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ORIGINAL ARTICLE

Air-polishing followed by ultrasonic calculus removal for the treatment of gingivitis: A 12-month, split-mouth randomized controlled clinical trial

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Abstract

Objective: To evaluate the advantages of a novel protocol involving full-mouth erythritol-powder air-polishing followed by ultrasonic calculus removal in the maintenance of patients treated for gingivitis, with a focus on time and comfort.

Methods: Systemically healthy patients with gingivitis were selected. Following a split-mouth design, quadrants 1–4 and 2–3 were randomly allocated to receive air-polishing followed by ultrasonic calculus removal following a protocol known as Guided Biofilm Therapy (GBT) or traditional full-mouth ultrasonic debridement followed by polishing with a rubber cup and prophylactic paste (US + P). Bleeding on probing (BoP) and the plaque index (PI) were collected at baseline (T0), 2 weeks (T1), 4 weeks (T2), 3 months (T3), and 6 months (T4) and 12 months (T5). Following the same randomization, prophylactic therapy was provided at 3 months (T3) and 6 months (T4). Clinical parameters, treatment time and patient comfort and satisfaction were evaluated.

Results: A total of 41 patients were selected, 39 completed the study. The clinical parameters were clinically satisfactory for both treatments at every time. At 4 months after treatment, GBT maintained significantly lower BoP and PI. GBT protocol required a significantly lower treatment time, especially at T3 and T4, when it saved 24.5% and 25.1% of the time, respectively. Both treatments were rated positively by most patients. However, GBT was perceived as more comfortable, and a higher number of patients preferred it.

Conclusion: No significant difference was observed between GBT and conventional ultrasonic debridement and rubber cup polishing in terms of BoP and PI levels. The GBT protocol allowed less time expenditure and higher patients' perceived comfort.

KEYWORDS
air-polishing, dental biofilm, gingivitis, oral hygiene, plaque disclosing

1 | INTRODUCTION

Professional dental prophylaxis plays an important role in the prevention of periodontal disease and caries. Alongside oral hygiene instructions and motivation, fluoride application and dietary advice, it represents a lifelong commitment.[1] The standard instruments used for professional prophylaxis are ultrasonic tips and manual instruments for the mechanical removal of hard and soft deposits,

followed by polishing with rubber cups or bristle brushes with polishing pastes.

There is some in-vitro evidence suggesting that these instruments may cause damage to the enamel surface. In particular, rubber cups with polishing paste and ultrasonic instrumentation might alter enamel microstructure, and ultrasonic scalers could lead to enamel loss around cracks and early caries.[2–4]

While limited evidence exists around the ideal interval between prophylaxis appointments,[5,6] most dentists recommend 6-monthly dental examinations, including scaling and polishing.[7] There is also limited evidence regarding potential long-term adverse effects associated with traditional debridement and polishing, such as alterations in clinical attachment levels or tooth loss.[6] However, considering the frequency of this procedure, opting for a minimally[8] invasive approach may be a prudent choice.

Air-polishing with low-abrasiveness powders, such as erythritol powder, is emerging as an alternative for supra-gingival and sub-gingival plaque removal. Some in-vitro studies show no loss of substance or increased surface roughness on enamel and cementum.[2,4] In a previous clinical study from this same research group,[9] it was shown that full-mouth air-polishing guided by plaque disclosing and followed by targeted ultrasonic calculus removal is a suitable treatment for gingivitis, equally as effective as traditional instrumentation. This novel protocol is known by the commercial name of Guided Biofilm Therapy (GBT), created by E.M.S Electro Medical Systems.[9,10] High-level evidence around GBT is still scant at this stage but is appears promising.[11]

Patient comfort and treatment time are also crucial aspects of practice. Pain during dental treatment can discourage regular dental care,[12] and appointment duration can impact the cost-effectiveness of the selected prophylaxis protocol.[13] Some clinical evidence suggests that, compared to traditional rubber cup and prophy paste, patients and clinicians prefer air-polishing,[14,15] and GBT is perceived more favourably than traditional Scaling and Root Planing (SRP) in the treatment of periodontitis.[10] Moreover, air-polishing followed by ultrasonic scaling seems to require less treatment time than traditional methods.[9,10,15]

The aim of the present split-mouth, randomized, controlled study was to evaluate air-polishing followed by ultrasonic calculus removal (GBT) during professional dental prophylaxis in patients that were treated for gingivitis, in terms of maintenance of gingival health, treatment time and patient comfort/satisfaction during 12 months of observation, and compared it to conventional full-mouth ultrasonic debridement followed by rubber cup with polishing paste (US + P).

2 | MATERIALS AND METHODS

2.1 | Study design and population

The present study was a double-blinded, split-mouth randomized controlled clinical trial, approved by the Ethics Committee of ASST— Spedali Civili di Brescia (Italy) with protocol number 2637 and conducted in accordance with the Helsinki Declaration. Patients were selected from the population afferent to the Dental School 'Clinica Odontoiatrica Lidia Verza', University of Brescia, Department of Radiological Science and Public Health, within the ASST Spedali Civili di Brescia, Department of Odontostomatology (Brescia, Italy).

The inclusion criteria were as follows:

- Presence of gingivitis (BoP >25%);
- Presence of at least 5 teeth per quadrant;
- Systemically healthy;
- Age between 20 and 40 years.

The exclusion criteria were as follows:

- The presence of periodontal disease, defined as >3 mm of clinical attachment loss at any site;
- The presence of fixed retainers, orthodontic appliances or complex prosthetic restorations;
- The presence of crowding;
- Pregnant or lactating;
- Allergy to chlorhexidine or erythritol;
- Smoking >10 cigarettes per day;
- Unwillingness to undergo the proposed treatment and recalls;

All participants signed written informed consent before the beginning of the study.

2.2 | Intervention

A trained dentist blinded to the treatment (M.D.) performed the clinical examination, collected the periodontal parameters, and administered the satisfaction questionnaires. All the treatments were provided by the same trained dentist (E.S.), who recorded the treatment time. Age, gender and smoking status were collected at baseline, along with a complete periodontal charting including 6-point pocket probing depth (PPD), clinical attachment level (CAL), the plaque index (PI) according to a modified O'Leary index[16] measured on 6 surfaces per tooth (distobuccal, buccal, mesiobuccal, distolingual, lingual and mesiolingual), bleeding on probing (BoP) and gingival index (GI) according to Loe & Silness.[17] After a pre-treatment 60-s rinse with Chlorhexidine 0.12% (Curasept, Curaden Healthcare srl, Saronno, Italy) and placement of a lips and cheeks retractor (OptraGate, Ivoclar Vivadent), a plaque disclosing agent (MIRA-2-TON® 60 mL bottle, HAGER WERKEN) was applied with a micro-brush to cover the entire tooth surface, and thoroughly rinsed with water. At this point, quadrants 1–4 and 2–3 were randomly allocated to GBT or US + P treatment via randomization list and numbered opaque envelopes. All the quadrants were treated in the same session, starting from 1 to 4.

The quadrants allocated to US + P treatment underwent the following steps:

- Full-mouth ultrasonic piezoelectric debridement (Airflow Master Piezon®, EMS, Nyon, Switzerland) with a slim tip (PS® Instrument, EMS, Nyon, Switzerland);
- Plaque removal and polishing with rubber cup (Pro Cup Soft Light Blue® Kerr, Bioggio, Switzerland) and prophylaxis paste with RDA = 27 (Cleanic®, Kerr, Bioggio, Switzerland).

The quadrants allocated to GBT underwent the following steps:

- Supra-gingival and sub-marginal air-polishing (Aiflow Master Piezon®, EMS Nyon, Switzerland) with erythritol + chlorhexidine powder (PLUS®, EMS, Nyon, Switzerland);
- Site-specific removal of calculus with ultrasonic piezoelectric scaler (Airflow Master Piezon®, EMS, Nyon, Switzerland) and a slim tip (PS® Instrument, EMS, Nyon, Switzerland).

Double suction with slow-speed and high-speed inserts was applied through a 2-hand technique with an assistant to control aerosol safely. Treatment time was recorded starting from the envelope opening and ending when the clinician was satisfied with the result. OHI were provided, and all patients were recommended a manual soft brush (CURAPROX CS 5460, Postfach, Switzerland), interdental floss (CURAPROX PTFE Dental Tape, Postfach, Switzerland) and regular sodium fluoride 0.24% w/w toothpaste (GUM® Hydral, Sunstar gums, RDA < 40).

An anonymous questionnaire was administered at the end of the session. The first part of the questionnaire included an assessment of the individual treatments in terms of perception of the quality of treatment received (insufficient, average, good or optimal), discomfort (rated from 0 – nil to 5 – maximum), and sensation of cleanliness (insufficient, average, good or optimal). The second part of the questionnaire asked the patient to express a preference between treatment US + P or treatment GBT or to indicate whether they liked both treatments equally (Both) or none of the treatments (None) in terms of perception of the quality of treatment, discomfort, the sensation of cleanliness and overall preference.

Patients were recalled at 2 and 4 weeks for further OHI, BoP and PI collection. The following recalls were at 3 months (T3), 6 months (T4) and 12 months (T5). At T3 and T4, the patients underwent the collection of periodontal parameters and a session of prophylaxis session respecting the initial randomization, followed by the administration of the satisfaction questionnaire. At T5, the end of our trial, periodontal parameters were collected again, and the patients were referred to the regular maintenance schedule of the dental clinic. The study protocol is displayed in Figure 1.

2.3 | Outcomes

The study's primary endpoint was the change in the percentage of sites showing BoP. The non-inferiority of the test treatment was calculated based on BoP only. Secondary outcomes were changes in PI, treatment time, patient's perception of comfort and treatment preference collected through a questionnaire.

2.4 | Sample size

The sample size was estimated for a split-mouth design with a non-inferiority hypothesis setting. Within patient, 36 sites are treated with either procedure (six teeth, six sites for each tooth, on each side). We used two different approaches for sample size estimation. In all settings, we assume at least a 70% reduction in BOP, a non-inferiority margin of 5%, a power of 80%, and a significance level of 5%. First, we modelled the outcome variable as the percentage of sites that stop bleeding on probing after treatment and computed sample size assuming asymptotic normality using a paired *t*-test procedure. Assuming an average 70% reduction, a standard deviation of 12%, a margin of 5%, and a zero true difference between treatments, we can estimate $N = 38$.

In the second setting, we used a simulation procedure modelling every site change in BOP status as a binomial variate. We, therefore, simulated a 1-level multilevel structure with both random intercept and slope (treatment effect), i.e. assuming a varying PI as well as treatment effect across patients. We assumed a true treatment effect of zero across patients' intercept variance and treatment effect variance set to 0.5 and intercept-slope correlation set to −0.6. We simulated $B = 200$ random datasets and estimated power as the proportion of simulations where the margin between the estimated effect is lower than 5%. The simulation procedure led to $N = 41$, the selected sample size.

2.5 | Randomization

Patients were randomized by a blinded statistician using a computer-generated randomization list. The random allocation sequence was generated with uninformative labels (A and B) and concealed in sealed opaque envelopes provided by the study adviser. All data analyses were carried out according to a pre-established analysis plan by a biostatistician blinded to group allocation.

2.6 | Statistical analyses

All data analyses were carried out according to a pre-established analysis plan by a biostatistician blinded to group allocation. Both BOP and PI were summarized at individual patient level and visit as counts and modelled, both between and within treatments using a multilevel GLM (with Poisson regression) using generalized estimation equations (GEEs). Total number of evaluated sites per patient was used as an offset in the model: the estimated values would therefore be equivalent to a proportion. Effects are reported as estimated ratios and corresponding 95% confidence intervals.

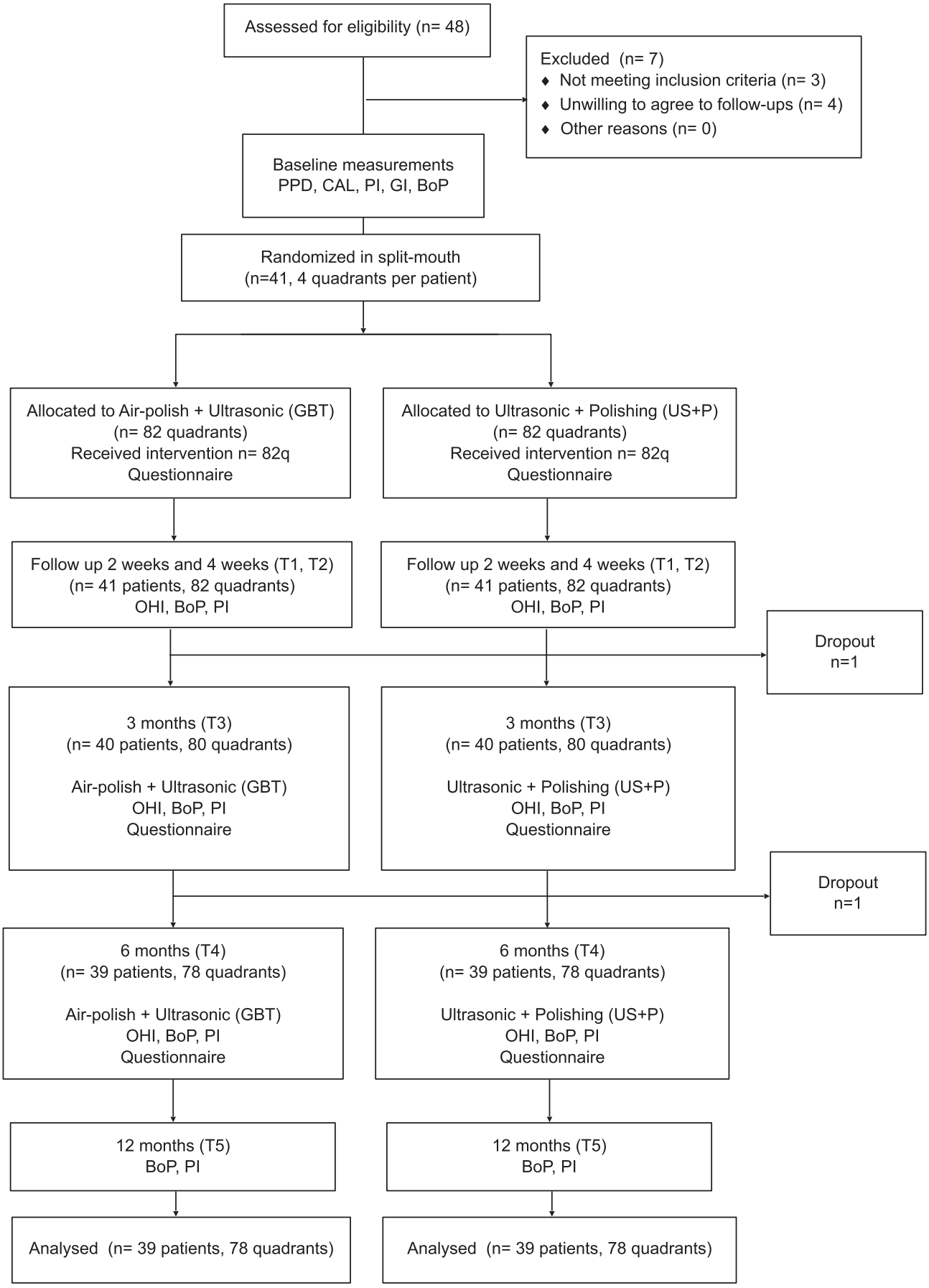

FIGURE 1 Study protocol.

Secondary outcomes were modelled using permutation tests (a non-parametric test procedure) for paired samples. All statistical comparisons were conducted at the 0.05 level of significance.

3 | RESULTS

A total of 48 patients were assessed for eligibility. A total of seven patients were excluded for not matching the inclusion criteria (three showing sites with CAL>3 mm, four unwilling to agree to the follow-up schedule). Recruitment started on 03/03/2017 and ended on 01/02/2018. A total of 41 patients (21 males, 20 females) were selected, 39 completed the study. One dropout occurred before T3 due to failure to attend the scheduled appointments, and a second dropout occurred before T4 due to pregnancy. Table 1 shows the demographic characteristics and clinical parameters at baseline. The mean periodontal parameters were reported, grouping the quadrants per treatment group.

Changes in BoP and PI over observation time, along with a inter- and intra-group analysis are reported in Table 2. A significant reduction BoP within the groups was observed at 2 and 4 weeks, with no further significant reduction at the subsequent points in time. PI significantly reduced from Baseline to T1, then maintained similar levels. BoP and PI were significantly lower in the GBT group compared to the control group at 4 weeks, but there was no difference between groups at any other time.

The mean treatment time is displayed in Table 3. GBT protocol was significantly faster than the control at all time points, resulting in a reduction of treatment time of 9.2%, 24.5% and 25.1% at T0, T3 and T4, respectively ($p<0.001$). Treatment time also decreased between baseline and T3 and T4 for both protocols, with a reduction of 19.1% for US+P and 32.5% for GBT at T3, 28.3% for US+P and 40.9% for GBT at T4.

Table 4 shows the results of the patients' questionnaires. Both treatments were mainly rated as either "Good" or "Optimal" at every time point in terms of perceived quality and sensation of cleanliness. However, GBT treatment showed a significantly higher number of patients rating it as "Optimal". In terms of discomfort, a significantly higher number of patients found GBT discomfort level to be zero or low (1), compared with US+P at any time point. At T3 and T4, the discomfort for both treatment modalities appeared to decrease. When comparing the two treatments, a significantly higher number of patients preferred GBT over US+P at any time regarding the perceived quality of treatment and sensation of cleanliness. In terms of comfort, 85.4% of patients preferred GBT at T0, reaching 94.9% of patients at T4. As an overall preference, 73.2% of patients preferred GBT as a treatment modality at baseline, and this number increased to 80% at T3 and 82.1% at T4 (Graphic available in Appendix S1).

TABLE 1 Demographic characteristics of the selected subjects and baseline clinical parameters grouped per treatment modality (US+P, ultrasonic debridement and abrasive paste; GBT, air-polishing and ultrasonic calculus removal).

	US+P (*N*=41)	GBT (*N*=41)
Males (*N*)	21 (48.8%)	
Average age (SD)	28.4 (6.1)	
Smokers (*N*)	11 (22.9%)	
PPD (SD)	1.85 mm (0.79)	1.86 mm (0.80)
CAL (SD)	1.88 mm (0.80)	1.87 mm (0.82)

Abbreviations: BoP, bleeding on probing; CAL, clinical attachment level; PI, plaque index; PPD, pocket probing depth; SD, standard deviation.

4 | DISCUSSION

The first part of the present clinical trial[9] demonstrated that the novel GBT protocol is suitable for re-establishing health in patients with gingivitis in the short term. In this second part, we wanted to investigate whether GBT is comparable to traditional protocols for maintaining periodontal health for a longer time, with a particular focus on time and comfort.

Both tested protocols successfully maintained periodontal health during the 12 months of observation. Bleeding on probing was significantly reduced for both protocols at 2 weeks and 4 weeks and then maintained statistically and clinically similar values throughout the study, and we observed a significant difference in favour of GBT at 4 weeks post-treatment. The same trend was observed with PI, which significantly decreased between baseline and T1, was lower for GBT at 4 weeks. While we could not provide a satisfactory explanation for this difference in the first part of this paper,[9] a recent study from Wolgin et al. (2021)[18] studying biofilm re-growth in young individuals after professional prophylaxis found a delay in enamel biofilm repopulation after treatment with air-polishing, and the authors hypothesize that the better removal of biofilm achieved with this protocol possibly leaves less post-treatment bacteria to repopulate the surfaces. Nevertheless, this explanation remains speculative. At subsequent recalls and up to 12 months (T5), no difference in BoP and PI was observed between the two groups in this study, and the levels of BoP were maintained around the 10% threshold for diagnosis of localized gingivitis.[19] Interestingly, PI reached the worst post-treatment point at 6 months follow-up (22.9% for US+P and 21.3% for GBT), then improving again towards the 12-month mark, even though in a non-statistically significant manner. The repetition and reinforcement of OHI at each time point could explain why the patients became increasingly better at managing plaque at home.[1] Evidence shows that professional prophylaxis is insufficient in periodontal prevention without providing OHI.[8]

Patient perception and treatment time constitute essential aspects of care that can impact compliance, motivation, and overall cost for the provider. One of the aims of the present study was to compare two different prophylaxis protocols in terms of the duration of the treatment and the patient's perception of comfort and thoroughness. We observed that, regardless of the treatment protocol, the time required for the prophylaxis appointment decreased significantly between baseline and T3-T4. The reason

TABLE 2 Inter-group full-mouth bleeding on probing (BoP) and PI over time and relative 95% confidence interval, inter-group ratio and *p*-value and within group effect comparison at the different time points.

	BoP			PI		
	US + P	GBT	*p*-value GBT versus US	US + P	GBT	*p*-value GBT versus US
Baseline (*N* = 41)	56.7% [50.7;63.4]	56.9% [51.1;63.5]	0.85	65.3% [59.7;71.4]	65.0% [60.3;70.2]	0.876
2 weeks (T1) (*N* = 41)	7.3% [5.2;10.2]	6.1% [4.4;8.4]	0.22	14.6%[11.2;18.9]	14.9%[11.6;19.0]	0.832
4 weeks (T2) (*N* = 41)	14.8% [10.6;20.6]	11.2% [7.7;16.5]	<0.01*	14.7%[11.1;19.5]	12.7%[9.7;16.5]	0.023*
3 months (T3) (*N* = 40)	14.1% [9.9;19.9]	15.8% [11.2;22.2]	0.24	17.2% [13.4;22.2]	17.2% [12.9;23.0]	0.995
6 months (T4) (*N* = 39)	15.0% [10.2;21.9]	16.6% [11.3;24.5]	0.31	22.9% [17.4;30.0]	21.3%[16.5;27.5]	0.112
12 months (T5) (*N* = 39)	10.2% [6.4;16.4]	11.5% [7.4;17.9]	0.36	19.5% [14.8;25.7]	17.3% [12.8;23.3]	0.034
Intra-group time analysis						
T1/Baseline	0.13 [0.09;0.17]	<0.01*	0.11 [0.08;0.14]	<0.01*	0.22 [0.18;0.28]	<0.01*	0.23 [0.18;0.29]	<0.01*
T2/T1	2.03 [1.48;2.79]	<0.01*	1.84 [1.30;2.62]	<0.01*	1.01 [0.79;1.29]	0.923	0.85 [0.65;1.11]	0.242
T3/T2	0.95 [0.59;1.54]	0.837	1.40 [0.81;2.43]	0.223	1.17 [0.82;1.68]	0.393	1.36 [0.95;1.96]	0.096
T4/T3	1.07 [0.67;1.70]	0.788	1.05 [0.68;1.64]	0.817	1.33 [0.95;1.86]	0.101	1.24 [0.91;1.68]	0.176
T5/T4	0.68 [0.46;1.00]	0.051	0.69 [0.47;1.02]	0.060	0.85 [0.63;1.16]	0.309	0.81 [0.59;1.11]	0.196

Note: Modell: GEE model with Poisson family.

Abbreviations: GBT, guided biofilm therapy; US + P, ultrasonic debridement and abrasive paste.

*Statistically significant.

TABLE 3 Treatment duration of the two treatment modalities at baseline (T0), 3 months (T3) and 6 months (T4).

	Mean treatment time (Min) [SD]		
	US + P	GBT	*p*-value A versus B
T0	20:32 [19:30;21:38]	18:39 [17:42;19:38]	<0.0001*
T3	16:38[15:34;17:47]	12:35 [11:46;13:27]	<0.0001*
T4	14:45[13:47;15:46]	11:01[10:18;11:47]	<0.0001*
Ratio (%) T3/Baseline	19.1%	32.5%	
Ratio (%) T4/Baseline	28.3%	40.9%	

Abbreviations: GBT, guided biofilm therapy; Min, minutes; SD, standard deviation; US + P, ultrasonic debridement and abrasive paste.

*Statistically significant.

might be that the interval between the follow-ups was relatively short (3 months), not allowing enough time for any considerable amount of hard build-up to accumulate, but also to the fact that the patients received repeated sessions of OHI. This finding reinforces the importance of regular dental attendance, which leads to improved oral health outcomes.[20] Interestingly, the reduction in treatment time was more evident for the GBT protocol: the time difference between GBT and US + P started from 9.2% at baseline and reached around 25% of treatment time saved at 3 and 6 months. The lack of abundant hard deposits could again be the reason which made air-polishing the preponderant instrument during the treatment, removing plaque and biofilm faster than conventional instruments. Our results are in accordance with the study of Fu et al. (2021),[14] in which four different approaches were tested in a split-mouth design: air-polishing or rubber cup with and without prior plaque disclosing. Air-polishing was significantly faster than rubber cup polishing for dental prophylaxis, totalling approximately 5.5 min of saved time for each patient. On the other hand, Park et al. (2021)[15] performed professional prophylaxis on 173 patients with either ultrasonic followed by rubber cup, ultrasonic followed by air-polishing and air-polishing followed by ultrasonic, and found that plaque control with air-polishing took longer than with a rubber cup. However, when air-polishing was applied before scaling, similarly to our study's protocol, it reduced the time needed for ultrasonic scaling and the overall treatment time. Both Fu et al. (2021)[14] and Park et al. (2021)[15] also agree that the protocols involving air-polishing, especially if guided by plaque disclosing, achieve better plaque removal than traditional instrumentation, in accordance with the first part of this study.[9]

Decreasing treatment time means a reduction in clinic expenses. Staff time is a significant factor when evaluating a dental treatment's cost-effectiveness.[13] According to a report of the German Federal Association of Statutory Insurance Dentists from 2013,[21] 1 h of chair time is worth 190.00€, which translates

TABLE 4 Patient perception questionnaire: assessment of the individual treatment modalities at baseline (T0), 3 months (T3) and 6 months (T4).

	T0			T3			T4		
	US + P	GBT	*p*-value GBT versus US + P	US + P	GBT	*p*-value GBT versus US + P	US + P	GBT	*p*-value GBT versus US + P
1. Quality of treatment									
Insufficient	0	0	<0.0001*	1 (2,5%)	0	<0.0001*	2 (5.1%)	0	<0.0001*
Average	9 (22.0%)	1 (2.4%)		4 (10.0%)	3 (7.5%)		4 (10.3%)	1 (2.6%)	
Good	24 (58.5%)	13 (31.7%)		27 (67.5%)	8 (20%)		25 (64.1%)	5 (12.8%)	
Optimal	8 (19.5%)	27 (65.9%)		8 (20%)	29 (72.5%)		8 (20.5%)	33 (84.6%)	
2. Discomfort									
0	1 (2.4%)	12 (29.3%)	<0.0001*	1 (2.5%)	14 (35%)	<0.0001*	0	14 (35.9%)	<0.0001*
1	5 (12.2%)	13 (31.7%)		10 (25%)	14 (35%)		12 (30.8%)	16 (41%)	
2	14 (34.1%)	10 (24.4%)		16 (40%)	8 (20%)		14 (35.9%)	7 (17.9%)	
3	17 (41.5%)	5 (12.2%)		9 (22.5%)	2 (5%)		8 (20.5%)	1 (2.6%)	
4	1 (2.4%)	1 (2.4%)		4 (10%)	2 (5%)		4 (10.3%)	1 (2.6%)	
5	3 (7.3%)	0		0	0		1 (2.6%)	0	
3. Sensation of clanliness									
Insufficient	1 (2.4%)	1 (2.4%)	<0.0001*	1 (2.5%)	1 (2.5%)	<0.0001*	0	0	0.0004
Average	3 (7.3%)	0		1 (2.5%)	1 (2.5%)		2 (5.1%)	3 (7.7%)	
Good	17 (41.5%)	15 (36.6%)		14 (35%)	8 (20%)		16 (41%)	9 (23.1%)	
Optimal	20 (48.8%)	25 (61.0%)		24 (60%)	30 (75%)		21 (53.8%)	27 (69.2%)	

Note: Discomfort was expressed through a scale from 0 (nil discomfort) to 5 (maximum discomfort).

Abbreviations: GBT, guided biofilm therapy; US + P, ultrasonic debridement and abrasive paste.

*Statistically significant.

to around 3€ per minute, whilst a randomized study about the cost-effectiveness of non-surgical periodontal treatment calculated that 1 min of periodontal treatment is worth 6€.[22] As prophylaxis appointments constitute a significant portion of the treatment provided in a dental clinic – is it calculated that, in the United Kingdom, around 50% of the treatments provided are examinations followed by "scale and polish"[23] – time saved on this treatment could have a heavy impact on the overall profitability of the practice. The present study did not aim to calculate the cost-effectiveness of air-polishing compared to the conventional protocol. However, a study from 2015[13] investigating the cost-effectiveness of different treatment modalities for peri-implantitis, found that air-polishing was the second-best alternative after debridement alone, with only a relatively small increase in cost.

Professional dental prophylaxis constitutes a life-long commitment. However, non-regular dental care is a reality many of us face in everyday clinical practice. Fear and anxiety seem to be important in children and adults among the individual factors associated with dental avoidance.[12] Therefore, assuring a comfortable and pleasant dental treatment and creating a positive experience around the prophylaxis appointments could help increase compliance and attendance. In the present study, the perceived quality of the treatment was fairly high for both protocols; just 1–2 patients rated US + P quality as insufficient. However, significantly more patients thought that the quality of GBT was optimal. A similar pattern was observed regarding the sensation of cleanliness after treatment, except for the 6-month appointment, in which the difference between the two protocols was not significant. The similarity might be due to the improved oral hygiene status after repeated prophylaxis and oral hygiene instructions. We added this parameter to the questionnaire as we feared some patients might perceive the shorter appointment time we expected with GBT as a decrease in the time they are dedicated and, consequently, a decrease in the thoroughness of the process. However, a decrease in satisfaction did not seem to happen.

Regarding discomfort, 7.3% of patients found it "maximum" for US + P at baseline and only 1 at 6 months. No patient at any time point rated GBT with "maximum discomfort". Quite the opposite, 29–35% of patients perceived no discomfort during GBT across the observation period, significantly more than US + P, which was scored as such only by 2.5% of patients (one patient) at baseline and 3 months.

When asked to choose the preferred treatment method, GBT was selected by the vast majority of patients in terms of perceived quality (from 70.7% at baseline to 79.5% at 6 months) and comfort (from 85.4% at baseline to 94.9% at 6 months). Overall, after 6 months of treatment, 82.1% of patients prefer to be treated with GBT, versus 5.1% preferring US + P. Our results differ from the ones from Park et al. (2021),[15] in which patients' satisfaction level was similar among all groups. However, their survey was minimal (patients were asked to rate the treatment from 0 to 10) and administered only once. A more comprehensive survey was administered by Fu et al. (2021),[14] and participants were asked to rank the treatment on a scale from 0 to 10 in regards to the level of discomfort, sensitivity, pain, duration of treatment, messiness, fear-inducing, noise level, and overall satisfaction. They were also asked to state their preferred treatment option. Most participants (53.4%) preferred the air-polishing protocol, but still a smaller percentage than our study (82.1% at T4). The authors provide a possible explanation, as they seemed to find the air-water spray control challenging, influencing the tidiness ranking for the air-polishing group.[14] The operators in our study were experienced in using an air-polishing device and controlling the related splatter and aerosol. Moreover, and most importantly, in Fu et al. (2021)[14] the protocol did not involve manual or ultrasonic scaling, focusing only on plaque control. Usually, scaling is the part of the treatment that is perceived as more uncomfortable by the patients, and not having to undergo any of it might have levelled the perception of comfort in the two study groups. Finally, air-polishing before scaling seems to significantly reduce the time needed with ultrasonic and manual instruments,[15] possibly positively influencing our study's overall treatment perception.

To the best of our knowledge, this is the only study on applying GBT during the regular maintenance therapy of periodontally healthy patients, with an observation period of 12 months. Most studies investigate the application of air-polishing in the maintenance therapy of periodontal patients, again with clinical success compared to traditional methods, with better patients' comfort.[24]

Some limitations of the present study might be the fact that the selected patients were all relatively young and healthy, and variability in the results might exist for the real population in everyday practice, in which we might encounter subjects that are not suitable for air-polishing treatment (for example, severe asthma or respiratory illness). Moreover, the interval between review and maintenance appointments was initially very strict and short, whilst, in actual practice, most patients with no particularly elevated periodontal or decay risk are seen every 6–12 months. Finally, it would be of great interest to collect long-term data on the possible adverse effects of both protocols to determine whether the minimal invasiveness of the new air-polishing technology observed in vitro and protocol can translate into observable benefits for the patients.

5 | CONCLUSION

GBT protocol seems to achieve and maintain satisfactory low levels of BoP and PI, with no difference when compared to conventional ultrasonic debridement and rubber cup polishing in patients treated for gingivitis, therefore demonstrating to be a suitable prophylaxis modality. Additional observed advantages of GBT were shorter treatment time and patients' perceived quality, comfort and cleanliness.

6 | CLINICAL RELEVANCE

6.1 | Scientific rationale

To compare the traditional dental prophylaxis method with a new approach based on the use of full-mouth air-polishing followed by targeted ultrasonic calculus removal.

6.2 | Principal findings

The tested protocol is suitable for the maintenance of patients treated for gingivitis and might result in shorter treatment time and higher comfort.

6.3 | Practical implications

Professional prophylaxis can be enhanced by applying air-polishing and targeted ultrasonic instrumentation.

AUTHOR CONTRIBUTIONS

MM designed the study, SE and DM were the principal investigators, SA wrote the article, CS performed the statistical analysis.

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CONFLICT OF INTEREST STATEMENT

Dr. Mensi reports Personal fees from EMS, personal fees from KULZER, personal fees from SUNSTAR outside the submitted work. Dr. Scotti has nothing to disclose. Dr. Dalè has nothing to disclose. Dr. Sordillo reports personal fees from EMS Electro Medical Systems, during the conduct of the study. Dr. Calza has nothing to disclose. No financial sponsorship was provided by any company for the present study nor was any contractual agreement signed.

DATA AVAILABILITY STATEMENT

Data are available on request from the authors.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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