, gender, smoking status, and age to one of the two treatment groups: power brush

Table 1. Inclusion and exclusion criteria for study participation.

Inclusion Criteria
<ul style="list-style-type: none"> Signed informed consent.
<ul style="list-style-type: none"> In good general health.
<ul style="list-style-type: none"> Aged 18-70 years.
<ul style="list-style-type: none"> Minimum of 18 scorable teeth (not including third molars, teeth with orthodontic appliances, bridges, crowns, or implants).
<ul style="list-style-type: none"> Having at least two teeth showing recession on the facial surface of ≥ 2 mm
<ul style="list-style-type: none"> Willing and able to complete the study.
Exclusion Criteria
<ul style="list-style-type: none"> Dental professionals or dental students.
<ul style="list-style-type: none"> Any physical limitations or restrictions that might preclude normal oral hygiene procedures (i.e., toothbrushing, etc.).
<ul style="list-style-type: none"> Any evidence of neglected dental health (i.e., severe periodontal disease or rampant caries).
<ul style="list-style-type: none"> Evidence of major hard or soft tissue lesions or trauma at the baseline visit.
<ul style="list-style-type: none"> Known allergy to the test products.
<ul style="list-style-type: none"> Received therapy with any drugs for at least three consecutive days within the last 28 days that might affect the outcome of the study (i.e., anti-inflammatory medications, Dilantin, NSAIDs).
<ul style="list-style-type: none"> Pregnant or nursing, as determined by medical history.
<ul style="list-style-type: none"> Medical condition or history requiring prophylactic antibiotic coverage prior to dental treatment, (e.g., rheumatic fever, rheumatic heart disease, heart murmur, mitral valve prolapse, valvular dysfunction, enlarged heart, bacterial endocarditis, congenital heart defect, or prosthetic replacements such as heart valve, hip, etc.).
<ul style="list-style-type: none"> Any systemic condition, significant illness, or disease that might influence or preclude subject's participation in the study (e.g., AIDS, diabetes).
<ul style="list-style-type: none"> Currently or have recently (within the last 30 days) participated in any other oral hygiene clinical study.

or manual brush. All subjects were instructed to brush their teeth twice daily for two minutes each time using the sodium fluoride dentifrice supplied. Subjects assigned to the PT group received brushing instructions according to the manufacturer's package insert and were required to demonstrate their brushing technique prior to leaving their facility. Subjects assigned to the MT group received instructions on an individual basis as recommended by the investigator, and any errors in brushing were corrected.

Subjects returned to the center after three months (Visit 2) and were supplied with a new manual brush or brush head, as appropriate. The standard toothpaste, which was available throughout the study on request, was also supplied at this visit. Any questions raised by the subjects were answered and brushing instructions were reviewed. Subjects were instructed to return to the center after another three months for a second oral examination.

At six months (Visit 3), subjects received oral assessments of all soft and hard tissues followed by the same clinical measurements as those conducted at Visit 1. Clinical recession measurements were validated by comparing the clinical evaluation of gingival recession with recession measurement using stone replicas from high precision full mouth impressions. Dental impressions with a high precision polyethergum impression material (i.e., casts) were taken at

baseline for all subjects from the maxilla and the mandible. The stone replica recessions were measured using a digital measuring gauge by an examiner (SW) who was different from the examiner who carried out the clinical measurements and who was blinded with respect to the results of the clinical measurements.

Statistical Analysis

No power calculation was conducted before the start of the study, but subject recruitment was aimed at having 50 subjects per group completing the study. Gingival recession was of primary interest in this study, and changes from baseline at six months were assessed using the Wilcoxon non-parametric test for paired samples and group differences in changes from baseline were assessed using the non parametric Mann-Whitney-U Test. Proportions of improving, unchanged, and increasing recession sites were calculated as well. The Pearson's product-moment correlation coefficient was used to assess the relationship between clinical and stone replica assessments of gingival recession. All statistical tests were two-sided and used a significance level of $\alpha=0.05$.

Results

A total of 109 subjects were enrolled in the study and 106 subjects (53 in the PT group; 53 in the MT group) completed the study. The remaining subjects were withdrawn from the study because of the use of antibiotics during the last three weeks prior to the six months examination. The demographic details of subjects who completed the study are summarized in Table 2.

The mean baseline and Month 6 periodontal pocket depth, clinical attachment level, as well as plaque and gingivitis index values are summarized in Table 3.

The results of recession measurements at preexisting recessions are given for all sites and separate for tooth type in Table 4.

Analysis of the clinical data for all pre-existing recession sites showed recession was highly significantly reduced from baseline to month six ($p < 0.001$). Analysis of the data for different tooth types showed recession was significantly reduced for both the manual and power brush at

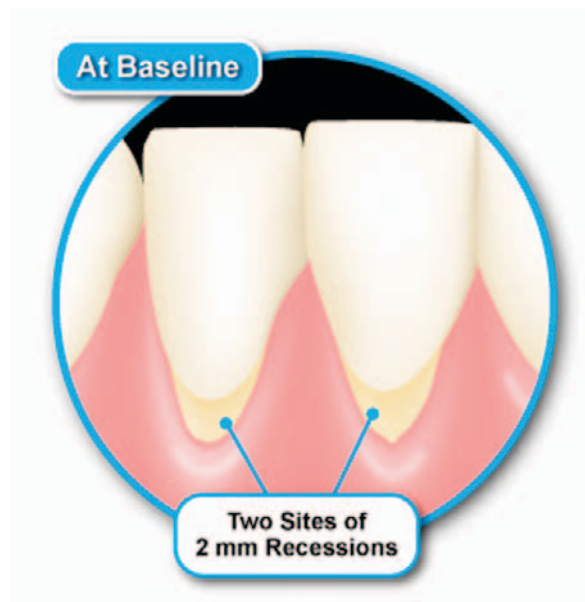


Table 2. Baseline demographic characteristics of subjects who completed the study.

Subjects	Treatment Group	
	Power Toothbrush (PT)	ADA Manual Toothbrush (MT)
Gender		
Female	27 (51%)	28 (53%)
Male	26 (49%)	25 (47%)
Age (years)		
Mean ± SD	33 ± 10	32 ± 9

Table 3. Probing Pocket Depths (PPD [mm]), Clinical Attachment Levels (CAL [mm], Plaque (TMQHI) and Gingivitis-Index (GI) at all sites. Mean values ± standard deviations are given for baseline and six-month results.

Site	Brush	Baseline (Mean ± SD)	Six Months (Mean ± SD)	Change from Baseline	
				Absolute Difference	P-value
PPD	Manual	1.9 ± 0.2	1.9 ± 0.2	0.0 ± 0.2	n.s.
	Power	1.8 ± 0.2	1.8 ± 0.2	0.0 ± 0.2	n.s.
CAL	Manual	2.1 ± 0.3	2.1 ± 0.3	0.0 ± 0.2	n.s.
	Power	2.1 ± 0.3	2.1 ± 0.3	0.0 ± 0.2	n.s.
TMQHI	Manual	0.9 ± 0.5	0.8 ± 0.5	0.0 ± 0.1	n.s.
	Power	0.8 ± 0.4	0.7 ± 0.4	0.1 ± 0.5	n.s.
GI	Manual	0.7 ± 0.4	0.7 ± 0.4	0.0 ± 0.3	n.s.
	Power	0.6 ± 0.4	0.6 ± 0.4	0.0 ± 0.3	n.s.
SD = Standard Deviation n.s. Non-significant (p>0.05) Group difference non significant at all timepoints (p>0.05)					

Table 4. Recessions at sites with initial recession (mm) in total and separate for different toothtypes. Mean values \pm standard deviations are given for baseline and six-month results.

Site	Brush	n	Baseline (mean \pm SD)	Six Months (mean \pm SD)	Change from Baseline	
					Absolute Difference	P-value
All	Manual	53	2.3 \pm 0.3	1.9 \pm 0.5	0.4 \pm 0.3	p < 0.001
	Power	53	2.4 \pm 0.4	2.0 \pm 0.6	0.4 \pm 0.4	p < 0.001
Central Incisor	Manual	17	2.4 \pm 0.6	2.0 \pm 0.9	0.4 \pm 0.8	p = 0.024
	Power	19	2.4 \pm 0.5	2.1 \pm 0.9	0.3 \pm 0.7	p = 0.019
Lateral Incisor	Manual	19	2.2 \pm 0.4	1.7 \pm 1.1	0.5 \pm 0.9	p = 0.021
	Power	26	2.3 \pm 0.6	2.1 \pm 0.9	0.2 \pm 0.6	n.s.
Canine	Manual	43	2.4 \pm 0.5	2.0 \pm 0.8	0.4 \pm 0.5	p < 0.001
	Power	46	2.6 \pm 0.9	2.1 \pm 1.3	0.5 \pm 0.7	p < 0.001
1st premolar	Manual	45	2.3 \pm 0.5	2.1 \pm 0.6	0.2 \pm 0.4	p = 0.004
	Power	45	2.4 \pm 0.5	2.1 \pm 0.7	0.3 \pm 0.5	p = 0.001
2nd premolar	Manual	40	2.2 \pm 0.5	1.9 \pm 0.7	0.3 \pm 0.5	p = 0.001
	Power	46	2.2 \pm 0.3	1.8 \pm 0.6	0.3 \pm 0.5	p < 0.001
1st molar	Manual	44	2.3 \pm 0.5	1.8 \pm 0.8	0.5 \pm 0.6	p < 0.001
	Power	47	2.4 \pm 0.6	2.1 \pm 0.8	0.4 \pm 0.6	p = 0.002
2nd molar	Manual	19	2.1 \pm 0.3	1.3 \pm 0.6	0.8 \pm 0.6	p < 0.001
	Power	19	2.2 \pm 0.4	1.5 \pm 0.9	0.7 \pm 0.7	p < 0.001
SD = Standard Deviation n.s. = Non-significant (p>0.05) 1 Group difference non significant at all timepoints (p>0.05)						

the central incisor, the canine, the first and second premolar, the first and second molar, and for the manual brush at the lateral incisor. No statistically significant group differences in recession were seen at any site.

In terms of proportions, 40% of recession sites in the power tooth brushing group and 38% in the manual toothbrushing group were improved by at least 0.5 mm. These values corresponded with 52% and 54% of unchanged sites and 8% and 7% of increasing recession sites, respectively.

Analysis of the stone replica validation data showed full agreement (a difference of <0.5 mm) in 72.3% of comparisons with clinical measurements; 96.8% of measurements differed by ≤ 1 mm. The mean difference (\pm standard deviation) was 0.4 ± 0.7 mm and the correlation was highly significant (Pearson's $r = 0.761$; $p < 0.001$).

No adverse effects on oral hard and soft tissues were observed in either treatment group during examination of the oral cavity (Figure 2).

Discussion

The primary aim of this controlled, parallel group study was to compare the effect on gingival recession of use of the Oral-B ProfessionalCare® 7000 PT with manual brushing over a period of six months. No significant differences between

groups were obtained for any measures of gingival recession. This is in general agreement with previous findings, none of which recorded greater gingival abrasion or gingival recession with powered than with manual brushes.¹¹⁻¹⁵ Thus, despite the fact that PTs with a rotating-oscillating and pulsating action have been shown to be more effective than MTs in plaque removal and control of gingivitis,^{8,9} these gains are not at the cost of increased gingival abrasion or recession. A failure to find a difference between groups can sometimes be the result of a lack of statistical power rather than the genuine absence of an effect; however, in the present study the substantial number of subjects in each group provides sufficient power to give confidence in the conclusion there is no difference in gingival recession following power or manual brushing.

It is known further recession is most likely to occur at sites where there has already been some degree of recession,⁵ in the present study consideration of these sites provides a very sensitive measure of the effects of tooth brushing on gingival recession. Not only was there no increase in recession in these sites, there was a highly significant decrease. In light of these findings, it can be concluded with confidence that neither power nor appropriate manual brushing increases gingival recession.

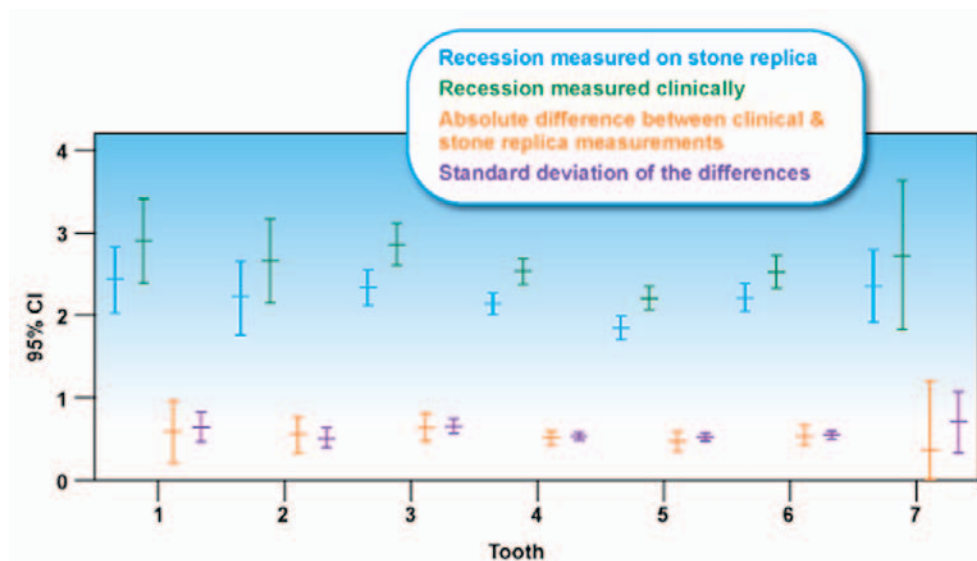


Figure 2. Stone replica validation of clinical recession measurement. Absolute recession values [mm] measured clinically (blue) and on stone replica (green) as well as their absolute difference [mm] (yellow) and the standard deviation of the differences (purple) are given.

As discussed in the introduction, while it appears both manual or power tooth brushing may result in some gingival abrasion, there is no convincing evidence this leads to gingival recession.^{4,5} There are a number of experimental studies which demonstrate a causal association between tooth brushing and gingival abrasion but there are few such studies of gingival recession. In one large scale, six-month study comparisons in gingival recession were made between a group of subjects using an oscillating-rotating powered brush (n=76) and a group using a manual brush (n=81); at the end of the study, no significant changes from baseline were found in either group.¹⁵ A smaller scale one-year study found no change in gingival recession over the period of the study in either the manual or the power brushing group, although the power brush was more effective in plaque removal.¹⁴ Another one-year study of periodontal maintenance patients using either manual or power brushes found no changes in PPD or loss of attachment.¹³ The conclusion from these rather limited studies, therefore, is that tooth brushing does not lead to gingival recession. Given differences in procedure, sample size, and subject populations these studies are not necessarily inconsistent with the improvement found in the present study.

However, as noted in the introduction, there are a range of studies which suggest there is an association between amount of tooth brushing and the development of gingival recession.^{6,7} The highly significant reversal in recession in our study is in complete conflict with these findings and is entirely unexpected. It should be noted the present experiment was a well controlled prospective study: subjects were enrolled according to pre-defined inclusion and exclusion criteria; assignment to groups was randomized and single-blinded; outcomes were assessed by a trained and calibrated examiner whose assessments were verified by impression based casts. There is no reason, therefore, to doubt the reliability of these results. By contrast, the findings which suggest toothbrushing results in gingival recession used a different and less convincing methodology. In general, they report a range of observations carried out at a particular time and derive conclusions from correlational findings. Thus, Serino et al.⁶ found in a population of subjects with a high standard

of oral hygiene there was a positive correlation between age and gingival recession. This was interpreted as indicating that prolonged tooth brushing induced gingival recession. However, in an observational study of 100 dental students the presence of gingival recessions in patients with a high standard of oral hygiene was related to wrong toothbrushing technique, too much strength exerted in brushing, overbrushing, and usage of hard toothbrush bristles.¹⁶ These findings were supported by Tezel et al., who concluded recession is particularly associated with toothbrushing technique, in particular horizontal scrubbing.⁷ Another observational study, which focused on the use of hard or soft MTs, reported recession was far more pronounced in subjects who had used a hard toothbrush and for users of hard toothbrushes a correlation between the percent of surfaces with recession and increasing brushing frequency.¹⁷

In observational studies such as these it is unsafe to draw conclusions about causation from correlational evidence alone. Thus, Serino et al.'s finding of a positive correlation between age and gingival recession⁶ has been interpreted as evidence of the amount of toothbrushing, which necessarily increases with age, results in greater gingival recession. However, these findings could have been an effect of aging alone, regardless of toothbrushing, or the correlation might, as suggested above, have been mediated by the hardness of the toothbrushes or by brushing technique. Experimental studies, such as the present one, provide much more reliable evidence of causation and where, as in this case, there is



apparent conflict greater weight should be placed on experimental findings. It may, therefore, be accepted that in this study brushing with either a MT or a PT reduced gingival recession over a six-month period. It seems possible the correlations obtained in observational studies are due to the use of inappropriate toothbrushes and brushing techniques rather than the mere amount of toothbrushing; this is also the conclusion reached in the most recent systematic review of the literature.⁴

It appears, as compared to the small number of other experimental studies,¹³⁻¹⁵ the experimental manipulation in this study was particularly effective in inducing better oral hygiene. A possible causal mechanism is provided by the 'Hawthorne effect'. The term 'Hawthorne effect' refers to any 'unexplained result in an experiment on human subjects, on the assumption the result occurred simply because the subjects were in an experiment and, thereby, experienced something that otherwise would not have affected them.'^{18,19} The effect is also recognized as a reaction of subjects to the realization they are in a study and are being observed.¹⁷ In the present study the subjects were alerted to the fact they were participating in a clinical trial and this may have changed their behavior. In particular, it may have led to more careful and systematic tooth brushing which, in turn, may have served to reduce gingival recession. It has been shown oral hygiene can be significantly improved in

non-compliant adolescents by the deliberate induction of this effect and this improvement can extend over six months.²⁰ This provides support for the notion the reduction in gingival recession achieved in this study was due to the same mechanism. It should be noted Hawthorne effects, unlike placebo effects, are the result of real changes in behavior; these behavioral changes are an unintended consequence of exposing subjects to a study protocol. In this study it is suggested this resulted in improved tooth brushing and this, in turn, reduced gingival recession. Whatever the reason for the improvement it clearly merits further investigation particularly if it offers the possibility of reversing gingival recession.

Conclusion

- Both groups showed a reduction in the amount of recession over the period of the study.
- Over a period of six months there was no difference in the amount of gingival recession in groups using the Oral-B ProfessionalCare® 7000 PT and a MT.
- It is possible that this is due to improved brushing technique engendered by the 'Hawthorne effect'.

Clinical Significance

Based on these six-month data, clinicians should not be concerned that power tooth brushing results in a higher risk for gingival recession.

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About the Authors

Christof E. Dörfer, DDS, PhD



Dr. Dörfer is a Professor and Chair of the Department for Conservative Dentistry, School of Oral Medicine, Christian-Albrechts-University at Kiel and the Director of the Clinic for Conservative Dentistry and Periodontology, Center for Oral Diseases at the University Hospital of Schleswig-Holstein in Kiel, Germany. His research interests include the prevention of oral diseases and their consequences on systemic health. He is member of the International Association for Dental Research and its Continental European Division and of the German and European Federation of Periodontology.

e-mail: doerfer@konspar.uni-kiel.de

Daniela Joerss, DDS



Dr. Joerss is an Instructor in the Department for Conservative Dentistry of the School of Oral Medicine at Ruprecht-Karls University in Heidelberg, Germany. Her research interests are preventive dentistry and adhesive dentistry.

e-mail: joerss.daniela@med.uni-Heidelberg.de

Diana Wolff, DDS



Dr. Wolff is an Assistant Professor in the Department for Conservative Dentistry of the School of Oral Medicine at Ruprecht-Karls-University in Heidelberg, Germany. She is a specialist in esthetic dentistry and operative dentistry. Her research interests are in preventive dentistry and cariology.

e-mail: wolff.diana@med.uni-Heidelberg.de

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