In Vitro, Clinical, and Microbiological Evaluation of a Linear Oscillating Device for Scaling and Root Planing

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Background: The purpose of this study was to conduct an in vitro and short-term clinical and microbiological evaluation of a linear oscillating device for scaling and root planing (SRP). A comparison was made between conventional ultrasonic scaling (US) and hand scaling (HS) with and without chlorhexidine.

Methods: In vitro, SRP was carried out on human teeth with calculus. Roots and cross-sections thereof were microscopically examined for the efficacy of calculus removal, hard tissue loss, and surface smoothness. In vivo, 11 patients with chronic periodontitis and single-rooted teeth in all quadrants with probing depths of ≥5 mm were selected. One quadrant was treated with linear oscillation and compared to US with chlorhexidine irrigation in the contralateral site. The other arch was treated with HS and compared to HS followed by laser disinfection. One hundred twenty teeth were assessed for clinical attachment level, probing depth, bleeding on probing, and suppuration at baseline and 7, 28, 90, and 180 days. Microbiologically, total numbers of bacteria and six specific periodontal pathogens were determined by quantitative polymerase chain reaction prior to and 1 and 28 days after SRP. Clinical and microbiological data were analyzed statistically with respect to the SRP method, patient specificity, and time effect.

Results: In vitro, linear oscillation preserved more root tissues but left more calculus ($P < 0.05$). Significant improvements of all clinical and microbiological parameters were observed for all groups. However, 21 out of 24 tests demonstrated that the clinical microbiological correlations between linear oscillation and control groups did not differ ($P < 0.05$).

Conclusion: Linear oscillation scaling was clinically acceptable and microbiologically comparable to the control groups despite microscopic remnants of calculus observed in vitro. *J Periodontol 2005;76:1942-1949.*

KEY WORDS

Clinical trials; dental scaling; microbiology; root planing; scanning electron microscopy; ultrasonic.

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Several clinical studies have demonstrated the efficacy of deep scaling and root planing (SRP) for the treatment of periodontitis.[1-3] Current SRP techniques are directed to plaque and calculus removal and the preservation of root tissues.[4,5] Clinically, this treatment has resulted in a gain of clinical attachment level (CAL) and reduction of periodontal pockets (probing depth [PD]) and, microbiologically, in a considerable decrease of the subgingival flora.[5-8] Because of the limited eradication of some key periodontal pathogens by mechanical debridement,[9-11] adjunctive measures have been suggested such as irrigation with water, iodine, hydrogen peroxide, chlorhexidine, and laser treatment.[7,12-17]

The clinical and microbiological results of SRP by sonic and/or ultrasonic techniques were reported to be comparable to the use of hand curets.[1,2,5,6] Both techniques resulted in the loss of soft and hard tissues followed by recession and tooth hypersensitivity.[18-23] Recently, a modified ultrasonic device‖ (Fig. 1) was developed, generating a linear monoaxial vertical oscillation.[24,25] For conduction and irrigation, a suspension of hydroxyapatite in water is used. It was postulated that the advantages of this principle were based on a combination of gentle plaque and calculus removal with preservation of root substance and gingival tissues.[24] Initial

‖ Vector, Duerr Dental, Bietigheim-Bissingen, Germany.

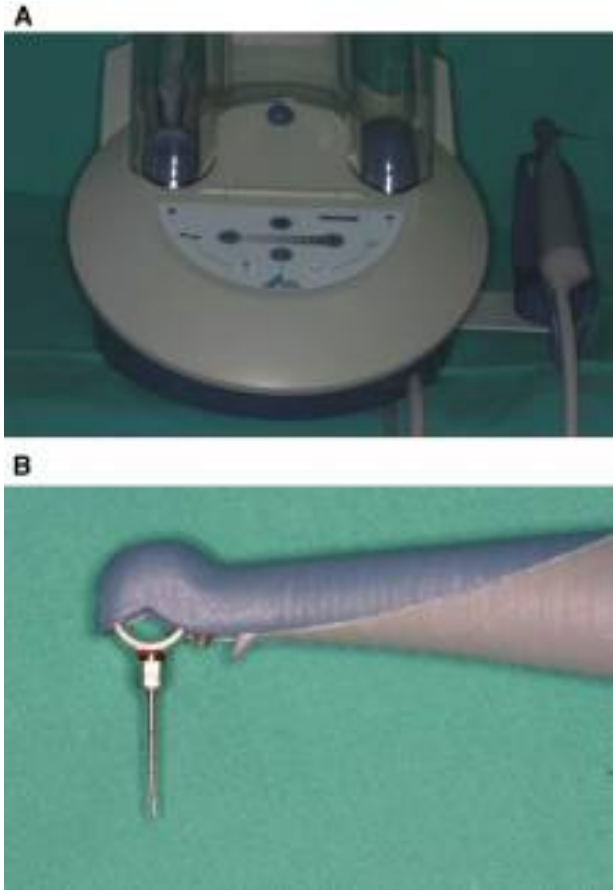

Figure 1.
Image of the oscillating device ***(A)*** *and tip* ***(B)*** *used in this study. The tip is the equivalent of a straight periodontal probe.*

studies reported on the in vitro effects,[26] clinical results, and patient acceptance.[27,28] To date, only limited clinical and microbiological data are available.[29]

The aim of this study was to test the oscillation device in vitro, clinically and microbiologically, and to compare it to hand scaling (HS) with and without laser disinfection and conventional ultrasonic scaling (US) with chlorhexidine.

MATERIALS AND METHODS

In Vitro

Human teeth (N = 32) extracted for periodontal reasons with visible aggregations of calculus were used for the experiment. On each root, an area was selected measuring ~5 mm in height from the cemento-enamel junction by ±10 mm in width. This area was divided in a left and right half: one served as test area and the other as control. The following three procedures were tested: group 1: oscillating device[¶] with the use of a metal tip (equivalent to a straight periodontal probe; Fig. 1) set at maximal intensity (N = 8); group 2: US with a piezoelectric device[#] at medium intensity using an H1 tip (N = 8) with water irrigation; and group 3: HS using curets[**] (N = 16). Each SRP technique was carried out until no calculus was visible, and the surface appeared to be smooth to tactile sense. Upon completion, the specimens were fixed in 5% glutaraldehyde, rinsed in 0.1 M sodium-phosphate buffer, and examined by means of light microscopy.[††] They were subsequently imbedded in resin and cut perpendicular to the long axis of the root into seven sections per tooth each measuring 50 μm thick, using a diamond wavering blade under copious water cooling.[‡‡] The sections were dehydrated in an ascending series of acetone/ethanol, air-dried, mounted, and sputter coated with carbon.[§§] Samples were then analyzed by scanning electron microscopy (SEM)[||||] to assess the effects of the various scaling techniques on the surface. An SEM materials contrast technique was used to determine the organic and inorganic composition. The cross-sections were examined using the following parameters: presence or absence of calculus, amount of loss of cementum measured in micrometers, the relative loss of cementum expressed as a percentage, surface topographical analysis (shallow, medium, or deep grooves, subsequently <10, 10 to 20, and >20 μm in depth), smoothness of root surface determined by means of tactile sense (rough or smooth), and exposure of dentin (yes or no). On all samples, 10 randomly selected locations were analyzed.

In Vivo

This study was carried out according to the Helsinki Declaration of 1975, as revised in 2000. All patients signed an informed consent form. Of the154 patients who were examined and diagnosed with chronic periodontitis, only 11 (four males and seven females) met the inclusion criteria (Table 1). These patients generated a total of 120 single-rooted teeth with a clinical attachment level and probing depth of ≥5 mm, after supragingival calculus had been removed and oral hygiene instructions had been given 4 to 6 weeks prior to the experiment. The following parameters were assessed at baseline (T_0) and 7 (T_7), 28 (T_{28}), 90 (T_{90}), and 180 days (T_{180}) after treatment: CAL, PD, bleeding on probing (BOP), suppuration (S), interproximal plaque index (IPI), and papilla bleeding index (PBI). To ensure the same placement of a pressure-sensitive periodontal probe[¶¶] during recall visits, a custom made acrylic splint was fabricated for each patient.

SRP was performed in one quadrant, selected at random for one of the following four groups: group

¶ Vector, Duerr Dental.
# Satelec-ProphyMax, Acteon, Mettmann, Germany.
** Gracey, Hu-Friedy Europe, Leimen, Germany.
†† Axioplan, Zeiss, Oberkochen, Germany.
‡‡ Sägemikrotom Leitz 1600, Wetzlar, Germany.
§§ Edwards Sputter Coater S150B, London, U.K.
|||| CamScan CS 24, Cambridge Scanning, Cambridge, U.K.
¶¶ Hawe Click-Probe, Kerr Hawe SA, Bioggio, Switzerland.

Table 1.

Criteria for the Clinical Trial

Inclusion	Exclusion
Age 30 to 55 years	Systemic disease(s) affecting treatment results
Good general health	Pregnancy
Minimum of 20 teeth (caries free or restored)	Smokers
Generalized chronic periodontitis	Antibiotics in the last 6 months
Single-rooted teeth with PD and CAL ≥5 mm in all four quadrants	Periodontal therapy in the last 6 months
Bleeding on probing	Contraindications to ultrasonic scaling
Patient compliance	Deep subgingival restorations
	Removable dentures
	Endodontically treated teeth
	Non-compliance

1: the oscillating device;## group 2: piezoelectric ultrasonic scaling*** with chlorhexidine irrigation (US); group 3: hand scaling with curets††† (HS); and group 4: hand scaling with curets and laser disinfection (HS + L) for which an Nd:YAG laser was used.‡‡‡ For the oscillating device, a stainless steel tip (equivalent to a straight periodontal probe) was used in combination with a suspension of hydroxyapatite in water according to the manufacturer's instructions. Ultrasonic scaling was done with diamond coated tips followed by stainless steel tips in combination with 0.2% chlorhexidine for irrigation.[23,30] In group 4, additional laser disinfection treatment was given 1, 8, and 15 days after hand scaling as per the instructions of the manufacturer.

Microbiological Study

Subgingival plaque samples of each tooth were collected using sterile paper points. After 10 seconds they were removed and stored in a 1.5-ml tube at –20°C until further investigation. Subgingival plaque samples were taken at baseline (T_0), 1 day (T_1), and after 28 days (T_{28}).

The subgingival flora was analyzed by quantitative competitive polymerase chain reaction (PCR) using primer sets for 16S rRNA genes for the total bacterial number (TBN) and the specific periodontal pathogens (PPN), *Actinobacillus actinomycetemcomitans* (*Aa*), *Tannerella forsythensis* (*Tf*), *Eikenella corrodens* (*Ec*), *Prevotella intermedia* (*Pi*), *Porphyromonas gingivalis* (*Pg*), and *Treponema denticola* (*Td*).[31] Quantification was achieved by coamplification of species-specific homologous competitors.[32] Counts for TBN, the six periodontal pathogens, and the ratios of bacterial count per millimeter of probing depth were calculated based on the amounts of 16S rRNA gene copies for the bacterial species investigated.

Statistical Analysis

The data of the surface morphology were analyzed using the Mann-Whitney U test.

To determine the differences of the clinical parameters, CAL and PD, and the total numbers of bacteria, a "linear mixed-effect model" was applied.[33] The observable y_{ij} (bacteria numbers or clinical parameters) was explained by a time effect, t_i ($i = T_0$ to T_{180}), treatment method effect, m_j (j = SRP groups), patient specific effect, b_k ($k = 1,..,p$ with p number of patients), and error term, ϵ_{ijk}. Whereas t_i and m_j were fixed, design specific model variables, b_k and ϵ_{ijk}, are assumed to be normally distributed random variables, i.e., $b_k \sim N(0,\sigma_b^2)$ and $\epsilon_{ijk} \sim N(0,\sigma^2)$. Effect sizes and standard errors within these models were calculated using the maximum likelihood method. The significance of fixed effects were determined using F tests and significance of specific contrast between effect levels using *t* tests. Different models were compared in respect of their ability to explain the observed data set using likelihood-ratio tests. Test results with a *P* value smaller than a given type-1 error level of $\alpha = 0.05$ were denoted as statistically significant.[34] The clinical bleeding indices and suppuration were analyzed between T_0 and T_7 to T_{180} according to the McNemar test. Comparison between the oscillating device and the three control groups was performed by means of a Mann-Whitney U test. For multiple comparisons of different time points, the alpha level of 0.05 was adjusted using the Bonferroni correction. The changes in microflora were analyzed using the Wilcoxon test followed by the Mann-Whitney U test.

RESULTS

In Vitro

Figure 2 shows representative scanning electron micrographs of cross-sections of, subsequently, the oscillating device, ultrasonic scaling, and hand scaling.

Vector, Duerr Dental.
*** Satelec-ProphyMax.
††† Gracey, Hu-Friedy Europe.
‡‡‡ Pulse Master 1000, AD-Technologies, San Carlos, CA.

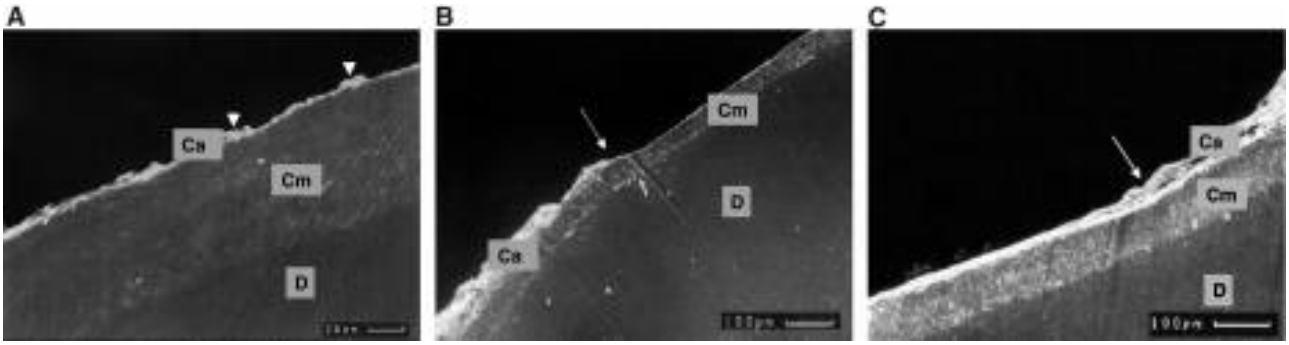

Figure 2.
*SEM of cross-sections of roots instrumented with the three SRP techniques. **A)** The effect of the oscillating device. The arrowheads indicate microscopic remnants of calculus (Ca) between an inorganic smear layer. Cm indicates the cementum with the deeper underlying dentin (D). In **B**, the arrow indicates the border between the treated and untreated root surface. Note the smooth clean appearance of the slightly reduced cementum (Cm). The arrow in **C** indicates the border between the experimental and control site with the presence of Ca. The effect of hand scaling has produced a smooth cementum surface.*

Micromorphological analysis revealed that the thickness of calculus in the untreated areas varied between 40 and 200 μm (mean = 112 ± 52 μm), without significant differences between the three groups. Calculus, though considerably reduced in thickness, persisted on ~30% of the treated surfaces in the oscillating device group. These remnants of calculus were interspersed by a thin inorganic smear layer (~5 μm thick), which was visible only using SEM (Fig. 2A). Light microscopy demonstrated what was interpreted as burnished hydroxyapatite into the calculus and/or cementum (dark line) of the root (Fig. 3). A statistical analysis determined that significantly more calculus was left behind in the oscillating device group compared to the control groups ($P<0.05$). The cementum layer ranged in thickness between 105 and 190 μm and was less affected by instrumentation using the oscillating device (in the order of 2 μm), followed by hand scaling (20 μm) and ultrasonic scaling (24 μm). This was confirmed by a statistical analysis of the percentage loss of cementum (1% for the oscillating device, 12% for hand scaling, and 15% for ultrasonic scaling) by means of a Mann-Whitney U test, which established that the oscillating device removed significantly less cementum than the HS and US groups ($P<0.05$). Microscopic assessment of the surface topography of the oscillating device group demonstrated the presence of shallow grooves, whereas both hand scaling and ultrasonic scaling produced a medium grooved surface. There was no difference between the groups in tactile smoothness, and no dentin had been exposed (Table 2).

In Vivo

Within each group, there were clinically significant improvements between baseline and each subsequent time period of evaluation (Tables 3 and 4; Fig. 4).

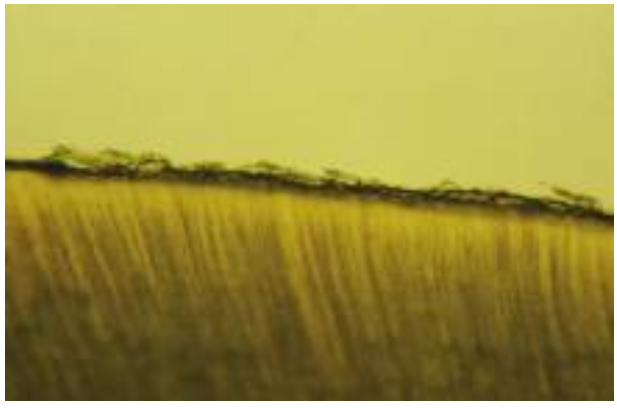

Figure 3.
A light microscope photograph of a cross-section demonstrating the burnishing of hydroxyapatite into the calculus and/or cementum (dark line) of the root.

The mean gain of clinical attachment was in the range of 1.6 to 2.5 mm after 1 month (T_{28}) and 2.4 to 2.9 mm after 6 months (T_{180}). When analyzed as a function of time, a statistical analysis showed a significant higher gain for HS + L ($P<0.001$). The mean probing depth was reduced by 2.0 to 2.7 mm after 1 month and 2.8 to 2.9 mm after 6 months ($P<0.001$).

The linear mixed-effect model for CAL and PD for patient effect (b_k) was 0.23. The gain in CAL of group HS + L was statistically significant and better than the oscillating device group ($P<0.018$; Fig. 4A). No statistical significance could be demonstrated for the PD measurements (Fig. 4B).

All SRP methods resulted in significant improvements of BOP from 90% to 97% at baseline to 10% to 27% at T_{28} and 0% to 3% at T_{180}. Suppuration was reduced in all groups to 0%. The mean patient IPI during the total period of observation ranged from

Table 2.

Root Surface Condition After SRP

Group	Oscillating Device	US	HS
Residual calculus (%)	34 ± 20*	3 ± 5	3 ± 4
Amount of loss of cementum (μm)	2 ± 3*	24 ± 18	20 ± 15
Relative loss of cementum (%)	1 ± 2*	15 ± 11	12 ± 9
Surface topography (SEM)	Shallow	Medium	Medium
Surface smoothness (tactile sense)	Smooth	Smooth	Smooth
Dentin exposure	None	None	None

* Statistically significant differences for the oscillating device versus US and oscillating device versus HS using the Mann-Whitney U test.

3% to 30%, and the PBI was reduced from 27% to 33% (T_0) to 0% to 7% (T_{180}). There were no significant differences between the oscillating device and the three control groups ($P<0.05$; Mann-Whitney U test; Table 4).

Microbiological Data

Of the 11 patients, one had to be excluded from the study because of a technical error.

All groups showed a significant reduction in the total number of bacteria and periodontal pathogens between T_0 and each period of evaluation (T_1 to T_{28}; Table 5). With respect to total bacteria numbers and periodontal pathogens, a patient effect (b_k) of 0.19 was established using the linear mixed-effect model.

A comparison of the reduction in TBN demonstrated that the oscillating device was less effective only when compared to US used with chlorhexidine at T_1 and T_{28} (Table 5).

Mann-Whitney U and Wilcoxon tests were used and generated the following information. The ratios of TBN per millimeter of probing depth were reduced for US with chlorhexidine by 63% ($P=0.013$), oscillating device by 25% ($P=0.285$), and HS by 13% ($P=0.646$) and increased for HS + L by 54% ($P=0.333$) at T_{28}. The difference between US and HS + L was significant ($P=0.029$).

Aa was found in eight patients, *Pi* in nine patients, and *Tf*, *Ec*, *Pg*, and *Td* in all other cases at T_0; however, no eradication of periodontal pathogens was observed.

The ratios of PPN per millimeter of probing depth were reduced for oscillating device by 49% ($P=0.037$), US with chlorhexidine by 22% ($P=0.285$), HS by 37% ($P=0.059$), and HS + L by 56% ($P=0.013$) at T_{28}. No significant differences were found between the groups ($P>0.05$).

DISCUSSION

Over the last few years, new scaling and root planing procedures have emerged aiming at the selective removal of bacterial plaque and the preservation of hard and soft tissues.[23,35] As a result, scaling with curets and/or ultrasonic SRP are now accepted as established standard techniques. The interest for better preservation of root tissues on the one hand and the effective removal of plaque and calculus on the other has led to the development of less aggressive SRP devices and/or techniques. A recently introduced linear oscillating device was aimed at meeting the more gentle approach in the removal of calculus and hard tissues.[24,25,28] This in vitro, clinical, and microbiological study was conducted to assess the merits of this linear oscillating device in comparison to standard (curets and ultrasonic scaling) and other less frequently used SRP methods (laser disinfection and chlorhexidine). The in vitro results regarding calculus

Table 3.

Treatment Effects of SRP

Group	Oscillating Device		US		HS		HS + L	
Parameter	CAL	PD	CAL	PD	CAL	PD	CAL	PD
T_0	5.9 ± 0.9	5.5 ± 0.7	5.8 ± 0.8	5.3 ± 0.7	6.1 ± 1.1	5.6 ± 0.8	6.1 ± 0.8	5.8 ± 0.7
T_7	5.0 ± 1.1	4.3 ± 1.0	4.8 ± 1.1	4.1 ± 0.9	4.7 ± 1.4	4.1 ± 0.8	4.3 ± 1.2	3.9 ± 0.9
T_{28}	4.1 ± 1.3	3.3 ± 1.2	4.2 ± 0.9	3.3 ± 0.7	4.1 ± 1.2	3.3 ± 0.8	3.6 ± 1.0	3.1 ± 0.7
T_{90}	3.6 ± 1.3	2.8 ± 1.0	3.6 ± 0.9	2.8 ± 0.8	3.9 ± 1.3	3.1 ± 0.9	3.4 ± 1.2	3.0 ± 0.8
T_{180}	3.3 ± 1.1	2.6 ± 0.8	3.3 ± 0.7	2.5 ± 0.6	3.6 ± 1.4	2.8 ± 0.9	3.3 ± 1.1	2.9 ± 0.8

The mean values and standard deviation of CAL and PD are expressed in millimeters. For all groups, there was a statistically significant difference between all periods of evaluation and baseline measurements (linear mixed-effect model).

Table 4.

Clinical Effects of SRP

Group	Oscillating Device				US				HS				HS + L			
Parameter	BOP	S	IPI	PBI	BOP	S	IPI	PBI	BOP	S	IPI	PBI	BOP	S	IPI	PBI
T_0	97	10	17	23	97	7	23	27	90	30	23	30	93	3	10	33
T_7	20*	0*	7	0*	13*	0*	7	0*	13*	0*	20	0*	7*	0	10	3*
T_{28}	10*	0*	3	7	20*	0*	20	0*	27*	0*	23	3*	13*	0	17	0*
T_{90}	7*	0*	20	0*	7*	0*	20	0*	7*	0*	3	0*	0*	0	13	0*
T_{180}	3*	0*	7	3*	0*	0*	23	7	3*	0*	30	0*	0*	0	10	3*

Values are given in percentages.
* Statistically significant differences for the four parameters of evaluation when compared to the baseline were established (McNemar test) for BOP and PBI (except for T_{28} for the oscillating device and T_{180} for the US group) and S (except group HS + L) for the four groups. No statistically significant differences were established for IPI ($P > 0.05$). A comparison between the four scaling groups using a Mann-Whitney U test demonstrated no statistically significant differences ($P > 0.05$). There were no significant differences between the oscillating device and control groups.

removal, hard tissue loss, and surface smoothness and topography were in agreement with previously published investigations.[18,22,35-37] With regards to calculus removal and root surface preservation, there was a noticeable difference with the oscillating device. Approximately 30% of the root surface had microscopic remnants of calculus, whereas, as a result thereof, less root surface was removed (Table 2). This contradicts an in vitro report by Naef et al.,[38] who recorded significantly more tooth substance loss with the oscillating device, though with the use of a carbon fiber tip. In this investigation, a metal tip was used. At the time of the experiment, no diamond tip was available for the oscillating device. The use of a metal tip may account for the more conservative removal of calculus and the time involved for complete removal. This easily accounts for the difference in results that has been further confirmed by Kishida et al.[26] This also explains the presence of a smear layer of about 5μm that was seen on the cementum. However, these remnants of calculus were only seen by means of SEM and not with light microscopy. The SEM material contrast analysis was indicative of the presence of an inorganic layer. It is also possible that the effect of the linear oscillation of the device, combined with the hydroxyapatite suspension in water, left burnished hydroxyapatite particles on the root surface (Fig. 3). Based on the clinical results of this study, it is highly unlikely that this smear layer has any clinical relevance.

To reduce the clinical variables as much as possible, only single-rooted teeth were selected. Thus, teeth with furcations and limited access were excluded. Furthermore, only patients with teeth with CAL and PD ≥5 mm were included in the study. Yet, despite all these efforts, the systemic individual patient variability could not entirely be controlled.

Twenty-one of 24 tests (eight parameters per group × three groups) demonstrated no statistically significant difference. The results after 6 months showed that there was no difference in SRP treatment between the oscillating device and control groups. All groups combined experienced a gain in CAL of 2.5 to 2.8 mm and a reduction in PD of 2.5 to 2.9 mm (Table 3). These results were clinically and statistically significant using a linear mixed-effect model statistical analysis determining the variability between patients. Some significant improvements were observed for all clinical parameters (Table 4). BOP and PBI were statistically significant for all four groups ($P < 0.05$), except for T_{28} for the oscillating device and T_{180} for the US group, and S with the exception of group HS + L, whereas no statistical significance was demonstrated for IPI ($P > 0.05$). Furthermore a Mann-Whitney U test demonstrated no statistically significant differences between the four scaling groups at any time interval when compared to the baseline ($P > 0.05$).

Pretreatment supragingival plaque and calculus removal combined with patient compliance during the 6-month duration of the study must have contributed to these favorable results.

Table 5 presents the difference within each group in the percentage of TBN and PPN. A comparison of the reduction in TBN demonstrated that the oscillating device was less effective only when compared to US when used with chlorhexidine at T_1 and T_{28}. It may be hypothesized that the flushing action of the ultrasonic scaling augmented by the disinfection of the chlorhexidine is more effective than the hydroxyapatite suspension of the oscillating device. These results are in agreement with other clinical reports[6,23] but contradict an in vitro report by Schenk et al.[13]

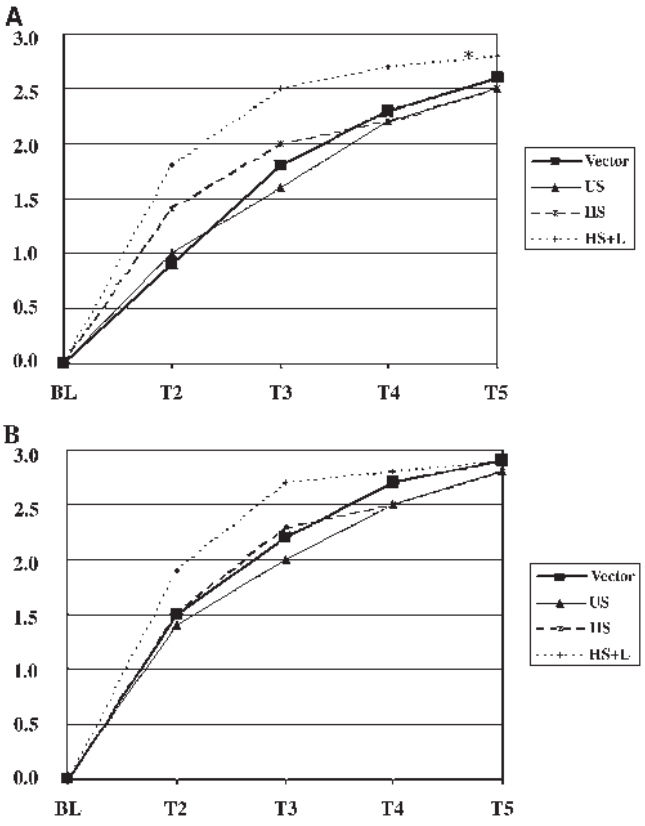

Figure 4.
A) *Graphical representation of the CAL gain from baseline (BL) and the combined postoperative time periods (T_0 to T_{180} [BL to T5]). A comparison of the oscillating device to the three control groups demonstrated a difference only with the HS + L treatment (P <0.05). The graph clearly demonstrates a reduced significance at the end of the study (T_{180}).* ***B)*** *Graphical representation of the reduction in PD from baseline (BL) and the combined postoperative time periods (T_0 to T_{180} [BL to T5]). No statistically significant differences between the oscillating device and control groups could be demonstrated.*

Table 5.

Microbiological Effects of SRP

	Oscillating Device		US		HS		HS + L	
Group	TBN	PPN	TBN	PPN	TBN	PPN	TBN	PPN
T_1	77	79	91	79	84	84	61	87
T_{28}	50	67	79	50	48	63	14	75

The reduction of TBN and the PPN is presented in percentages. There were statistically significant differences in comparison to the baseline count for both the TBN and PPN (P <0.005; linear mixed-effect model).

It appears from the data of this study that the effect of the laser disinfection as an adjunct to hand scaling has no particular beneficial advantages. The American Academy of Periodontology[39] and a study by Miyazaki et al.[40] have reported similar findings expressing the questionable benefits of using lasers in periodontal therapy in that, as an adjunct, laser disinfection did not produce different results in comparison to ultrasonic scaling.

One group in particular, group 4 (HS + L) needs further discussion. It was established that the TBN in ratio to probing depth increased by 54%, and there was a gain in CAL. This can be explained in that the pathogenic bacteria (PPN) were reduced in number over the T_0 to T_{28} period of microbiological evaluation.

In all groups, the measurement of the IPI produced erratic numbers. This variation may be explained because for this measurement, unlike the CAL, PD, BOP, and S parameters, no acrylic splint was used that dictated the exact location of the probe. Although no effort was made to keep an accurate record of the time involved for the treatment of each group, considerably more time was required for the oscillating device.

The oscillating device required as much as four times longer to remove all calculus. There is no clinical data available to support this observation because a comparison to the data of Kishida et al.[26] is invalid as their study was conducted in vitro.

Within the limitations of this study, based on the micromorphological data, the clinical results, and the microbiological findings, the oscillating device, when used with a metal tip, offered an acceptable method for scaling and root planing.

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