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Pilot study on the clinical and microbiological effect of subgingival glycine powder air polishing using a cannula-like jet

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Abstract: *Objectives:* To assess the efficacy of subgingival glycine powder air polishing (GPAP) during supportive periodontal therapy (SPT). *Methods:* Each quadrant of 25 subjects was randomly assigned to the following treatments: subgingival scaling with hand instruments (SRP), GPAP, subgingival ultrasonic debridement (UD) and no subgingival treatment (NT). Clinical recordings included the following: probing pocket depth (PPD), gingival recession (RE), clinical attachment level (CAL), Gingival and Plaque Index. Subgingival plaque samples were taken from two sites >4 mm per quadrant. Therapy, recordings and microbial sampling were performed at baseline, 3 and 6 months, while at 1 month only clinical recordings and sampling were performed. Subgingival samples were analysed using 'checkerboard' DNA-DNA hybridization for *Porphyromonas gingivalis, Tannerrella forsythia* and *Treponema denticola*. *Results:* All groups were homogeneous at baseline for the clinical parameters assessed. The GPAP group displayed statistically significant higher PPD compared to SRP and UD at 1, 3 and 6 months and no statistical differences with the 'no treatment' group at all time points. At 1 month, the GPAP group displayed statistically significantly higher levels of CAL compared to SRP, while at 3 and 6 months statistically significant differences were observed with groups assigned to SRP and UD. No differences were observed among groups for RE, PI, GI and numbers of the investigated bacteria at any time point. *Conclusions:* On the basis of clinical and microbiological data, this study does not support the superiority of GPAP as sole treatment over SRP or subgingival ultrasonic scaling.

Key words: glycine powder; supportive periodontal therapy

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Introduction

The primary aim of supportive periodontal therapy (SPT) is the maintenance of periodontal health by removing supra- and subgingival biofilm and calculus on the tooth surface which could cause an inflammatory reaction (1–4). This procedure has been generally performed by means of hand instruments such as Gracey curettes, power-driven devices such as ultrasonic or sonic instruments or a combination of both approaches. Power-driven instruments, such as ultrasonic or sonic devices, offer the advantage of a variety of scaler tips to select from. Selection of scaler tips is made on the size and shape of the tip to facilitate access to

anatomically difficult regions such as furcations. Ultrasonic scaling is considered to be advantageous over hand instrumentation as it is more ergonomic and less time-consuming for the operator. However current data have failed to demonstrate any definite clinical superiority over hand instruments (5, 6).

Air-polishing devices have been also used at SPT, but this involves a potentially major disadvantage concerning the use of an abrasive powder containing sodium bicarbonate which is sprayed under pressurized air and water onto the surface of the tooth to remove soft deposits but which may also cause abrasion of the cementum and dentine (7, 8). Air-polishing devices, which use specially formulated abrasive powders, use pressurized air and water to deliver the abrasive powder using kinetic energy. From the late 1970s until 2004, a specially formulated sodium bicarbonate powder was the only abrasive powder available. Currently, the commercially available air-polishing abrasive powders include calcium carbonate, glycine, sodium bicarbonate, calcium sodium phosphosilicate and aluminium trihydroxide.

Air polishing has been used in SPT, but was contraindicated for use subgingivally until glycine (Clinpro Prophy Powder, 3M ESPE and EMS Perio Powder) was made commercially available. (7, 9–11). The glycine powder is used with a specially designed tip and handpiece (Perioflow® handpiece for Airflow Master®, EMS, Nyon, Switzerland). Notably, the equipment that is designed to use the subgingival delivery tip uses a lower air pressure than air-polishing equipment that is contraindicated for subgingival use. It extremely important to note that only the air-polishing equipment that has this specially designed subgingival delivery tip should be used for GPAP (Air Flow, EMS, Nyon, CH). Traditional stainless steel handpiece inserts with a metal nozzle for air-polishing handpieces were not designed for subgingival delivery and are contraindicated for subgingival delivery of any type of air-polishing powder.

A number of *in vitro* and *in vivo* studies have evaluated the efficacy of glycine powder air polishing (GPAP) in reducing the subgingival microbial load and demonstrated that the portion of subgingival microflora remaining unaffected increases with pocket depth (7, 9, 10). Thus, a new air-polishing device with a special tip intended for subgingival application using glycine powder (GPAP) has appeared on the dental market (Perioflow® handpiece for Airflow Master®, EMS, Nyon, Switzerland). The tip is designed to be placed subgingivally, deep in a periodontally involved pocket, and then activated to propel a mixture of water, air and glycine powder, which removes only the soft deposits (Fig. 1). To date, a limited number of studies have evaluated the clinical and microbiological effects of this device in periodontal patients. A 7-day study has demonstrated a statistically significant reduction of bleeding index and subgingival microbial load 7 days after application in patients at SPT (12). In another short-term study, also involving patients at SPT, the clinical and microbiological effects of GPAP were compared to those of ultrasonic treatment using the split-mouth model (13), with similar clinical improvements at 2 months. While a three-month randomized controlled trial involving moderate to deep periodontal pockets, demonstrated that total *P. gingivalis* counts in the oral cavity were significantly reduced with the combination of full-mouth supra gingival GPAP and GPAP in pockets up to 9 mm, compared to SRP and indicated that GPAP is more efficacious in removing subgingival biofilm in this group of pockets (14). Currently, there are few active studies directly comparing clinical and microbiological outcomes of different treatment modalities including GPAP in residual pockets during supportive periodontal treatment. The aim of this study was to compare the effect of and the immediate and short-time efficacy of GPAP on clinical and microbiological parameters as the sole treatment during SPT compared to ultrasonic devices or hand instrumentation.

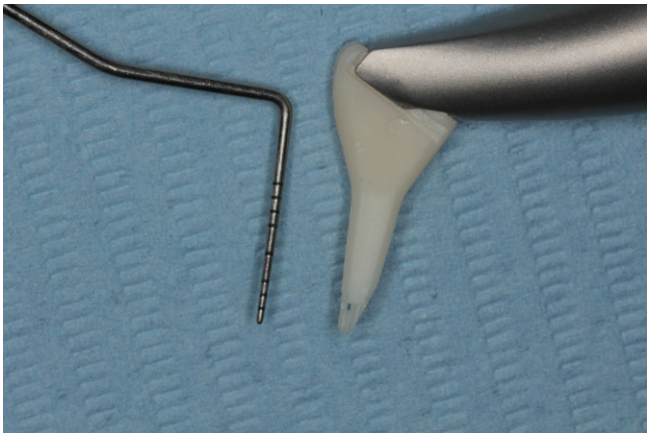

Fig. 1. The cannula-like jet for subgingival glycine-powder air-polishing.

Materials and methods

Subject sample

Twenty-five subjects, patients of the postgraduate clinic of the Department of Periodontology and Implant Biology, Dental School, Aristotle University of Thessaloniki, Greece, were recruited for this study. The minimum subject sample needed was calculated as follows: the patient was chosen as the experimental statistical unit and the change of PPD was set as the primary outcome. In the current trial, it was estimated that a minimum sample size of 21 patients has a power of 0.95 to detect an absolute difference of 1 mm between PPD mean values, at a significance level (alpha) of 0.05 (two-tailed). In addition, a conservative moderate correlation of $r = 0.30$ between before-after measurements was anticipated. This difference of 1 mm is in accordance with the current literature (15), considering that the expected SD of the before-after differences will be approximately 1 mm. *A priori* power analysis was accomplished using the G*Power v.3.1.0 software (16). Twenty-five patients were enrolled in the current trial to allow for possible dropouts.

In order for individuals to be enrolled as subjects in the study, they had to meet the following inclusion criteria:

- Must have been previously diagnosed with generalized chronic periodontitis (according to American Academy of Periodontology) (17) and successfully treated.
- Subsequently, entered the supportive treatment phase (SPT)(4), with at least two non-bleeding residual pockets >4 mm in each quadrant.
- Have at least 20 natural teeth.
- Non-smoker.
- Could not taken an antibiotic, anti-inflammatory medication, corticosteroids or other immunosuppressive drugs during the previous 6 months.
- Pregnant or lactating women were also excluded from this study.

Demographic data for participants are displayed in Table 1. All subjects signed an informed consent and the study was conducted according to the protocol outlined by the Research Committee, Aristotle University of Thessaloniki Greece and approved by the Ethical Committee of the School of Dentistry (#99).

Experimental design

Upon recruitment, each quadrant in the mouth of eligible subjects was randomly assigned by computer-generated tables to the following groups, in accordance with a split-mouth design concept:

Subgingival scaling with hand instruments (SRP) as a positive control, subgingival glycine air polishing (GPAP), subgingival ultrasonic debridement (UD) and no further subgingival treatment (NT) as the negative control.

Subjects were scheduled for baseline sampling of subgingival plaque and clinical recordings a week later, as described below.

All patients received detailed oral hygiene instructions, including interdental brushes, and were provided with identical nylon, soft, multitufted toothbrushes (Tepe, Sweden). Mechanical treatment was performed by one therapist (KK) and included supragingival ultrasonic instrumentation (Piezon®, Instrument A, EMS, Nyon, Switzerland). Subsequently, each quadrant received the assigned subgingival treatment as follows: quadrants assigned to SRP were treated with subgingival scaling–root planing using hand instruments (Gracey curettes 3/4, 11/12, 13/14, Hu-Friedy, Chicago, IL, USA). In quadrants assigned to GPAP, subgingival instrumentation was performed solely by the Perioflow® handpiece according to the manufacturer's instructions (5 s per site), while quadrants assigned to the UD group were treated with subgingival ultrasonic (Piezon® Instrument PS, EMS, Switzerland). No further subgingival treatment was provided to quadrants assigned to the no treatment group.

Table 1. **Demographic data of participants**

Patients	Female	Male	Age (mean ± SD)	Smoking status	Years in maintenance (mean ± SD)
	10	15	52.50 ± 9.54	Non-smokers	4.62 ± 2.25

At 3 and 6 months after completion of treatment, patients were rescheduled for microbial sampling and clinical recordings. At these time points, patients were retreated as described above for baseline while 1 month after baseline only microbial sampling and clinical recordings were taken.

A questionnaire concerning patient's perception of pain (0–4 scale) (18), cold or pressure during treatment and friendliness of each technique was also filled at baseline by participants immediately after treatment. Patients were also asked to report which method they would prefer for the next treatment and if they had the feeling that the air-polishing device cleans their teeth. Any adverse effects should also be reported.

Compliance was checked and reinforced at each appointment. After completion of statistical analysis, the codes of subgingival plaque samples were broken.

Demographic data for participants are presented in Table 1, and the flow chart of the study is presented in Fig. 2.

Clinical recordings

Clinical examination included evaluation of all soft oral tissues for manifestations of any signs of ulcerations or mucosal infections.

Clinical data were recorded for all teeth present in the dentition. The following parameters were recorded at six sites for each tooth (disto-, mid- and mesiobuccal, mesio-, mid- and distolingual).

a) Probing pocket depth (PPD), defined as the distance from gingival margin to the bottom of the pocket.
b) Gingival recession (RE), defined as the distance from cementoenamel junction to the gingival margin.
c) Clinical attachment level (CAL), defined as the distance from the distance of the cementoenamel junction to the bottom of the pocket.

The following parameters were recorded at four sites for each tooth (distal, buccal, mesial and lingual).

a) Gingival Index (Löe & Silness 1963, 19)
b) Plaque Index (Silness & Löe 1964, 20)

Time points of recordings included baseline, one, three and six months after treatment. All clinical measurements were performed by one calibrated examiner (KK), using a manual Williams probe (POW, Hu-Friedy, Chicago, IL). The examiner had regularly performed clinical recordings in the clinic of the department and had reproducible assessments (Pearson's correlation, $r = 0.901$) as determined in 10% of his weekly registrations.

Microbiological examination

At all time points, microbial plaque samples were taken prior to all clinical measurements. Time points of sampling included baseline, three and six months after treatment. Subgingival

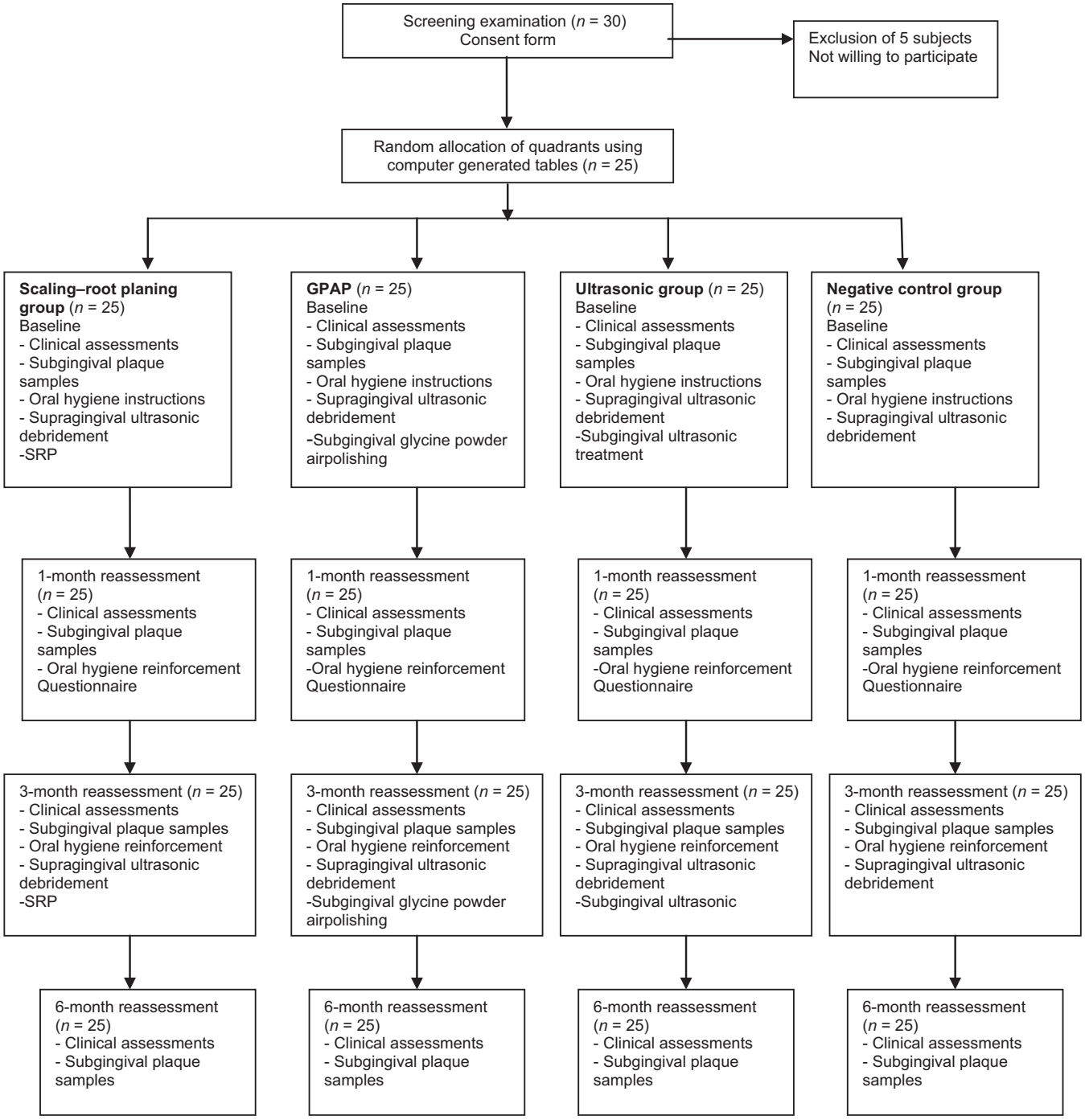

Fig. 2. Flow chart of the study.

plaque samples were taken from two sites per quadrant displaying PPD >4 mm and no bleeding on probing, after isolating with cotton rolls and drying by means of a sterile Gracey curette, placed in 200 µl of TE buffer (Tris HCL 10 mM, EDTA 1 mM, pH 7.5) and stored after treatment with an alkali solution (0.5 M NaOH) at −20°C. A total of 800 samples were processed for 3 bacterial species, using the 'checkerboard' DNA-DNA hybridization technique as described in detail by Socransky *et al.* (21). The subgingival species used for development of digoxigenin-labelled whole genomic probes were *Porphyromonas gingivalis* (FDC 381), *Tannerella forsythia* (FDC 338) and *Treponema denticola* (TD1).

Cell numbers were quantified using software for array analysis (TotalLab TL100 v 2005, NonLinear Dynamics Ltd., Newcastle Upon Tyne, UK).

Statistical analysis

Data for PPD, RE, CAL and numbers of investigated microbial species were analysed by the ANOVA method within the

frame of mixed linear models, considering the patient as the statistical unit. The ANOVA model included 3 within-subject factors with repeated measures on the same patient (method with 4 levels, site with 2 levels, and time with 4 levels). Patient was considered as a blocking factor. Method and time were entered in the model as fixed effect factors. Patient and site, nested within patient, were considered as random effect factors. Comparison of means was performed by the Bonferroni test. Central tendencies of distributions of ordinal variables (GI and PI) were compared with the Friedman's and Wilcoxon's tests for related samples. Friedman's test served as an omnibus non-parametric ANOVA. Wilcoxon's test was used for pairwise comparisons. In all non-parametric statistical tests, the observed significance level (*P*-value) was computed by the Monte–Carlo simulation method which was based on 10 000 resampling circles (22). This approach leads to valid inferential conclusions even in cases where the methodological (i.e. random and independent measurements) and statistical (i.e. symmetrical and unimodal distributions) presuppositions of the corresponding statistical test are not satisfied. The significance level was preset at 0.05 for all statistical tests. The statistical analyses were carried out with SPSS v.20.0 (IBM Corp: Armonk, New York, U.S) software.

Results

Clinical data of participants at baseline are presented in Tables 2–6. All groups were homogeneous at baseline for clinical parameters assessed ($P > 0.05$). Comparisons of means of PPD, RE and CAL between and within groups during the experimental period are displayed in Tables 2–4, respectively.

Regarding PPD, the primary outcome of the present study, no differences were observed between groups at baseline (Table 2). The group which received GPAP displayed statistically significant higher PPD compared to scaling–root planing and subgingival ultrasonic treatment at 1, 3 and 6 months and no statistically significant differences with the group which received no subgingival instrumentation at all time points. A series of post hoc power analyses revealed that the lowest level of statistical power for between groups PPD statistically significant differences was about 0.96 and for within groups statistically significant differences the lowest level of power was about 0.80.

Regarding RE, no differences were observed between GPAP and the other groups at any time point (Table 3). In the case of CAL at baseline, the group assigned to GPAP displayed statistically significant differences with the group randomly assigned to subgingival instrumentation, but not with the other two groups (Table 4). At 1 month, the GPAP group still displayed statistically significantly higher levels of CAL compared to the group which received scaling–root planing, while at 3 and 6 months statistically significant differences were observed with both the group treated with subgingival ultrasonics and the group that received scaling and root planing (Table 4). No differences were observed regarding CAL, at any time point, between GPAP and the group that received no further instrumentation (Table 4). Comparisons of PPD, RE and CAL within each group are also displayed in Tables 2–4. Regarding PPD, GPAP resulted in statistically significant reduction at 1 and 3 months compared to baseline, but no statistically significant difference was detected between baseline and 6 months (Table 2). In contrast, both ultrasonic treatment and scaling–root planing resulted in PPD reduction that was statistically significantly different from baseline at all time points. No differences were observed from baseline for the group which received no further treatment.

The same pattern of changes was observed for RE within groups, with the GPAP group displaying statistically significant differences from baseline at the 1- and 3-month time points, while the other two treatments resulted in statistically significantly higher levels of RE at 1, 3 and 6 months (Table 3). No differences were observed from baseline for the control group. Regarding CAL, the only group which displayed a statistically significant improvement from baseline at all time points was the group treated with subgingival ultrasonics (Table 4). The other three groups did not display any statistically significant differences from baseline.

Results of the present study concerning GI and PI are presented in Tables 5 and 6. No differences in central tendency were observed among groups at any time point. Within each group, a number of statistical differences compared to baseline were observed. Regarding GI, a statistically significant reduction was observed for the groups treated with GPAP and scaling and root planing at the 1-month time point, while the group treated with subgingival ultrasonics displayed statistically significant differences from baseline at all time points

Table 2. **Probing pocket depth (mean ± SE) of investigated sites in every group during the experimental period**

	GPAP *n* = 25 (mm ± SE)	UD *n* = 25 (mm ± SE)	SRP *n* = 25 (mm ± SE)	No subgingival treatment *n* = 25 (mm ± SE)
Baseline	4.78 ± 0.10	4.66 ± 0.10	4.50 ± 0.09	4.42 ± 0.10
1 month	4.44 ± 0.10†	3.88 ± 0.10*†	3.74 ± 0.08*†	4.36 ± 0.10
3 months	4.40 ± 0.11†	3.84 ± 0.07*†	3.70 ± 0.08*†	4.40 ± 0.10
6 months	4.52 ± 0.09	4.00 ± 0.08*†	4.06 ± 0.10*†	4.52 ± 0.10

GPAP, glycine powder air polishing; SRP, scaling–root planing; UD, ultrasonic debridement.
*Statistically significant differences between GPAP and the other groups (Bonferroni's test).
†Statistically significant differences within groups between specific time point and baseline (Bonferroni's test).

Table 3. **Gingival recession (mean ± SE) of investigated sites in every group during the experimental period**

	GPAP $n = 25$ (mm ± SE)	UD $n = 25$ (mm ± SE)	SRP $n = 25$ (mm ± SE)	NT $n = 25$ (mm ± SE)
Baseline	0.64 ± 0.08	0.46 ± 0.10	0.44 ± 0.08	0.64 ± 0.09
1 month	0.98 ± 0.13†	1.10 ± 0.13†	1.06 ± 0.07†	0.74 ± 0.09
3 months	0.98 ± 0.11†	0.92 ± 0.11†	1.14 ± 0.08†	0.76 ± 0.11
6 months	0.88 ± 0.10	0.82 ± 0.09†	0.76 ± 0.11†	0.60 ± 0.10

GPAP, glycine powder air polishing; SRP, scaling–root planing; UD, ultrasonic debridement; NT, no subgingival treatment.
No statistically significant differences were observed between GPAP and the other groups (Bonferroni's test).
†Statistically significant differences within groups between specific time point and baseline (Bonferroni's test).

Table 5. **Gingival Index (mean values) of investigated sites in every group during the experimental period**

	GPAP $n = 25$	UD $n = 25$	SRP $n = 25$	NT $n = 25$
Baseline	0.70	0.72	0.48	0.64
1 month	0.38†	0.40†	0.20†	0.58
3 months	0.50	0.28†	0.24	0.72
6 months	0.58	0.38†	0.40	0.72

GPAP, glycine powder air polishing; SRP, scaling–root planing; UD, ultrasonic debridement; NT, no subgingival treatment.
No statistically significant differences were observed among groups (Wilcoxon test).
†Statistically significant differences within groups between specific time point and baseline (Wilcoxon test).

(Table 5). No differences were observed for the control group. Regarding PI, any kind of treatment (including GPAP) resulted in statistically significant reductions from baseline at all time points, while the group that received no further treatment displayed an improvement from baseline only at the 1-month time point (Table 6).

The microbiological parameters assessed in the present study are displayed in Table 7. No differences were observed among groups regarding numbers of the three investigated bacteria at any time point. Few differences of minor substantial importance were observed when testing within groups, between time points. An increase in *Porphyromonas gingivalis* was observed for the GPAP and the control groups when comparing 6 months to baseline and the same pattern was observed in the GPAP group for *Treponema denticola*. Regarding *Tannerella forsythia*, the control group displayed an increase when comparing the 6-month time point to baseline, while a statistically significant decrease compared to baseline was observed at 1 month for the group which received ultrasonic treatment.

Subjects reported less pain, no sense of pressure, together with an overall greater feeling of 'friendliness' with GPAP compared to the other two experimental techniques. Furthermore, GPAP was the most widely preferred option for the next treatment, while most subjects had the feeling that the device adequately cleaned their teeth (Table 8).

No adverse side effects were observed or reported throughout the experimental period.

Discussion

The purpose of the present 6-month study, was to evaluate the effectiveness of subgingival glycine powder air polishing compared to scaling–root planing and ultrasonic scalers on the clinical and microbiological parameters of moderate pockets in periodontitis patients undergoing supportive periodontal treatment.

Although GPAP has been shown to be less time-consuming (5 s for each periodontal pocket) more comfortable and friendly and produced less pain and pressure for subjects, findings from the present study do not support the superiority of the method as sole treatment in reducing clinical indices of periodontal inflammation. Both scaling and root planing and subgingival ultrasonics displayed statistically significantly greater improvement of PPD, the primary outcome of the present study, at all time points, compared to GPAP. No differences were observed for gingival recession, gingival and plaque indices. These findings are supported by microbiological

Table 4. **Clinical attachment level (mean ± SE) of investigated sites in every group during the experimental period**

	GPAP $n = 25$ (mm ± SE)	UD $n = 25$ (mm ± SE)	SRP $n = 25$ (mm ± SE)	NT $n = 25$ (mm ± SE)
Baseline	5.42 ± 0.13	5.12 ± 0.11	4.94 ± 0.09*	5.06 ± 0.11
1 month	5.42 ± 0.13	4.98 ± 0.11†	4.80 ± 0.09*	5.10 ± 0.12
3 months	5.38 ± 0.12	4.76 ± 0.11*†	4.84 ± 0.09*	5.16 ± 0.13
6 months	5.40 ± 0.11	4.82 ± 0.11*†	4.82 ± 0.09*	5.12 ± 0.11

GPAP, glycine powder air polishing; SRP, scaling–root planing; UD, ultrasonic debridement; NT, no subgingival treatment.
*Statistically significant differences between GPAP and the other groups (Bonferroni's test).
†Statistically significant differences within groups between specific time point and baseline (Bonferroni's test).

Table 6. **Plaque Index (mean values) of investigated sites in every group during the experimental period**

	GPAP $n = 25$	UD $n = 25$	SRP $n = 25$	NT $n = 25$
Baseline	1.12	0.96	0.88	1.04
1 month	0.48†	0.56†	0.32†	0.62†
3 months	0.52†	0.44†	0.54†	0.86
6 months	0.64†	0.50†	0.44†	0.80

GPAP, glycine powder air polishing; SRP, scaling–root planing; UD, ultrasonic debridement; NT, no subgingival treatment.
No statistically significant differences were observed among groups (Wilcoxon test).
†Statistically significant differences within groups between specific time point and baseline (Wilcoxon test).

Table 7. **Numbers of investigated species ($\times 10^5 \pm$ SE) in every group during the experimental period**

	GPAP $n = 25$			UD $n = 25$			SRP $n = 25$			NT $n = 25$		
	P. gingivalis	*T. denticola*	*T. forsythia*	*P. gingivalis*	*T. denticola*	*T. forsythia*	*P. gingivalis*	*T. denticola*	*T. forsythia*	*P. gingivalis*	*T. denticola*	*T. forsythia*
Baseline	7.86 ± 2.37	4.07 ± 1.08	7.60 ± 1.17	11.17 ± 4.15	7.09 ± 3.67	6.52 ± 1.36	10.25 ± 4.14	8.58 ± 4.13	5.80 ± 0.99	9.29 ± 3.44	7.23 ± 3.84	4.95 ± 1.16
1 month	3.59 ± 0.91	2.53 ± 0.54	4.91 ± 0.84	4.62 ± 2.52	3.02 ± 0.63	1.98 ± 0.36†	2.36 ± 0.55	4.73 ± 2.32	3.47 ± 0.60	3.20 ± 0.54	4.98 ± 2.27	4.53 ± 0.84
3 months	12.31 ± 4.21	11.00 ± 4.27	5.60 ± 1.02	13.28 ± 4.76	11.26 ± 5.40	5.01 ± 1.08	9.84 ± 3.64	7.34 ± 3.02	5.05 ± 0.99	16.57 ± 5.38	10.45 ± 4.23	4.88 ± 0.98
6 months	26.88 ± 6.82†	20.95 ± 7.30†	5.60 ± 1.78	13.60 ± 4.81	11.60 ± 4.07	8.21 ± 1.54	12.80 ± 4.40	8.90 ± 3.64	9.52 ± 1.93	29.60 ± 6.83†	14.03 ± 4.44	10.72 ± 1.82†

GPAP, glycine powder air polishing; SRP, scaling–root planing; UD, ultrasonic debridement; NT, no subgingival treatment.
No statistically significant differences were observed among groups (Bonferroni's test).
†Statistically significant differences within groups between specific time point and baseline (Bonferroni's test).

data from the present study which also indicate no differences between GPAP and the other groups.

No adverse effects were observed in subjects, indicating the safety of GPAP. Previous studies have also demonstrated both the absence of serious adverse effects such as emphysema and of soft tissue damage following the application of the low-abrasive glycine powder, probably due to the specially designed instrument tip and the reduced pressure on tissues (12, 13, 23). However, it should be stated that the lack of emphysemas in the previous studies cannot be attributed to the type of powder or the instrument tip, because there has never been research investigating the direct relationship between facial emphysemas and the use of the new subgingival tip or a specific type of powder.

In contrast, the application of an air-polishing jet with sodium bicarbonate in the past has been associated with inducing emphysema (24, 25). It should be emphasized that it is the use of the compressed air required for air polishing that causes facial emphysemas and is therefore contraindicated for use near extraction sites and in individuals with extensive loss of bony support and deep periodontal pockets due to periodontal disease (26).

Moene *et al.* (12) in an examiner-masked study also evaluated the safety, patient acceptance and short-term microbiologic effect of a new air-polishing device in subjects in maintenance care with residual pockets >5 mm. In that study, no adverse events were reported, but although it was shown that subgingival air polishing was perceived to be more acceptable by the patients, on a microbiologic level, it was not superior to conventional SRP. These results are similar to the outcomes of the present study, albeit our observations extend over a longer time period.

Wennström *et al.* (13) conducted a trial as a split-mouth designed study of 2-month duration including 20 recall patients previously treated for chronic periodontitis. The researchers aimed 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. They found no significant differences in clinical or microbiological outcomes between subgingival air polishing and ultrasonic debridement of moderate deep pockets in SPT patients, although they had applied GPAP for twice as long (2×5 s) compared with the manufacturer's instructions which were followed in the present study.

Our results, as mentioned above, are not in agreement with Flemmig *et al.* (14) who indicated that GPAP is more efficacious in removing subgingival biofilm in moderate to deep periodontal pockets than conventional SRP and, furthermore, that full-mouth GPAP may result in a beneficial shift of the oral microbiota and appears to be well tolerated. A possible explanation for this discrepancy might be the combination of full-mouth GPAP and subgingival GPAP in the Flemmig *et al.* study, where notably deeper pockets were included. Contratry to the Flemming *et al.* study, this study was designed to select

Table 8. **Perception and overall opinion of participants about treatment modalities**

	UD [*n* (%)]	SRP [*n* (%)]	GPAP [*n* (%)]	NT [*n* (%)]
Which method is more friendly?	5 (20)	0 (0)	17 (68)	3 (12)
During which method did you feel:				
Pain	9 (36)	11 (44)	5 (32)	
Cold	10 (40)	3 (12)	6 (24)	
Uncomfortable feeling	15 (60)	18 (72)	9 (36)	
Pressure	12 (48)	17 (68)	0	
In which quadrant did you have the most sensitivity?	3 (12)	5 (20)	1 (4)	0 (0)
Which method would you prefer for the next treatment?	6 (24)	0 (0)	16 (64)	3 (12)

	Not at all [*n* (%)]	Maybe [*n* (%)]	Little [*n* (%)]	Enough [*n* (%)]	Very much [*n* (%)]
Do you have the feeling that the air-polishing device cleans your teeth?	6 (24)	0 (0)	3 (12)	13 (52)	3 (12)

UD, subgingival ultrasonic debridement; SRP, scaling–root planing; GPAP, glycine powder air polishing; NT, no subgingival treatment.

a subject sample that reflected normal conditions of patients in SPT (absence of deep pockets and no bleeding) who attend clinical practices to maintain healthy periodontal conditions. Furthermore, it cannot be ruled out that moving the nozzle itself, alone without powder and/or water, respectively, could also have had an effect. Additionally, this study differed from the Flemming *et al.* study, in that the investigator was not masked.

Conclusions

Data from this 6-month study, taken collectively, do not support the superior effect of GPAP as a sole treatment over hand instrumentation or subgingival ultrasonics during supportive periodontal therapy on clinical or microbiological parameters of periodontal disease, despite this treatment modality being less time-consuming and better accepted by patients.

Clinical relevance

Scientific rationale of the study

Few data exist in current literature concerning the efficacy of subgingival glycine powder air polishing during supportive periodontal therapy of chronic periodontitis patients.

Principal findings

Superiority of GPAP as the sole treatment over hand instrumentation or subgingival ultrasonics on clinical or microbiological parameters of periodontal disease cannot be supported.

Practical implications

Although this treatment modality was less time-consuming and better accepted by patients, it did not provide better clinical or microbiological results compared to conventional treatment methods.

Author contributions

Konstantinos Kargas: examiner and therapist, preparation of manuscript. Lazaros Tsalikis: study design, allocation of groups, preparation and review of the manuscript. Dimitra Sakellari: study design, microbiological examination, preparation and review of the manuscript. George Menexes: statistical analysis. Antonios Konstantinidis: review of the manuscript, statistical re-evaluation.

Conflict of interest and source of funding statement

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