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Subgingival debridement of periodontal pockets by air polishing in comparison with ultrasonic instrumentation during maintenance therapy

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Abstract

Aim: The objective was to determine clinical and microbiological effects and perceived treatment discomfort of root debridement by subgingival air polishing compared with ultrasonic instrumentation during supportive periodontal therapy (SPT).

Material and methods: The trial was conducted as a split-mouth designed study of 2-month duration including 20 recall patients previously treated for chronic periodontitis. Sites with probing pocket depth (PPD) of 5–8 mm and bleeding on probing (BoP+) in two quadrants were randomly assigned to subgingival debridement by (i) glycine powder/air polishing applied with a specially designed nozzle or (ii) ultrasonic instrumentation. Clinical variables were recorded at baseline, 14 and 60 days post-treatment. Primary clinical efficacy variable was PPD reduction. Microbiological analysis of subgingival samples was performed immediately before and after debridement, 2 and 14 days post-treatment.

Results: Both treatment procedures resulted in significant reductions of periodontitis-associated bacterial species immediately and 2 days after treatment, and in significant reduction in BoP, PPD and relative attachment level at 2 months. There were no statistically significant differences between the treatment procedures at any of the examinations intervals. Perceived treatment discomfort was lower for air polishing than ultrasonic debridement.

Conclusion: This short-term study revealed no pertinent differences in clinical or microbiological outcomes between subgingival air polishing and ultrasonic debridement of moderate deep pockets in SPT patients.

Key words: air-abrasive; chronic periodontitis; non-surgical; periodontal treatment

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Conflict of interest and source of funding statement

The authors declare that they have no conflict of interest.

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Because of the bacteriological aetiology of periodontal disease it is of paramount importance to maintain adequate infection control after active treatment of the disease. Thus, the patient is commonly recalled with a 3–4 months interval for supportive periodontal therapy (SPT) including (i) repeated mechanical instrumentation for elimination/suppression of the subgingival microflora at sites showing remaining or recurrent clinical signs of pathology and (ii) reinforcement of self-performed supragingival infection control (Lang et al. 2008). Frequently repeated mechanical instrumentation, however, may cause cumu-

lated damage of the root surfaces (Zappa et al. 1991, Schmidlin et al. 2001), and the use of treatment modalities effective in removing biofilm but causing minimal abrasion of the root surface would be preferable during SPT.

Subgingival air polishing (for review see Petersilka 2011) has been suggested as a treatment approach for root debridement. In a series of studies Petersilka et al. (2003a, b, c, d) demonstrated that air polishing with a low abrasive amino acid glycine powder effectively removed biofilm on the root surface, and that the tested powder caused significantly less root surface abrasion than the earlier commonly used sodium bicarbonate powder (Berkstein et al. 1987, Kontturi-Narhi et al. 1990, Agger et al. 2001). The authors also demonstrated that air polishing with glycine powder applied supragingivally for 5 s in a direction towards the orifice of pockets with 3–5 mm in depth resulted in a statistically significantly greater reduction of subgingival bacterial counts than pocket/root debridement with hand instruments (Petersilka et al. 2003c, d). In a subsequent publication by the same research group (Flemmig et al. 2007) it was shown that with the use of this application method of powder/air polishing a median debridement depth of 2 mm was achieved and that at sites with a clinical probing pocket depth (PPD) of $\sim$4 mm about 60% of the root surface was cleaned, while in deeper pockets the efficacy of root debridement decreased to about 40%.

In a recent publication by Moëne et al. (2010) a new air-polishing device was described by which the glycine powder/air spry was delivered within the pocket (Fig. 1), but with the jet directed perpendicularly to the root surface. In addition, with the use of this specially designed nozzle the effective working pressure was reduced compared with that of supragingivally applied air polishing. The authors reported from a 7-day clinical trial involving SPT subjects with pockets $\geqslant$5 mm that subgingival glycine powder/air polishing with the new device was safe, perceived to be more acceptable by the patients, and was more time efficient than mechanical debridement with hand instruments. Furthermore, on a microbiological level there were no differences between the two approaches for root debridement.

Whether the deplaqueing and microbiological effects of glycine powder/air polishing reported in the studies referred to above are of clinical significance needs to be validated by clinical assessments. The objective of this investigation involving subjects on SPT was therefore to determine (i) clinical and microbiological effects and (ii) perceived treatment discomfort of subgingival debridement by airflow polishing with a low abrasive amino acid glycine powder compared with ultrasonic instrumentation.

Material and Methods

This trial was conducted as a split-mouth study of 2 months duration. Approval of the study protocol by the Ethics Committee at University of Gothenburg (Dnr 749-08) was obtained and all participating subjects provided informed consent before the start of the study.

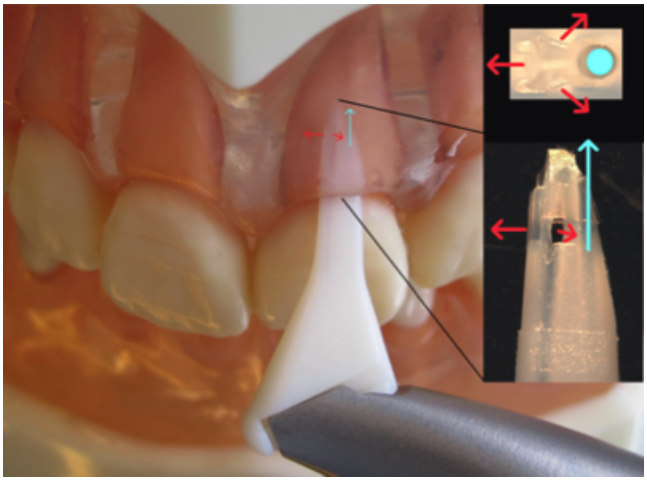

Fig. 1. Mode of application for subgingival air polishing debridement with the specially designed nozzle.

Participants

Patients treated for moderate-advanced chronic periodontitis and involved in an SPT programme at the Department of Periodontology, Sahlgrenska Academy at University of Gothenburg, Sweden, were invited for the study that was conducted between August 2009 and June 2010. The patients were eligible if meeting the following inclusion criteria:

- Two periodontal sites in each of two jaw quadrants with PPD of 5–8 mm and bleeding following probing. The pockets should not be located at furcation sites.
- No antibiotic therapy or subgingival treatment within 3 months preceding the start of the trial.
- No ongoing drug therapy that might affect the clinical signs and symptoms of periodontitis and no requirement for prophylactic antibiotic coverage during treatment.

The following criteria excluded subjects from participating:

- Diabetes mellitus, cancer, HIV, disorders that compromise wound healing, chronic high dose steroid therapy, bone metabolic diseases, radiation or immune-suppressive therapy.
- Pregnancy.
- Acute infectious oral lesions.

Following a screening examination, the patients were subjected to reinforcement of self-performed mechanical tooth cleaning and professional supragingival tooth cleaning with a rubber cup and a low-abrasive polishing paste. The study was initiated 1 week after the screening examination.

Interventions

Test treatment comprised pocket/root debridement with the use of a low abrasive amino acid glycine powder (Air-Flow® Perio Powder, EMS, Nyon, Switzerland) applied by the use of Perio-Flow® hand-piece connected to an airflow unit (Air-Flow Master®, EMS). The settings for water and powder were approximately 75% of the maximum scale, and the powder chamber was filled to the indicated maximum

level before each treatment to ensure reproducible conditions. A specially designed nozzle for *subgingival* application (Perio-Flow® Nozzle, EMS) was used that directed the powder/air jet mainly towards the root surface while the water exited at the tip of the nozzle (Fig. 1). Each periodontal pocket was debrided for 2 × 5 s. Before the start of the trial, the dental hygienist performing the treatment procedures was specially trained in proper use of the airflow device.

The periodontal sites assigned to the control treatment were debrided for 30 s using a piezoceramic ultrasonic device (EMS Piezon Master® 400, PerioSlim tip, EMS) with power set to 75% and water as coolant.

Study outline

After a *baseline* microbiological and clinical examination, the patients were given repeated instruction in proper supragingival plaque control measures at the investigational sites. The investigational sites were then debrided according to the randomization protocol. Both test and control sites were treated at the same visit. Local anaesthesia was not used. After completed treatment, subgingival plaque samples were again collected from both test and control pockets. Mouthrinsing with a 0.1% chorhexidine solution twice daily for 1 min. during 14 days post-treatment was prescribed.

The patients were recalled for repeated microbiological sampling 2 days post-treatment. Clinical and microbiological examinations were repeated at day 14. The study was terminated with a clinical re-examination at day 60. Following the completion of the study, the patients were reassigned to the previously used recall intervals for SPT.

Outcomes

Primary clinical efficacy variable was PPD reduction. Changes in relative attachment level (RAL) and bleeding on probing (BoP) were considered secondary outcomes. The number of ''closed pockets'' (PPD $\leqslant$ 4 mm and BoP −) as an endpoint of treatment success (Wennström et al. 2005) was evaluated for descriptive interpretation. Plaque and marginal gingival bleeding (MGB) scores were considered descriptors of the patients' standard of self-performed infection control.

Clinical assessments

At the baseline examination before treatment, as well as at the 14- and 60-day follow-up examinations, the investigational sites were examined with respect to the following variables:

- *Oral hygiene status* – presence/absence of plaque at the soft tissue margin.
- *MGB* – presence/absence of bleeding following angulated probing of the gingival sulcus.
- *PPD* – measured with a manual Hu-Friedy PCP15 periodontal probe (Hu-Friedy Inc., Leimen, Germany) to the closest lower millimetre.
- *RAL* – probing depth assessed from a fixed reference point on the tooth (cemento-enamel junction or the border of a restoration).
- *BoP* – presence/absence of bleeding within 15 s following pocket probing.

One examiner, who was not involved in the treatment of the patients, performed the assessments at all time intervals. Before the start of the trial, the examiner had to prove his consistency in a pre-study calibration trial; a standard deviation for repeated PPD measurements of <0.6 mm and a reproducibility of 95% within $\pm$ 1 mm. Corresponding values for RAL were set to <0.8 mm and 90%.

Microbiological assessments

Sampling of the subgingival microbiota at each investigational site was performed by the use of sterile curettes before and immediately after the treatment, at 2 and 14 days post-treatment. Before sampling the supragingival area was cleaned by the use of cotton pellets.

The samples were analysed for the detection of *Porphyromonas gingivalis*, *Prevotella intermedia*, *Prevotella nigrescens*, *Tannerella forsythia Aggregatibacter actinomycetemcomitans*, *Fusobacterium nucleatum*, *Treponema denticola*, *Parvimonas micra*, *Campylobacter rectus*, *Porphyromonas endodontalis*, *Prevotella tannerae* and *Filifactor alocis* using the checkerboard DNA-DNA hybridization technique and with whole genomic probes (Dahlén & Leonhardt 2006). The samples were transferred to a tube containing 100 μl TE buffer (10 mM Tris-HCL, 1 mM EDTA, pH 7.6) and 100 μl 0.5 M NaOH was added and the suspensions boiled for 5 min. After cooling, 800 μl 5 M ammonium acetate was added to each tube and the samples further processed according to standardized procedures. The hybrids formed between the bacterial DNA and the probes were detected by application of an anti-digoxigenin antibody conjugated with alkaline phosphatase and incubation with a chemiluminiscent substrate. Evaluation of the chemiluminiscent signal was performed at a LumiImager™ Workstation by comparing the obtained signals with those of pooled standard samples containing 10^6 or 10^5 of each of the 12 studied microorganisms. The obtained chemiluminiscent units were transformed into a scale of scores from 0 to 5 according to Papapanou et al. (1997), related to the low and high standards, respectively. In addition, the specificity of each bacterial probe was tested against species of the panel. A site was considered positive for the various microorganisms at a concentration $\geqslant 10^5$ (score 2).

Sample size

Based on power calculation for two-tail intra-individual comparison (G*Power 3; Faul et al. 2007), inclusion of 20 patients (considering a risk of 10% drop-out) would allow the detection of a mean difference of 0.5 mm between treatments in PPD change with a study power of 0.80, α error of 0.05 and with a standard deviation of 0.7 mm.

Randomization

After verifying that a patient met the criteria for inclusion, the subject was enrolled in the study and given a case number. A person otherwise not involved in the study performed the randomization of the treatments of investigational pockets by quadrants, using a computer-generated randomization table. The randomization code for the patient number was available to the operator only to reveal the treatment assignments. Investigational sites in one quadrant were assigned to the test and the sites in the other quadrant to the control treatment. Treatment procedure was in all patients to be initiated in the quadrant with the lowest number. Throughout the study, the randomization code was concealed for the examiner and the statistician.

Adverse events

At the completion of the treatment session the patients scored *degree of treatment discomfort* using a 100 mm visual analog scale (VAS) with ''none'' at the left and ''unbearable'' at the right end as verbal endpoints, and separate for the two treatments. Any adverse events occurring during the treatment procedures were recorded. Furthermore, the patients were interviewed at day 2 regarding any adverse post-treatment events.

Data handling and analysis

The percentage frequency of presence of plaque, MGB and BoP at the various examination intervals were calculated on a site level. For probing assessments (PPD, RAL) mean values were determined for each individual and time interval and then averaged for treatment groups. Proportions of sites within various categories of scoring units were also calculated for data description.

Microbiological data were described with respect to frequency of sites with detectable levels of each of the 12 target microorganisms ($\geqslant 10^5$) and the total sum of detection scores for each of the 12 microorganisms at each examination interval ($n = 40$ samples). The data were also analysed with respect to number of sites positive for one or several of the bacteria belonging to the ''red complex'' (*P. gingivalis*, *T. forsythia* and *T. denticola*) and ''orange complex'' (*P. intermedia*, *P. nigrescens*, *F. nucleatum*, *P. micra* and *C. rectus*) as defined by Socransky et al. (1998).

Statistical analysis was based on intra-individual comparison between the two treatment procedures. Difference in PPD and RAL between the treatment groups was tested by the use of the Student *t*-test. The McNemar test was utilized for statistical analysis of categorical variables. A p-value < 0.05 was considered statistically significant. Data handling and statistical testing were performed with the use of the SPSS 18 software package (SPSS Inc., Chicago, Illinois, USA).

Results

Twenty recall patients, 14 females and six males, with a mean age of 60 years (range 40–71 years) agreed to participate in the study. Fifteen of the subjects were current smokers with a daily consumption varying between 5 and 20 cigarettes. All patients completed the 2-month trial.

Clinical assessments

At baseline both the air polishing and the ultrasonic debridement group showed a plaque frequency of $< 10\%$ at target sites, and the standard of self-performed infection control remained high throughout the observation period, although at the final examination (day 60) the plaque score was somewhat higher in the air polishing (17%) than in the ultrasonic treated group (7%). MGB scores decreased in both treatment groups from approximately 40% at baseline to 10% at the final examination. Both treatment modalities resulted in a significant reduction in BoP (Table 1); from 100% at baseline to 25% for the air polishing and 30% for the ultrasonic treated sites (between treatments $p > 0.05$).

Tables 1 and 2 presents observed alterations in probing assessments. At baseline the mean PPD of at the target sites was 5.8 and 5.7 mm in the air polishing and the ultrasonic treated quadrants, respectively. Eighty-eight to 92% of the pockets had a probing depth of 5–6 mm and 8–12% 7–8 mm. At the final examination (day 60) the mean PPD had decreased to 4.4–4.5 mm in the two treatment groups. A PPD of $\leqslant 4$ mm was found in 23 of 40 sites (58%) in the air polishing and 25 of 40 sites (63%) in the ultrasonic-treated group (Table 2). ''Pocket closure'' (PPD $\leqslant 4$ mm and BoP $-$) was reached in 19 sites (48%) in the air-polishing group compared with 18 (45%) in the ultrasonic treated group.

RAL assessments revealed a mean improvement at day 60 of 0.6 mm in both the air polishing and the ultrasonic treated group. In the ultrasonic treated group an improvement of RAL with $\geqslant 1$ mm was observed at 18 of the sites (45%), while the corresponding figure in the air polishing treated group was 19 (48%) (Table 2). There were no statistically significant differences between the two treatment groups at any of the examination intervals with regard to probing assessments.

Microbiological assessments

Numbers of sites positive for the various microbial species at the different examination time points are given in Table 3. Before treatment the recovery rate varied, depending on microbial species, between 0–26 sites (0–65%) in the air polishing and 0–24 sites (0–60%) in the ultrasonic group. There was a general trend of reduced number of positive sites immediately after both air polishing and ultrasonic debridement, as well as at day 2. At day 14 the recovery rates had returned to figures comparable to those before treatment. As graphically presented in Fig. 2, a similar pattern of only a short-term reduction was evident from the description analysis of the sum of detection scores for each of the 12 microbial species at the various examination intervals. With regard to the proportion of sites positive for one or more of the bacteria belonging to the ''red complex'' or the ''orange complex'', early post-treatment reductions were more marked for the ''red complex'' in both treatment groups (Fig. 3). At baseline as well as at the post-treatment examinations, none of the analyses

Table 1. Frequency (%) of bleeding on probing (BoP) positive sites and mean values (SD) on subject level for probing pocket depth (PPD) at baseline, 14 and 60 days post-treatment and for change in relative attachment level (RAL) at the follow-up examinations

	Ultrasonic debridement	Air polishing debridement	Significance
BoP	($n = 40$)	($n = 40$)	
Baseline	100%	100%	NS
Day 14	42%	40%	NS
Day 60	30%	25%	NS
PPD (mm)	($n = 20$)	($n = 20$)	
Baseline	5.7 (0.62)	5.8 (0.70)	NS
Day 14	5.1 (0.79)	5.0 (0.71)	NS
Day 60	4.4 (0.93)	4.5 (0.87)	NS
RAL (mm)	($n = 20$)	($n = 20$)	
Change Day 14*	0.0 (0.77)	$-$ 0.2 (0.73)	NS
Change Day 60*	$-$ 0.6 (1.03)	$-$ 0.6 (0.69)	NS

*Negative value = RAL gain.
NS, not statistically significant.

Table 2. Number of sites with probing pocket depth ⩽4, 5–6 and 7–8 mm and change in relative attachment level (RAL) at the various examination intervals

	Ultrasonic debridement ($n = 40$)			Air polishing debridement ($n = 40$)		
Probing pocket depth	⩽4 mm	5–6 mm	7–8 mm	⩽4 mm	5–6 mm	7–8 mm
Baseline	–	37	3	–	35	5
Day 14	13	24	3	12	27	1
Day 60	25	14	1	23	15	2
RAL change*	⩽ − 1 mm	0	⩾1 mm	⩽ − 1 mm	0	⩾1 mm
Day 14	8	19	13	10	25	5
Day 60	18	16	6	19	16	5

*Negative value = RAL gain

Table 3. Number of sites positive for the various microbial species ($\geqslant 10^5$) before treatment (day 0 Pre), immediately post-treatment (day 0 Post) and at days 2 and 14

	Ultrasonic debridement ($n = 40$)				Air polishing debridement ($n = 40$)			
	day 0 pre	day 0 post	day 2	day 14	day 0 pre	day 0 post	day 2	day 14
P. gingivalis	5	1	0	5	6	1	13	2
P. intermedia	18	7	5	24	16	11	7	15
P. nigrescens	19	12	9	23	20	7	8	19
T. forsythia	14	0	2	6	13	1	1	8
A. actinomycetemcomitans	0	0	0	1	0	0	1	1
F. nucleatum	6	0	1	11	4	0	1	10
T. denticola	13	5	1	13	11	3	4	12
P. micra	6	4	3	19	9	4	3	15
C. rectus	7	4	5	12	7	1	3	11
P. endodontalis	24	13	9	32	26	15	20	25
F. alocis	1	0	0	4	2	0	0	2
P. tannerae	9	5	3	18	12	2	2	15

revealed any statistically significant differences between the two treatment groups.

Perceived treatment discomfort and adverse events

The evaluation of perceived treatment discomfort by the use of a 100 mm VAS immediately after completion of the treatment (Fig. 4) revealed low scores for both treatment modalities, but statistically significantly lower for air polishing than for ultrasonic debridement; median value 7.5 *versus* 15.0 ($p < 0.05$). No adverse events were observed or reported with any of the treatment procedures.

Discussion

The results of the present short-term trial revealed no clinically significant differences in treatment outcome between subgingival air polishing and ultrasonic debridement of moderate deep periodontal pockets during maintenance therapy. Neither were any significant microbiological differences observed between the two treatment approaches. With respect to perceived treatment discomfort, the patients judged air polishing to cause less discomfort than ultrasonic debridement.

The study was designed to compare the clinical efficacy of two approaches to pocket/root debridement during SPT. In order to be able to properly evaluate the effect of the subgingival debridement per se, careful means were taken to secure a high standard of supragingival infection control. Hence, the patients were given instructions in proper mechanical tooth cleaning before the initiation of the trial and were in addition prescribed daily mouth rinsing with a chlorhexidine solution during the first 2 weeks post-treatment. A maintained high standard of oral hygiene throughout the study period was confirmed by low plaque scores and markedly reduced prevalence of marginal gingival bleeding (Table 1).

Because of lack of clinical data with regard to the efficacy of subgingival air polishing, we considered it appropriate to limit the evaluation to a 2-month follow-up period. Also for that reason we selected SPT patients with only few sites in need of treatment, and a split-mouth design in order to reduce the number of subjects needed and to minimize variations in potential effect of confounding factors. Further, the risk for cross-over effects should be minimal considering that only two pathological pockets in each of two separate quadrants were used as investigational sites. Hence, these study conditions have to be considered in the interpretations of the results.

Glycine powder/air polishing applied supragingivally with a conventional airflow device, and with the jet directed into the orifice of the periodontal pocket and parallel to the long axis of the root for 5 s, was reported to more effectively reduce the subgingival microflora than mechanical debridement with hand instruments (Petersilka et al. 2003c, d). It was also demonstrated (Flemmig et al. 2007) from assessments on teeth extracted immediately following treatment that, with this mode of supragingival application of air polishing, a median debridement depth of 2 mm was achieved. Considering this observation, Flemmig et al. (2007) proposed that in sites with PPD ⩾ 5 mm mechanical instrumentation might be superior.

In the present clinical trial, as well as in a recent study by Moëne et al. (2010), a specially designed nozzle was used and inserted *subgingivally* during air polishing of periodontal pockets of 5–8 mm in depth, and by which the glycine powder/air jet was directed against the root surface. Moëne et al. (2010) performed subgingival bacterial sampling by the use of paper points 2 days before treatment and 7 days post-treatment. The authors reported a reduction in number of sites positive for six tested microorganisms varying between 13% and 43% at the follow-up examination, and no significant differences compared with subgingival debridement with hand instruments. In the current study, in which the microbial sampling was performed with curettes in order to harvest the biofilm on the root surface, reduced microbial recovery rates and amounts of bacteria were observed immediately following debridement that were of similar magnitude as following ultrasonic instrumentation (Table 3 and Figs 2 and 3). The microbiological effects were also evident in samples taken after 2 days, whereas at the repeated sampling after 14 days both the number of positive

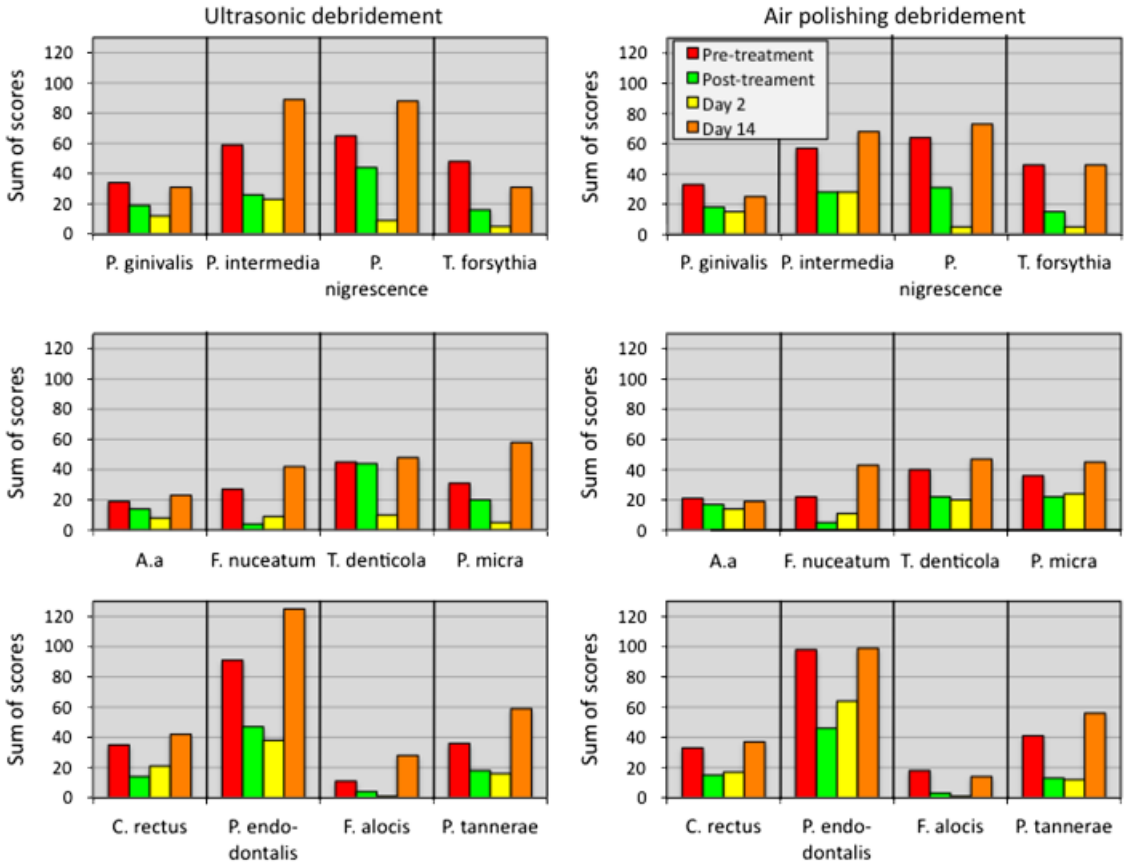

Fig. 2. Microbiological assessments. Total sum of detection scores for the various microbial species and time intervals ($n = 40$).

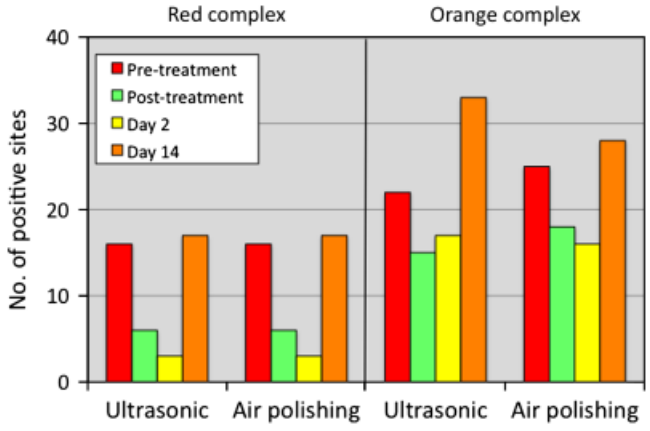

Fig. 3. Number of sites positive to microbial testing divided by treatment and microbial complex ''Red'' and ''Orange'', see text) at the various time intervals ($n = 40$).

sites and the amounts of bacteria load were more or less comparable to corresponding data before debridement. Although different methods were used for bacterial sampling (paper points *versus* curettes), taken together the data from the two clinical trials indicate a short-term effect of subgingival air polishing on the subgingival microflora in 5–8 mm deep periodontal pockets, and that this effect was not different from that seen following mechanical debridement. In this respect, the findings from the use of the specially designed nozzle supports previous observations (Petersilka et al. 2003c, d, Flemmig et al. 2007) of the potential of subgingival glycine powder/air polishing to remove biofilm on the root surface.

Despite only short-term assessable microbiologic effects, the clinical assessments revealed significant reduction in BoP, PPD as well as RAL in both the air polishing and the ultrasonic debridement group at the 60-day follow-up examination (Table 1). No bacterial sampling was performed at the final examination but data from other studies show that improved clinical conditions are in fact associated with significant reductions of subgingival bacteria loads (Haffajee et al. 1997, Darby et al. 2001). Hence, it is suggested that despite no significant differences relative to baseline in microbiological assessments at day 14, the subsequent improved tissue conditions (reduction of inflammation) might have affected the subgingival ecological environment and induced conditions less favourable for a disease-associated subgingival microbiota.

Change in PPD was considered the primary clinical outcome variable in the

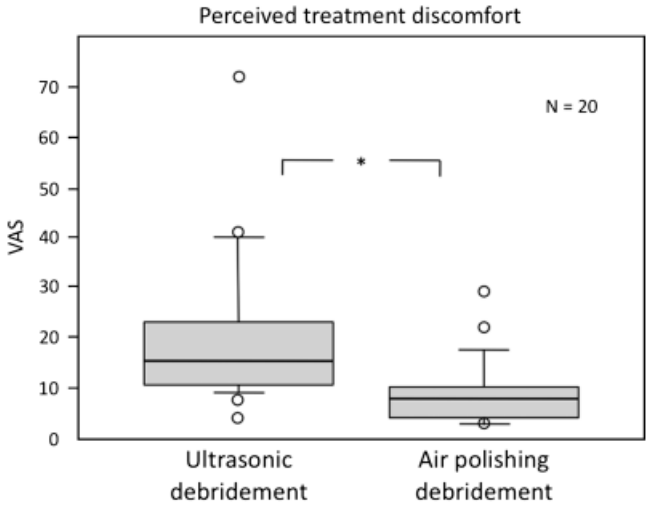

Fig. 4. Perceived treatment discomfort as assessed on a 100 mm visual analog scale (VAS).

present study. In this respect the improvement were similar following the two approaches for subgingival debridement and well in line with data reported in systematic reviews on the outcome of non-surgical mechanical instrumentation (Tunkel et al. 2002, van der Weijden & Timmerman 2002, Hallmon & Rees 2003). Also with regard to ''pocket closure'' (PPD $\leqslant$4 mm and BoP $-$) as a successful endpoint of treatment the data indicated similar outcomes (45–48%) for two treatment modalities of pocket/root debridement. In the interpretation of the results, however, it should be recognized that the majority of sites treated had a PPD of only 5–6 mm. Because subgingival pocket irrigation with water and antiseptic solutions lacks clinical significant effects (Hanes & Purvis 2003), the beneficial effects observed with regard to subgingival air polishing is most likely attributed to the use of the glycine powder. Hence, the results indicate that air polishing with glycine powder is a valid treatment approach to subgingival debridement of sites with moderate deep (5–6 mm) pockets during SPT. However, in presence of subgingival calculus and in the initial phase of periodontal therapy hand/ultrasonic instrumentation should be selected as the primary approach to root debridement.

Considering the safety of subgingival air polishing no major adverse effects were observed in the current study or in previously reported studies (Petersilka et al. 2003c, d, Flemmig et al. 2007, Moëne et al. 2010). However, Petersilka (2010) mentioned the knowledge of two cases of air emphysema, which ''resolved within 4 days without further sequelae'', following subgingival glycine powder/air polishing performed by general practitioners. With the specially designed nozzle used in the current study, the jet is directed mainly towards the root surface and with reduced flow pressure compared with supragingivally applied air polishing, which would lower the risk for such an adverse event. Furthermore, to minimize the risk education and training in the proper use of subgingival air polishing devices is important.

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References

Agger, M. S., Horsted-Bindslev, P. & Hovgaard, O. (2001) Abrasiveness of an air-powder polishing system on root surfaces in vitro. *Quintessence International* **32**, 407–411.

Berkstein, S., Reiff, R. L., McKinney, J. F. & Killoy, W. J. (1987) Supragingival root surface removal during maintenance procedures utilizing an air-powder abrasive system or hand scaling. An in vitro study. *Journal of Periodontology* **58**, 327–330.

Dahlén, G. & Leonhardt, Å. (2006) A new checkerboard panel for testing bacterial makers in periodontal disease. *Oral Microbiology and Immunology* **21**, 6–11.

Darby, I. B., Mooney, J. & Kinane, D. F. (2001) Changes in subgingival microflora and humoral immune response following periodontal therapy. *Journal of Clinical Periodontology* **28**, 796–805.

Faul, F., Erdfelder, E., Lang, A-G. & Buchner, A. (2007) G*Power 3: a flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior Research Methods* **39**, 175–191.

Flemmig, T. F., Hetzel, M., Topoll, H., Gerss, J., Haeberlein, I. & Petersilka, G. (2007) Subgingival debridement efficacy of glycine powder air polishing. *Journal of Periodontology* **78**, 1001–1010.

Haffajee, A. D., Cugini, M. A., Dibart, S., Smith, C., Kent, R. L. Jr. & Socransky, S. S. (1997) The effect of SRP on the clinical and microbiological parameters of periodontal disease. *Journal of Clinical Periodontology* **24**, 324–334.

Hallmon, W. W. & Rees, T. D. (2003) Local anti-infective therapy: mechanical and physical approaches. A systematic review. *Annals of Periodontology* **8**, 99–114.

Hanes, P. J. & Purvis, J. P. (2003) Local anti-infective therapy: pharmacological agents. A systematic review. *Annals of Periodontology* **8**, 79–98.

Kontturi-Narhi, V., Markkanen, S. & Markkanen, H. (1990) Effects of airpolishing on dental plaque removal and hard tissues as evaluated by scanning electron microscopy. *Journal of Periodontology* **61**, 334–338.

Lang, N. P., Brägger, U., Salvi, G. E. & Tonetti, M. S. (2008) Supportive periodontal therapy (SPT). In Lang, N. P. & Lindhe, J (eds). *Clinical Periodontology and Implant Dentistry*, 5th edition, pp. 1297–1317. Oxford: Blackwell Publishing Ltd.

Moëne, R., Décaillet, F., Andersen, E. & Mombelli, A. (2010) Subgingival plaque removal using a new air-polishing device. *Journal of Periodontology* **81**, 79–88.

Papapanou, P. N., Madianos, P. N., Dahlen, G. & Sandros, J. (1997) ''Checkerboard'' versus culture: a comparison between two methods for identification of subgingival microbiota. *European Journal of Oral Sciences* **105**, 389–396.

Petersilka, G. J., Bell, M., Haberlein, I., Mehl, A., Hickel, R. & Flemmig, T. F. (2003a) In vitro evaluation of novel low abrasive air polishing powders. *Journal of Clinical Periodontology* **30**, 9–13.

Petersilka, G. J., Bell, M., Mehl, A., Hickel, R. & Flemmig, T. F. (2003b) Root defects following air polishing. *Journal of Clinical Periodontology* **30**, 165–170.

Petersilka, G. J., Steinmann, D., Häberlein, I., Heinecke, A. & Flemmig, T. F. (2003c) Subgingival plaque removal in buccal and lingual sites using a novel low abrasive air-polishing powder. *Journal of Clinical Periodontology* **30**, 328–333.

Petersilka, G. J., Tunkel, J., Barakos, K., Heinecke, A., Häberlein, I. & Flemmig, T. F. (2003d) Subgingival plaque removal at interdental sites using a low-abrasive air polishing powder. *Journal of Periodontology* **74**, 307–311.

Petersilka, G. J. (2010) Letter to the editor. *Journal of Periodontology* **81**, 962–963.

Petersilka, G. J. (2011) Subgingival air-polishing in the treatment of periodontal biofilm infections. *Periodontology 2000* **55**, 124–142.

Schmidlin, P. R., Beuchat, M., Busslinger, A., Lehmann, B. & Lutz, F. (2001) Tooth substance loss resulting from mechanical, sonic and ultrasonic root instrumentation assessed by liquid scintillation. *Journal of Clinical Periodontology* **28**, 1058–1066.

Socransky, S. S., Haffajee, A. D., Cugini, M. A., Smith, C. & Kent, R. L. Jr. (1998) Microbial complexes in subgingival plaque. *Journal of Clinical Periodontology* **25**, 134–144.

Tunkel, J., Heinecke, A. & Flemmig, T. F. (2002) A systematic review of efficacy of machine-driven and manual subgingival debridement in the treatment of chronic periodontitis. *Journal of Clinical Periodontology* **29** (Suppl. 3), 72–81.

van der Weijden, G. A. & Timmerman, M. F. (2002) A systematic review on the clinical efficacy of

subgingival debridement in the treatment of chronic periodontitis. *Journal of Clinical Periodontology* **29** (Suppl. 3), 55–71.

Wennström, J. L., Tomasi, C., Bertelle, A. & Dellasega, E. (2005) Full-mouth ultrasonic debridement versus quadrant scaling and root planing as an initial approach in the treatment of chronic periodontitis. *Journal of Clinical Periodontology* **32**, 851–859.

Zappa, U., Smith, B., Simona, C., Graf, H., Case, D. & Kim, W. (1991) Root substance removal by scaling and root planing. *Journal of Periodontology* **62**, 750–754.

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Clinical Relevance

Scientific rationale for the study: Subgingival air polishing with low abrasive glycine powder has been shown to have deplaqueing and microbiological effects comparable to mechanical instrumentation. However, whether these effects of subgingival air polishing are of clinical significance needs to be validated.

Principal findings: This 2-month study revealed no differences with regard to clinical and microbiological outcomes of subgingival debridement performed with glycine powder/air polishing and ultrasonic instrumentation. Perceived treatment discomfort was lower for air polishing than ultrasonic debridement.

Practical implication: Subgingival glycine powder/air polishing with a specially designed nozzle may be used as an alternative approach to mechanical debridement of moderate deep periodontal pockets during SPT.