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Clinical effects after subgingival polishing with a non-aggressive ultrasonic device in initial therapy

Maren Kahl[1], Eike Haase[1], Thomas Kocher[2] and Andreas Rühling[1]

[1]Department of Periodontology, School of Dentistry, University of Kiel, Kiel, Germany; [2]Unit of Periodontology, School of Dentistry, University of Greifswald, Greifswald, Germany

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***Abstract*:**

Objectives: The Vector® ultrasonic system provides root debridement supported by different abrasive irrigation fluids. The aim of this study was to investigate the clinical outcome of initial therapy with subgingival low-abrasive debridement.

Material and Methods: Twenty patients, who had at least two teeth with pocket depths >5 mm in each quadrant, took part in this prospective randomized clinical study. Patients were treated in a split-mouth design as one test quadrant (1) subgingivally with Vector™ fluid polish (VU-H) and as three control quadrants, (2) with only supragingival polishing (PO-H), (3) with hand instruments (HI-H) performed by a hygienist and (4) with hand instruments (HI-D) performed by a dentist. At baseline, 3 and 6 months after treatment, pocket depths and attachment levels (ALs) were measured and bleeding on probing (BOP) was recorded.

Results: At 6-month evaluation, all groups showed an improvement in clinical parameters. No statistically significant differences in any of the investigated parameters could be observed between the Vector group and the hand scaling groups, or when comparing the results of the two different operators.

Conclusion: This study demonstrates that Vector™ treatment with polishing fluid was able to reduce pocket depths and the prevalence of BOP and improve clinical AL in a similar way as scaling with curettes.

Key words: hand instrumentation; initial therapy; non-aggressive debridement; ultrasonic therapy

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Clinical studies support the need to follow a standardized plan when treating periodontal disease including initial therapy, a corrective surgical phase and an individualized maintenance programme. The quality and success of the initial treatment influences the extent of surgery that is needed to treat residual pockets. Besides oral hygiene instructions, initial therapy should contain a thorough professional root debridement to eliminate the inflammation.

For mechanical debridement, hand instruments are the gold standard (Breininger et al. 1987, Copoulus et al. 1993, Anderson et al. 1996). Newer ultrasonic systems with more refined inserts offer better access to deeper pockets (Tunkel et al. 2002). Compared with hand instruments, the advantages of subgingival debridement with ultrasonic systems are a shorter time requirement, and a more thorough cleaning effect in furcations (Leon & Vogel 1987, Oda & Ishikawa 1989, Kocher et al. 1996a). In order to prevent pulpal and periodontal tissue injury, a systematic use of these devices is imperative, to compensate a reduced tactility (Meyer & Lie 1977), to avoid uncontrolled heat development (Kocher & Plagmann 1996b, Nicoll & Peters 1998) and to maintain exact alignment of the device on the root surface.

The Vector™-ultrasonic system (Dürr-Dental Bietigheim-Bissingen, Germany) (Hahn 2000) generates ultrasonic oscillations at a frequency of 25 kHz. These are converted by a resonating ring, so that a horizontal oscillation pattern is deflected vertically. Therefore, the instrument tip moves parallel to the tooth surface. Addition of hydroxlyapatite particles to the irrigation suspension (Vector™ fluid polish) is supposed to remove subgingival deposits and polish the root surface by hydrodynamic forces. The Vector™ abrasive fluid allows a more aggressive treatment of the root cementum.

In vitro, the straight metal probe of the vector unit (VU) was determined to be the least efficient of the inserts for calculus removal (Braun et al. 2005b). Root debridement with the straight metal probe and polishing fluid resulted in a less effective removal of calculus,

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The authors declare that they have no conflict of interest.

but preservation of more tooth substance than the conventional ultrasonic system (Hartschen & Frentzen 2002). Higher efficacy in the removal of calculus as well as root substance for VU and hand instruments was found when using abrasive fluid rather than using polishing fluid or a conventional ultrasonic system by Braun et al. (2005a, b).

Sculean et al. (2004) demonstrated in a clinical trial that clinical parameters, such as bleeding on probing (BOP), probing depth and attachment level (AL), could be improved by non-surgical pocket therapy with VU in a manner similar to that obtained by non-surgical therapy with hand instruments. In the study of Schwarz et al. (2006), VU in combination with Vector™ fluid polish enabled more effective removal of calculus and a predictable root surface preservation in vivo compared with hand instruments.

In the study of Braun et al. (2006), the in vitro efficacy of hand instruments was statistically higher compared with the conventional ultrasonic system and the Vector system with no difference between the polishing and abrasive fluid. The in vivo reduction of periopathogenic bacteria was similar. As the Vector debridement seems to be less painful (Braun et al. 2003, 2006, Hoffman et al. 2005, Kocher et al. 2005) it could be a useful complement in the armentarium of the operator.

However, only little published data are available pertaining to studies that examined clinical outcome variables after root debridement with VU. The aim of this study was to assess the clinical effects of subgingival polishing with Vector™ fluid polish compared with supragingival polishing or subgingival root debridement with conventional hand instruments.

Material and Methods

Patients

In this prospective randomized clinical trial in split-mouth-design, 20 patients between 35 and 65 years [mean age 47 ± 9 years, eight male (four smokers) and 12 female (four smokers)] with moderate to advanced chronical periodontal disease were included; no drop-out occurred. They were recruited from the Department of Periodontology, School of Dentistry, Kiel. The patients had to have at least two single-rooted teeth with a pocket depth (PD) between 5 and 8 mm in each quadrant. The upper and lower molars were excluded due to the difficult comparability of their anatomy. Patients with any of the following conditions were excluded from the study: systemic disease, use of systemic antibiotics in the previous 6 months, periodontal therapy in the previous 2 years and endodontic problems in the examined teeth. The protocol of the study was approved by the Ethics Committee of the Ernst-Moritz-Arndt University of Greifswald. Patients gave their informed consent after the study was carefully explained to them.

Clinical protocol

The patients underwent a baseline examination including oral hygiene status, gingival conditions, clinical probing depth and an assessment of relative AL. Following the baseline examination, each patient was given oral hygiene instructions. Visible supragingival calculus was removed with a Cavitron™ ultrasonic scaler (Dentsply De Trey; Konstanz, Germany), and supragingival plaque was removed by polishing with a rubber cup (REF 203.4 Gummikelche; Becht, Offenburg, Germany) and pumice (Tri Fluor O Clean; Kerr Hawe, Bioggio, Switzerland). A plaque index was assessed at baseline to ensure a high level of oral hygiene. At baseline, the patients had a mean plaque level of 18%.

In a split-mouth protocol, treatment was sequenced quadrant-wise at a weekly interval and was performed by two operators: a dentist (D) and a hygienist (H). Each patient's four dental quadrants were randomized by drawing a lot and the allocation to receive one of the following treatment modalities was enrolled by the senior author who was not involved in the treatment: (1) treatment with the Vector™-ultrasonic-device (VU-H), and as three control groups, (2) scaling and root planing with Gracey-curettes (American Eagle; Missoula MT, USA) (HI-H) and (3) scaling and root planing with Gracey-curettes (HI-D) and (4) supragingival polishing alone (PO-H) without additional subgingival treatment. Subgingival debridement was performed under local anaesthesia.

The VU-H, HI-H and HI-P treatment was performed by a well-trained hygienist with several years of experience in root debridement with hand instruments and conventional ultrasonic scalers. Before the use of the Vector™, the hygienist received theoretic instructions for the treatment and performed practical exercises with the Vector system. As one positive control, one quadrant in each patient was treated with hand instruments by an experienced dentist.

The VU device was used with a straight Vector probe and the Vector curette insert in combination with a polishing fluid (Vector™ fluid polish) containing hydroxlyapatite particles ($< 10\,\mu$m). According to the instructions given by the manufacturer, the power setting was set to 70%. Treatment time per tooth was limited to 6 min. and the end of the treatment was defined at the operator's own discretion. This point was reached when the operator felt that the root surface of each tooth was clean. The operator used an explorer (Hu Friedy, Chicago, IL, USA) to assess the quality of the root surface.

A supragingival professional tooth cleaning with re-motivation and re-instruction of oral hygiene was performed at the 3- and 6-month examinations.

Clinical measurements

At baseline, 3 and 6 months after therapy, duplicate measurements of the probing depth (PD) and the relative AL were taken with a computerized probe (Florida Probe Corporation, Gainsville, FL, USA) at six sites per tooth (mesio-, mid- and distobuccal, mesio-, mid- and distolingual) by an operator experienced in the use of the probe. He was blinded with regard to the treatment modalities. The relative AL was measured with the disc-probe insert taking cusp peaks or incisal edges as the reference point. The duplicated measurements were averaged. Deviations in the values exceeding 0.5 mm were verified by a third measurement. If three measurements had to be conducted, the one with the highest deviation was excluded. BOP was determined simultaneously with the first pocket measurements. If bleeding was noted within 30 s following probing, a positive score was noted. The proportion of bleeding sites out of the total number of examined sites was calculated.

Statistical analysis

The power calculation revealed that when the sample size is 9, there is 80% power to detect a difference in means of 0.40. Additional analyses were performed in order to assess upper limits

for sample size varying standard deviation between 0.50 and 1.00 and variance of means between 0.15 (e.g. means of 1.50, 1.75, 2.20 and 2.50) and 0.40. We decided to examine 20 subjects at baseline because in the worst case with a standard deviation of 1.00 and a small variance of means of 0.15, the required sample size is 20. The primary outcome variable was the change of the relative AL at baseline *versus* at 6 months.

Based on the initial PD, three categories were created for each patient: shallow sites with a PD value <3 mm, moderate sites with 3.0–5.9 mm and deep sites with 6–8 mm. The frequency distribution of these categories in the four treatment groups is shown in Fig. 1.

All data were subdivided by category of severity and by treatment groups. Within the categories means and standard deviations of PD and relative AL at baseline, 3 and 6 months after treatment, and the changes in PD and relative AL were calculated for each patient. The patient served as the unit of analysis. Analyses of variance (ANOVA) were performed for the change of the parameters. If significant differences were observed, Scheffe's procedure for pair-wise comparisons was carried out.

As the values for the BOP were not normally distributed, a Friedman test was used to detect significant differences among the treatment groups. If statistically significant differences were observed, a Wilcoxon test was carried out to detect the source of these differences. A significance level of $p<0.05$ was assumed for all analyses (Statview 5.0 SAS, CA, USA).

Results

PD frequency distribution (Fig. 1)

The percentage distribution of the examined sites, grouped according to the initial probing depth into three categories, is shown in Fig. 1. An average of 39% of all pockets were <3 mm at baseline examination. Probing depths 3–5.9 mm made up for 49% of all sites and 12% of the sites were 6–8 mm deep.

The frequency of sites >3 mm increased after 6 months to almost 70% in the three subgingival-treated groups, while the supragingival-treated group achieved only 54%. The probing depth in the 3–5.9 mm category decreased in the Vector™ and in the hand instrument-treated groups to approximately 29% and to 41% in the supragingival polished group. Deep pockets were reduced to 5% in the supragingival polished group and to an average of 2% in the three subgingival-treated groups.

Bleeding on probing (Fig. 2)

At baseline examination, about 60% of all investigated sites were BOP-positive in all treatment groups, which showed no statistical differences among each other. Within a period of 6 months, the BOP improved significantly in all groups, compared with the baseline examination. Within the first 3 months after subgingival instrumentation (VU-H, HI-H, HI-D), the percentage of BOP-positive sites decreased from 20% to 30%. During the next 3 months, the BOP of these groups only changed slightly from 14% to 25%. No significant differences were found between the subgingivally debrided groups (VU-H test group HI-H and HI-D control group). Sites treated by PO-H had significantly more bleeding after 6 months than sites treated by HI-H, HI-D, and the bleeding prevalence decreased from 61% at baseline to 47% at the first re-examination and declined to 35% after 6 months.

Probing pocket depth (Figs 3 and 4)

In initial shallow pockets (<3 mm), no changes in PD and relative AL were found; these results are therefore not shown.

In the VU-H group, sites with 3–5.9 mm initial probing depths showed a 1.2 mm reduction; in the HI-H and HI-D

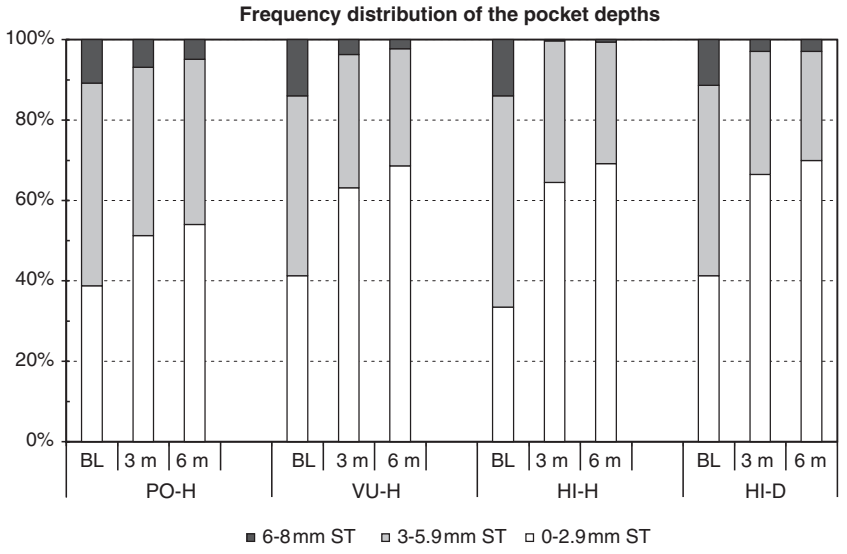

Fig. 1. Frequency distribution of the pocket depths.

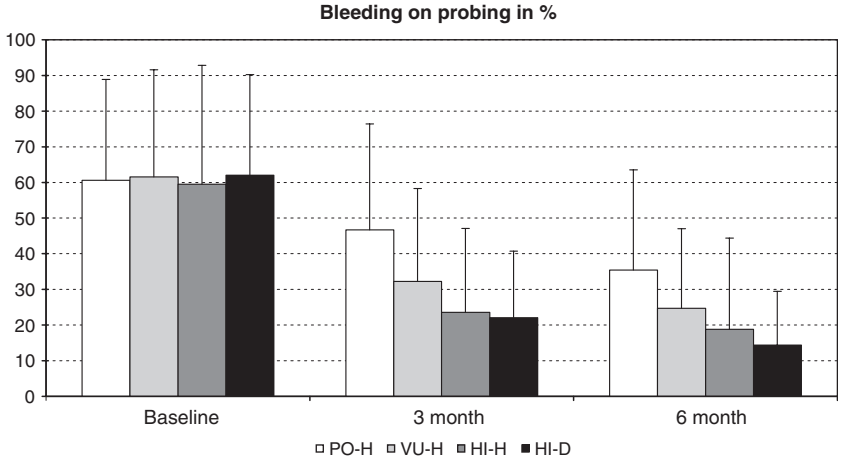

Fig. 2. Bleeding on probing in percentage.

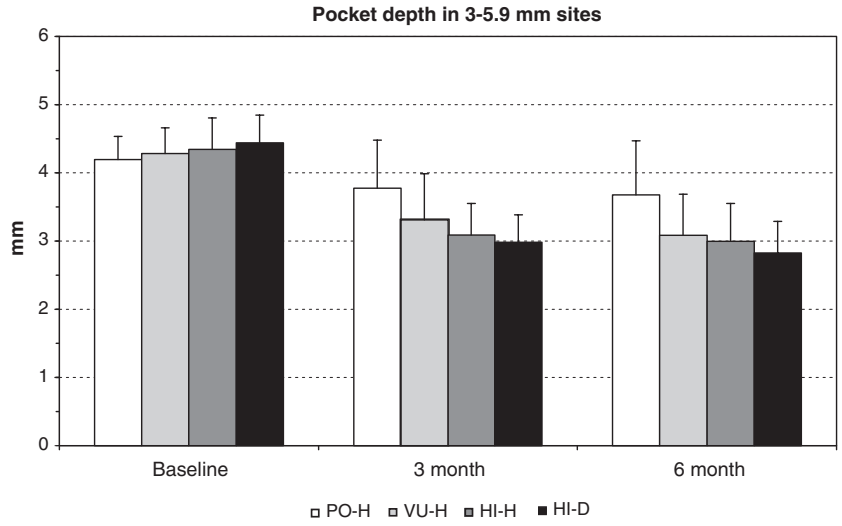

Fig. 3. Pocket depth in 3–5.9 mm sites.

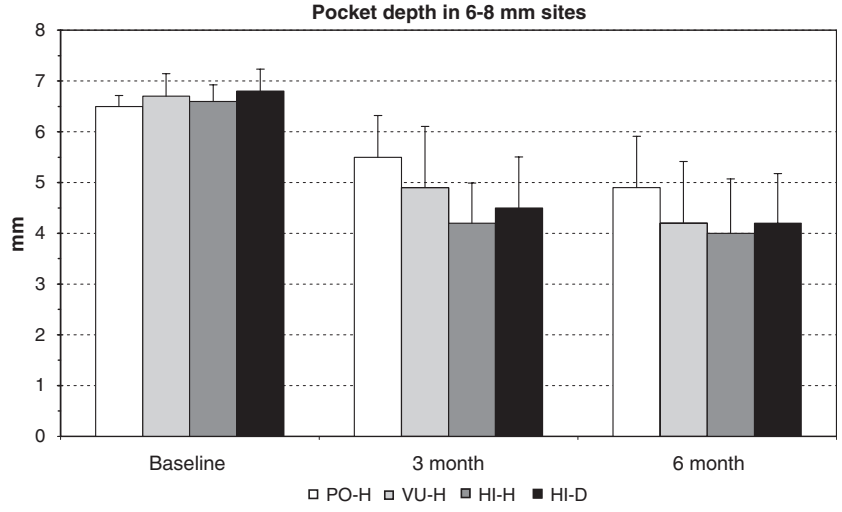

Fig. 4. Pocket depth in 6–8 mm sites.

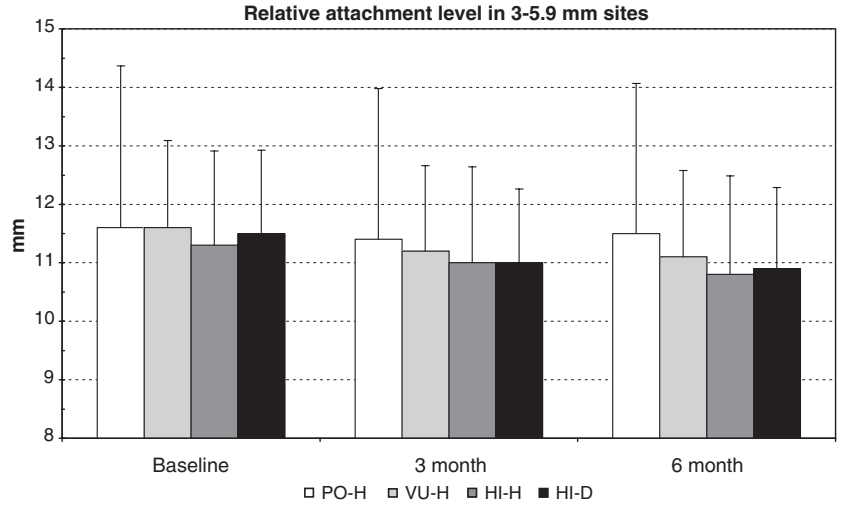

Fig. 5. Relative attachment level in 3–5.9 mm sites.

control group PD decreased 1.3 and 1.6 mm over the 6-month observation period. Changes in PD from the 3- to the 6-month examination were only slight (0.1–0.2 mm). In the PO-H control group, the change of PD was 0.4 mm from baseline to the 3-month and 0.5 mm to the 6-month examination. The mean reduction of pocket depth in this category was significantly higher for the VU-H, HI-H and HI-D groups in comparison with the PO-H group from baseline to the 3- and 6-month examination.

In initial deep pockets, the change of PD increased in VU-H from 1.8 mm during the first 3–2.5 mm after 6 months. The HI-H and HI-D control groups showed a reduction of PD 2.4 and 2.2 mm from baseline to the 3-month examination and 2.6 and 2.5 mm from baseline to the final examination.

In the PO-H control group, PD was reduced 0.9 mm during the first observation interval and 1.5 mm during the entire observation period. The HI-H and HI-D control groups showed a significantly greater reduction in PD from baseline to the 3-month examination than the PO-H control group.

No statistical differences were found between sites treated by VU-H, HI-H and HI-D. The mean PD reductions were higher in sites with deep initial probing depth than in sites with moderate pocket depth.

Relative AL (Figs 5 and 6)

Moderate sites (initial PD 3–5.9 mm) gained 0.5 mm in the VU-H and HI-H group and 0.6 mm in the HI-D group during the entire observation period. Within the second observation interval, the gain of attachment was 0.1 mm in the VU-H and HI-D groups and 0.2 mm in the HI-H group. Moderate sites treated by supragingival polishing showed a slight gain of attachment (0.2 mm) after the first 3 months, which was partially lost during the subsequent 3 months ($p < 0.05$ PO-H *versus* HI-D at the 3-month evaluation). The difference between the PO-H and HI-D group in moderate pockets at final examination was significant.

At deep sites (initial PD 6–8 mm), the gain of the relative AL amounted to 0.7 mm in the VU-H group, 1.2 mm in the HI-H and 0.9 mm in the HI-D group 6 months after treatment. The amount of the attachment gain during the first

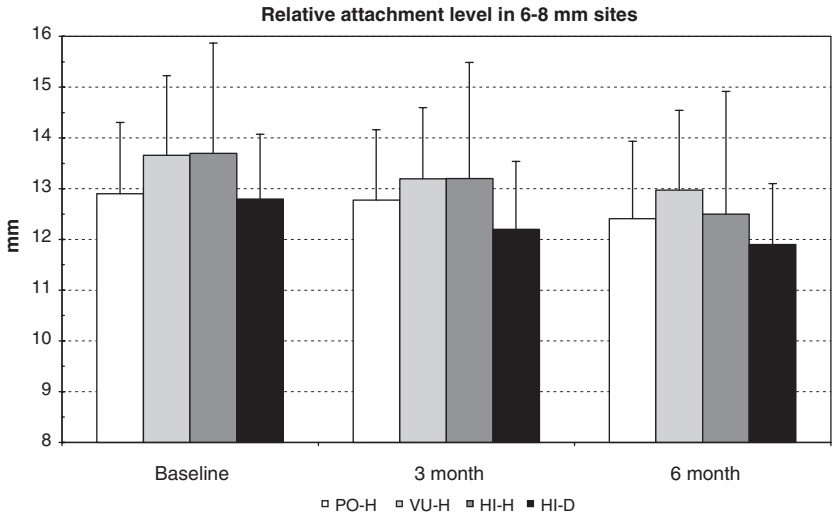

Fig. 6. Relative attachment level in 6–8 mm sites.

observation period in deep pockets is similar to the gain in moderate deep pockets within the first period. At the 6-month examination, initially deep pockets showed a greater gain in relative AL than moderate pockets.

Sites treated by PO-H showed a slight gain of 0.1 mm per observation period. In the deep pocket category, no significant differences among the groups were found.

Discussion

In the present study, the clinical effects of subgingival polishing with the Vector™ ultrasonic system (VU) were evaluated in a quadrant-wise sequenced treatment protocol. Before subgingival treatment, patients received oral hygiene instructions and supragingival professional cleaning. A plaque index was assessed at baseline to ensure a high level of oral hygiene. Following the subgingival treatment protocol, supragingival professional tooth cleaning with oral hygiene instruction was repeated at the 3- and 6-month examination.

One quadrant in each patient received as a test quadrant a Vector™ treatment by a hygienist (VU-H). Three quadrants served as controls: (1) subgingival debridement with hand instruments (HI-H) by a hygienist (positive control), (2) supragingival polishing (PO-H) performed by a hygienist (negative control) and (3) subgingival debridement with hand instruments performed by a dentist (HI-D, positive control). No complications such as abscesses were observed throughout the study period.

Our study demonstrates that subgingival root debridement with the VU device leads to clinical improvements in PD reduction, reduction in BOP and gain of clinical attachment, which are similar to those achieved by root debridement with hand instruments. Although no statistical differences could be observed in any of the investigated parameters between instrumentation with the VU and hand instruments, a tendency towards a smaller reduction in BOP and a smaller gain of attachment in initial deep pockets was noted after treatment with the VU device.

Periodontal healing following instrumentation with ultrasonic devices or sonic scalers *versus* hand instruments was found to be similar in many studies (for a review, see Tunkel et al. 2002). But on comparing the VU device with conventional ultrasonic scalers, one has to consider the different working principle of the VU: vertical oscillations, parallel to the root surface, lead to a minor mechanical effect of the working tip, which is supposed to be compensated by the addition of an abrasive medium to the irrigation fluid. Kocher et al. (2005) demonstrated in a trial on maintenance patients that a biofilm could be removed with the Vector™ device as well as with conventional ultrasonic instruments. However, in vitro studies indicated that on the other hand the VU in conjunction with the polishing fluid is less effective in calculus removal than conventional ultrasonic systems or hand instruments (Braun et al. 2005b); otherwise, it provides a more root substance-saving debridement than conventional instrumentation (Braun et al. 2005a). In all probability, in the VU group, more ''debrided'' calculus was left on the root surface after instrumentation and the question is: does residual, but ''debrided'' calculus impede clinical healing?

In the present study, the frequency of sites (Fig. 1) with probing depths <3 mm had increased from an average of 39% to almost 70% during the 6-month period. Sites with initially moderate probing depths (3–5.9 mm) were reduced from 49% to 32%, and deep sites (6–8 mm) decreased from 12% to 3%. These values are similar to those reported by other studies (Westfeld et al. 1985, Hämmerle et al. 1991).

In our study, the VU debridement caused within the 6-month observation period a 1.2 mm PD reduction in moderately deep and 2.5 mm in deep sites with an attachment gain of 0.5 and 0.7 mm, respectively. Sculean et al. (2004) reported similar results with 0.6 mm in moderately deep pockets and 0.5 mm in deep pockets 6 months after VU debridement. However, the mean change in PD was merely 0.8 mm in initial moderately deep sites and 0.6 mm for deep sites.

Root debridement with hand instruments (HI-H, HI-D) resulted in a PD reduction to 1.5 and 2.6 mm in moderate and deep pockets, respectively, and the gain of attachment was found to be 0.5 and 1.0 mm. This clinical outcome is in agreement with the results summarized by Cobb (1996), who reported a probing depth reduction for moderate deep sites of 1.29 and 2.16 mm for deep sites and a gain of attachment of 0.55 and 1.19 mm, respectively. Hung & Douglass (2002) reported in a meta-analysis for initial medium and deep probing depths a PD reduction of about 1 and 2 mm, respectively, and a gain of attachment of about 0.5 mm and slightly more than 1 mm, following scaling and root planing.

Even sites that received supragingival polishing alone showed improvements in the clinical outcome variables. The PD reduction is predominantly due to gingival recession, as the gain of attachment is rather negligible. However, compared with the clinical changes caused by subgingival therapy, the extent of these changes was small. Several studies comparing supragingival therapy with other therapies involving subgingival treatment have reported

similar results (Cercek et al. 1983, Kaldahl et al. 1996, Kocher et al. 2001).

In our study, the VU-H, HI-H and HI-P treatment was performed by a well-trained hygienist and as a control, one quadrant in each patient was treated with hand instruments by an experienced dentist, but an impact of different operators on the clinical outcome could not be proven. Badersten et al. (1985) reported that dental hygienists were as effective as dentists in removing subgingival deposits. Kocher et al. (1997a, b) stated in dummy-head trials that the degree of experience of the operator had an impact on the efficacy of root debridement, regardless of the instrument used.

In a dummy-head trial (Rühling et al. 2002), we assessed how effectively untrained operators were able to learn scaling with curettes and a power-driven curette. Operators reached a plateau in the learning curve (effectivity 84.7%, 81.3% respectively). Scaling time was always between 3 and 4 min. and did not differ between the two groups. In the present study we increased the treatment time to a maximum of 6 min. and in all cases this time was sufficient until the operator felt that the root surface was smooth. König et al. (2002) demonstrated that there was also an impact of operator motivation on the efficacy of root debridement.

However, while performing a study, it is possible that even an experienced operator will have different learning levels on different instruments that were to be compared. In the present study, before the trial, the hygienist received theoretic instructions for the treatment with the Vector system, and performed practical exercises but it cannot be ruled out that the efficacy of root debridement with the VU system may be further improved by developing a training programme that is aimed specifically at this instrument, such as introduced by Rühling et al. (2002). Schwarz et al. (2006) reported that in vivo the highest values of residual calculus were observed after scaling and root planing (SRP) with hand instruments. The SRP control group showed about five times more residual calculus compared with the VU system. It is beyond question that root debridement was performed by an experienced operator and it is quite within the limits of probability that even in our clinical study, complete removal could not be achieved. However, within the limits of our study, the clinical results have shown that Vector™ treatment in combination with polish fluid was able to reduce pocket depths and the prevalence of BOP and improve clinical AL in a similar way as hand scaling with curettes.

The VU system probably enables a less aggressive root debridement with preservation of root cementum (Schwarz et al. 2006). Former studies have shown that bacterial endotoxins are only superficially located on the root surface and can be removed by gentle methods without removing root substance (Nakib et al. 1982, Hughes & Smales 1986, Hughes et al. 1988, Smart et al. 1990) but there are no studies available on the removal of endotoxins with the Vector™ device. The assumption that superficial cleaning will lead to a satisfactory healing was re-inforced by Nyman et al. (1988) in a clinical study on patients with periodontal disease.

New methods for root debridement that sparsely affect the hard tooth tissue have been evaluated and proved to be sufficient in reducing inflammation during initial or supportive therapy (Gmür et al. 1994, Bardet et al. 1999, Kocher et al. 2000, 2001). However, further investigations should assess whether the healing results after non-aggressive treatment with the Vector™ device remain stable in the long term.

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Address:
Maren Kahl
Department of Periodontology, Dental School
Christian-Albrechts-Universität zu Kiel
Arnold-Heller-Str. 16
24105 Kiel
Germany
E-mail: kahl@konspar.uni-kiel.de

Clinical Relevance

Scientific rationale for the study: The Vector® system probably enables a less aggressive root debridement with preservation of root cementum. The aim of the study was to investigate the clinical outcome of subgingival treatment compared with root debridement with conventional hand instruments or supragingival polishing.

Principal findings: We found that pocket depth reduction, decrease of BOP and clinical attachment gain were similar compared with curettes.

Practical implications: Within the limits of the study our results support previous findings that Vector™ treatment is effective as initial therapy.