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ORIGINAL ARTICLE

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Adjunctive glycine powder air-polishing for the treatment of peri-implant mucositis: an observational clinical trial

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De Siena F, Corbella S, Taschieri S, Del Fabbro M, Francetti L. Adjunctive glycine powder air-polishing for the treatment of peri-implant mucositis: an observational clinical trial.

Abstract: *Objectives:* The aim of this study was to make a comparative evaluation of professional oral hygiene with or without the adjunct of glycine air-powder system for the treatment of peri-implant mucositis. *Methods:* After the application of inclusion and exclusion criteria, patients were divided in two groups: in control group, patients were treated with professional oral hygiene manoeuvres (POH) while in the test group, glycine air-powder system (SGA) was adjuncted to professional oral hygiene. Probing depth (PD), bleeding index (BI) and plaque index (PI) were measured at baseline, and 3 and 6 months after the treatment. *Results:* A total of 30 patients (15 per group) were selected for the study. In POH e SGA group, PD was, 2.86 ± 0.37 and 3.00 ± 0.36 mm at baseline, 2.90 ± 0.53 and 2.62 ± 0.50 mm after 3 months, 2.96 ± 0.56 and 2.41 ± 0.54 mm after 6 months, respectively, significantly lower in SGA group in the last follow-up visit. In both groups, both PI and BI decreased over time. *Conclusions:* The present reports showed that both techniques were useful for the treatment of peri-implant mucositis. In the test group (with glycine powder), a significant reduction of probing depth was observed.

Key words: air-abrasion; full-arch rehabilitations; glycine; peri-implant mucositis

Introduction

Dental implant treatment is a widely accepted treatment options for partial or complete edentulism, and this has been confirmed by a large number of studies (1–4).

In particular, the application of implant-retained prostheses for the solution of complete edentulism has been demonstrated to be an effective treatment option even in cases of severe bone atrophy (5, 6).

However, in medium and long-term studies, the occurrence of technical and biological complications was described, affecting the success rate of the prostheses and influencing implant survival rates (7). While the most common technical complications as fracture or detachment of veneers could be successfully treated without causing the loss of prosthesis function or of implants themselves, biological ones could jeopardize the whole restoration causing implant failure (7, 8).

Peri-implant mucositis and peri-implantitis represent the most common biological complications affecting implant surrounding hard and soft

tissues (9–11). Peri-implant mucositis is frequent adverse events. The incidence of peri-implant mucositis ranged from 50% to 90% of implants after 8–10 years (12, 13). It is characterized by mild soft tissue inflammation in the absence of any radiologic or clinical sign of bone resorption. On the other hand, peri-implantitis has been described to affect up to 36.6% of implants (14) and is characterized by pathologic peri-implant bone loss (9, 15). While peri-implant mucositis is reversible, often peri-implantitis could cause implant loss as the result of bone resorption process.

Treatment of peri-implant disease has the main objective of a complete debridement and disinfection of implant and prosthetic components, preventing bacterial biofilm formation and eliminating plaque and calculus (16, 17). Scientific literature showed a high predictability of the use of local antimicrobials as chlorhexidine (rinses or gel) for the treatment of peri-implant mucositis and peri-implantitis (17). Air-abrasive devices with bioactive powders were also used in the treatment of peri-implantitis aiming at a mechanical submucosal debridement of bacterial biofilm, without interfering with the microscopical architecture of the titanium surface (18–20). However, to our knowledge, there are relatively scarce data about the use of air-abrasive devices in the treatment of peri-implant mucositis.

The aim of this observational clinical trial was to compare standard professional oral hygiene manoeuvres versus treatment with adjunctive air-abrasive device with glycine powder for the treatment of peri-implant mucositis in patients with mandibular full-arch implant-supported restoration. The null hypothesis both treatments are equally useful for the treatment of peri-implant mucositis.

Materials and methods

The patients included in this investigation were treated following the principles established by the Helsinki Declaration as modified in 2000 (21). The research project was approved by the Review Board of the IRCCS Istituto Ortopedico Galeazzi in Milan, Italy. All patients were informed about the study protocol and signed an informed consent form before entering the study. This report was written following the CONSORT guidelines for reporting clinical trials (22). This observational-controlled clinical trial had a parallel group design (ratio 1:1).

Inclusion and exclusion criteria

Patients were included considering the following eligibility criteria:

- Patients with mandibular full-arch implant-supported rehabilitations,
- Bleeding on probing or spontaneous bleeding with local swelling (code 1, 2 or 3 as described in previously published report (23),
- Plaque accumulation at the implant-abutment level (code 1, 2 or 3 as described in previously published report (23),
- Implant probing depth ≤3.5 mm,
- Peri-implant bone resorption <3 mm evaluated through the use of standardized radiographs, taken with the use of a individualized radiograph holder.

Exclusion criteria were:

- Documented allergy or intolerance towards the components of the products used in the study,
- Antibiotic treatment within 6 months before the beginning of the study,
- Topical antimicrobial treatment within 4 weeks before the beginning of the study,
- Presence of active infection with suppuration.

All patients were enrolled and treated in the Dental Clinic of the IRCCS Istituto Ortopedico Galeazzi in Milan, Italy. Data were recorded and analyzed in the same department. They were allocated to one group or another following the order of presentation to the clinic. The first 15 patients were allocated to control group and the last 15 to the test one.

Clinical procedure

All clinical procedures were performed by a registered dental hygienist, in one single visit, trained for 3 years in the use of devices and products used in the study.

Professional oral hygiene (POH) only group (control): patients were treated with standard professional oral hygiene manoeuvres including debridement of plaque and calculus from the abutment and prosthetic surface using manual Teflon curettes followed by polishing.

Professional oral hygiene and submucosal glycine application (SGA) through air-abrasive device (Handy AirFLow® with insert PerioFlow®; EMS, Nyon, Switzerland) (test): after the described before oral hygiene manoeuvres, glycine powder was applied submucosal on each side of the implant abutment (mesial, distal, buccal and lingual) using a tip to avoid a damage of surrounding tissues, for no more than 5-s for each side.

Oral hygiene instructions were provided at baseline and repeated in each follow-up visit 3 and 6 months after intervention. No antibacterial treatment was performed in the follow-up visits.

Outcomes

The primary outcomes were as follows:

- Bleeding index (BI) as used in previously published reports (23, 24). The codes were assigned as follows: (i) code 0: no bleeding; (ii) code 1: bleeding on probing without swelling; (iii) code 2: bleeding on probing with redness and swelling and (iv) code 3: spontaneous bleeding,
- Plaque index (PI) as used in previously published reports (23, 24). The codes were assigned as follows: (i) no plaque accumulation; (ii) plaque accumulation revealed using a probe; (iii) moderate accumulation of visible plaque or calculus and (iv) high accumulation of visible plaque or calculus,

• Probing depth (PD) measured using a plastic probe (Colorvue® Hu-Friedy®, Rotterdam, Belgium with University of North Carolina markings) with a probing force of 0.25 N.

The secondary outcomes were as follows:
• Subjective appreciation of the used technique evaluated through a visual analogue scale (VAS) made of a 10-cm line, having a '0' label on its left extent and a '100' label on its right extent (24). The patients were instructed to mark a point on the line evaluating their appreciation where '0' represented the least appreciation and '100' the highest,
• Perception of ease-of-use using a VAS scale, as described before, where '0' represented the least perception and '100' the highest (easiest) (24),
• Prevalence of complications (acute infections, peri-implantitis and pain) or recession of soft tissues, measured evaluating photographs taken at baseline and in each follow-up visit.

All measurements were taken by the same operator (FDS) with more than 5 years of experience in this field.

Measurements of BI, PI and PD were taken at baseline (T0), before intervention, after 3 months (T1) and 6 months (T2) after intervention. The appreciation and perception of easiness of use was evaluated immediately after the interventions.

Sample size calculation

The sample dimension was computed using alpha = 0.05 and the power (1−beta) of 80%. For the variability (standard deviation) probing, depth modification was considered as covariate. Data for sample size calculation were retrieved from the study by De Siena *et al.* (24) in 2013. Based on the data, the needed number of patients to be recruited in this study was 12 for the each group. The number of recruited patients was then increased of 20% considering the possibility of dropouts (15 for each group).

Statistical methods

Statistical analysis was performed by a blinded operator (SC) using a software package (R 3.0.2; Institute for Statistics and Mathematics, Wirtschaftsuniversitat Wien, Wien, Austria). Descriptive statistics was performed using mean ± standard deviations for quantitative variables. Medians and confidence interval (95%) were also calculated. Frequencies were calculated for qualitative parameters. The Shapiro–Wilk test was used to assess normality. The comparison of PD, appreciation and perception of ease-of-use between groups was performed using unpaired Student's *t*-test (two-tailed). The analysis of variance (ANOVA one-way) was used to compare the same parameter in one group among different time frames. The comparison of BI and PI between groups and among different time frames was performed using Fisher's Exact test. The significance level was posed at $P = 0.05$.

Results

A total of 30 patients (15 per group) were selected for the study in the period between 2012 and 2013. The last follow-up visit was performed in 2013. All the patients attended the last follow-up visit. A diagram of patients' flow is presented in Fig. 1. Patient's baseline characteristics are presented in Table 1. At baseline, the two groups appeared statistically comparable.

In Table 2, data about PD over time are shown. In POH group, PD was 2.86 ± 0.37 mm at baseline, 2.90 ± 0.53 mm at the 3 months follow-up and 2.96 ± 0.56 mm at the 6 months follow-up without any significant difference among different time frames. In SGA group, PD was 3.00 ± 0.36 mm at baseline, 2.62 ± 0.50 mm at the 3 months follow-up and 2.41 ± 0.54 mm at the 6 months follow-up with a statistically significant difference among the different time frames ($P = 0.02203$). At 6 months, there was a statistically significant difference between the two groups ($P = 0.00103$) being significantly lower in the test group.

Frequencies of BI and PI are presented in Table 3. In POH group, nine patients after 3 months and nine after 6 months did not present any sign of bleeding and none in both follow-up visits presented moderate bleeding. In the same group, PI decreased significantly over time. In SGA group, 12 patients after 3 months and 13 after 6 months did not present any sign of bleeding and only one in both follow-up visits presented moderate bleeding (Figs 2 and 3). At the 6 months, follow-up plaque index was significantly lower in the test group ($P = 0.00439$). As a consequence, also bleeding index was

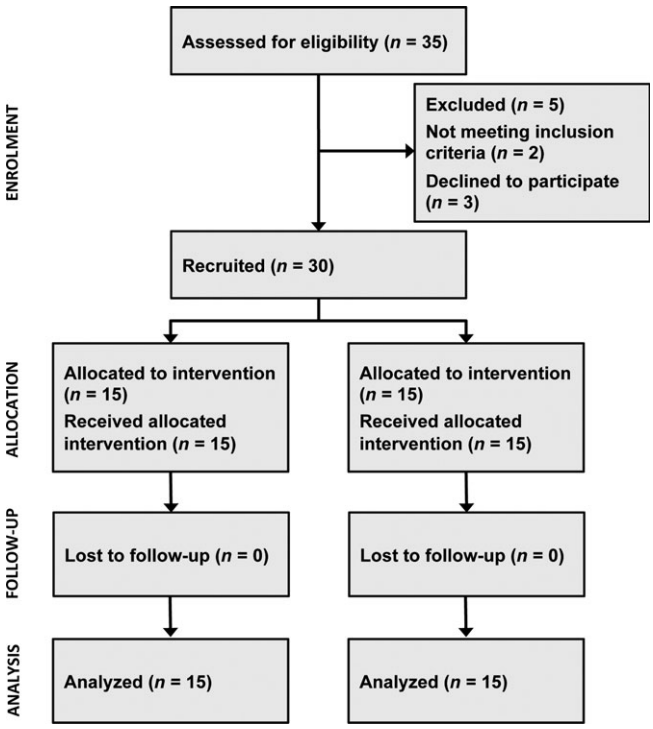

Fig. 1. Diagram of patients' flow.

Table 1. **Demographic characteristics of the sample**

Characteristic	POH group $n = 15$	SGA group $n = 15$	Total $n = 30$	Difference
Gender (M/F)	6/9	6/9	12/18	NS
Age (mean ± SD) years	64.8 ± 12.5	63.3 ± 9.3	64.0 ± 10.9	NS
Diabetes (*n*)	0	0	0	NS
Cigarettes (mean ± SD)	5.5 ± 2.6	4.3 ± 2.3	5.1 ± 3.0	NS
Periodontitis	0	0	0	NS
Alcohol consumption (*n* glass per day)	0.7 ± 0.9	0.5 ± 0.9	0.6 ± 0.9	NS
PI (median)	1	1	1	NS
BI (median)	1	1	1	NS
PD (mean ± SD) mm	2.9 ± 0.4	3.0 ± 0.4	2.9 ± 0.4	NS

Table 2. **Probing depth (mm)**

	Baseline	3 months	6 months	ANOVA
POH group	2.9 ± 0.4 (CI 95%: 2.8–3.2)	2.9 ± 0.5 (CI 95%: 2.7–3.3)	3.0 ± 0.6 (CI 95%: 2.8–3.4)	NS
SGA group	3.0 ± 0.4 (CI 95%: 2.8–3.2)	2.6 ± 0.5 (CI 95%: 2.3–2.8)	2.4 ± 0.5 (CI 95%: 2.2–2.8)	<0.05
t-test (POH versus SGA)	NS	NS	<0.05	

Table 3. **Frequencies of BI and PI values over time**

		Baseline		3 months		6 months	
	Values	POH	SGA	POH	SGA	POH	SGA
BI	0	0	0	9	12	9	13
	1	12	11	6	2	6	1
	2	3	4	0	1	0	1
	3	0	0	0	0	0	0
PI	0	0	0	7	10	5	12
	1	10	10	6	4	9	2
	2	5	5	2	1	1	1
	3	0	0	0	0	0	0

lower in the test group than in control group 6 months after treatment ($P = 0.02245$).

In the test group, appreciation was quantified as 87.2 ± 15.4 while in the control group, it was 83.3 ± 12.1, without any significant difference. The perception of ease-of-use was 87.0 ± 18.5 and 81.9 ± 22.4 respectively in the test and control group. No significant difference could be evaluated also for this parameter. No complication or soft tissue recession occurred after the intervention.

Discussion

The present paper reported outcomes of two techniques for the treatment of peri-implant mucositis in patients with full-arch implant-supported rehabilitations.

Some limitations in the study design should be acknowledged. First, this was a non-randomized study even though no significant differences emerged between the two groups at baseline, making them fully comparable. Moreover, the blindness of the statistician and of the patients might be considered when evaluating the significance of the results, because it can increase the external validity of the study. Moreover, all patients belonged to a well-maintained cohort of subjects, and they were instructed about home oral hygiene manoeuvres before the interventions and this could have confounded the results. However, this aspect could have been important in causing the absence of dropouts in attending the follow-up visits due to the high motivation of the enrolled patients.

As a summary, the present investigation showed that both clinical procedures can lead to a resolution of the inflammatory condition with a slightly superior beneficial effect in SGA group after 6 months in terms of BI and PI. Interestingly, the use of air-abrasive device leads to a significant reduction of probing depth over time if compared to POH group, and this may be due to a sort of trophic effect on peri-implant soft tissues of the use of glycine powder that must be further investigated.

A number of articles evaluated the use of glycine powder in the treatment of gingival infections. In one study by Petersilka *et al.* (25), the authors described the effect on periodontal tissues (gingiva) of glycine powder air-abrasion versus bicarbonate powder and hand-instrumentation. The authors showed that glycine powder resulted in minor erosions of the gingival epithelium if compared to other treatment options. This might be considered in the light of the results of the present study, because a less traumatic effect on tissue could have caused the beneficial effect on PD measurements.

Glycine powder, if compared with standard air-abrasive powder, did not produce any alteration in the titanium surface characteristics as described *in vitro* studies, and this was not influenced by the distance or the angulation of the air-abrasive spray (19, 26). Moreover, it was observed a positive effect on the mitochondrial activity of SaOs-2 cells, which possess several osteoblastic features (19).

This characteristic may cause a reduction of titanium alterations that may lead to an increase of biofilm formation and plaque accumulation. In this study, a significant difference in

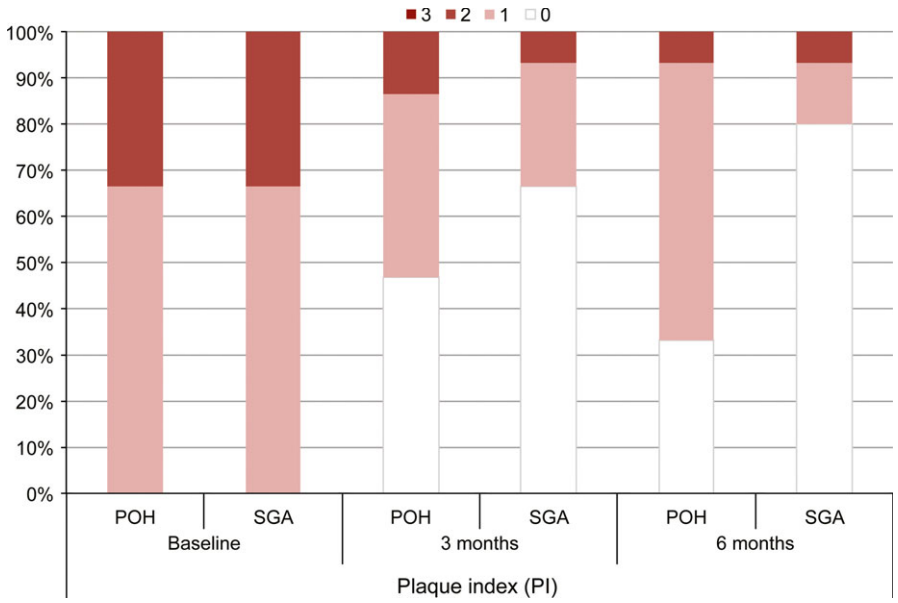

Fig. 2. Plaque index (PI) frequencies.

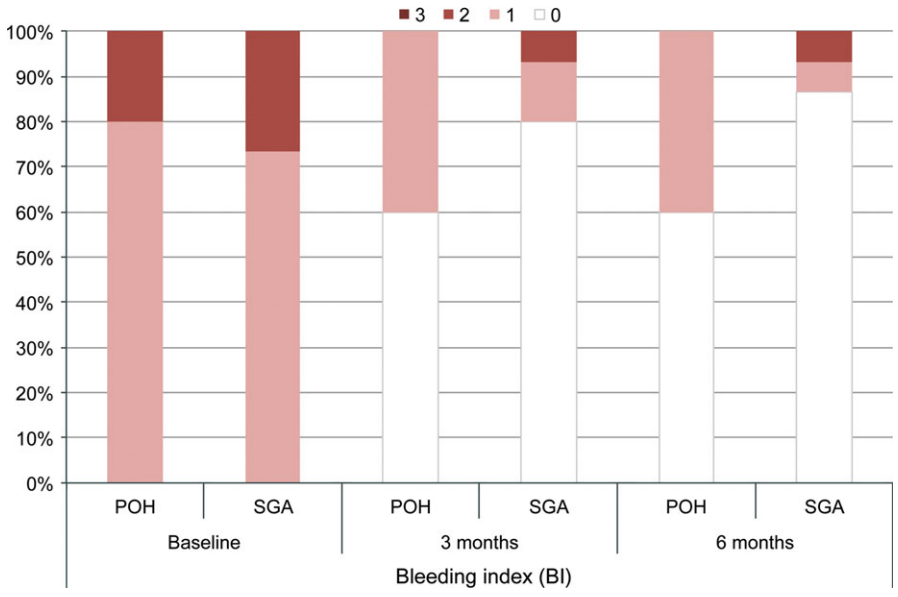

Fig. 3. Bleeding index (BI) frequencies.

plaque accumulation after 6 months between groups was observed. In addition of the absence of surface alteration, also the ability to inhibit of the formation of bacterial biofilm should be investigated in further studies.

Air-abrasive powder was used for the treatment of treatment of peri-implant infections, including peri-implantitis (18, 20, 27, 28).

Sahm *et al.* (18) compared the use of glycine powder versus chlorhexidine local applications for the treatment of peri-implantitis. In this study, data about bleeding on probing showed that this parameter decreased significantly more in the glycine powder group than chlorhexidine group, without a significant improvement in terms of clinical attachment level.

The use of glycine powder was also compared to Er:YAG laser application in the treatment of peri-implantitis (20). Beneficial effects on clinical parameters (bleeding on probing and probing depth) were evaluated for both groups, due to the ability of disinfecting the submucosal environment of both devices.

One study was more recently published about the adjunctive application of glycine powder for the treatment of peri-implant mucositis if compared to sole professional oral hygiene (29). In this study, authors did not find any significant more beneficial effect of the use of glycine powder on clinical parameters, 3 months after the intervention. Interestingly, at 3 months, the results appeared similar to those showed in this study. It could be hypothesized that the improvements in clinical parameters may be more evident after a longer follow-up, as showed in the present study. Moreover, differently from the present study, the report by Ji and coworkers found no differences in PD changes over time even though it has to be considered that the follow-up time (3 months) was shorter than the one used in this article.

In conclusion, it can be postulated that the use of glycine powder through air-abrasion device as an adjunct to professional oral hygiene could result in a beneficial effect for the treatment of peri-implant mucositis if compared to sole professional oral hygiene through mechanical devices.

However, more randomized studies and *in vitro* investigation can help a better understanding of the mechanisms of interaction with mucosal tissues and of the extent of the beneficial effects on clinical parameters.

Clinical relevance

Scientific rationale for study

Peri-implant diseases are a group of pathologies affecting mucosal tissues and with a high, growing prevalence in the population.

Principal findings

Air-abrasive system with glycine powder can be considered as viable treatment option for peri-implant mucositis as an adjunct to professional oral hygiene manoeuvres. Moreover, glycine may have an important effect on the mucosal health, with a consequent reduction of probing depth.

Practical implications

Glycine powder air-polishing could be safely used in the non-surgical treatment of peri-implant diseases.

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