Evaluation of a single non-surgical approach in the management of peri-implantitis: glycine powder air-polishing versus ultrasonic device

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Abstract

Background: Precise dimensional impression accuracy is crucial in dental prosthetiDental implants are often used to replace lost teeth and present a high level of predictability, patient satisfaction, and long-term success. However, biological complications such as peri-implant mucositis and peri-implantitis have become major challenges to the profession.

Peri-implant mucositis is an inflammation of the soft tissues adjacent to a dental implant diagnosed with bleeding on gentle probing (<0.20 N). if the clinical signs are combined with bone loss, the condition is called peri-implantitis.

The treatment goal of peri-implant disease is to remove or significantly depress the levels of pathogens to allow the healing of the soft and hard tissues. Peri-implant mucositis is a common clinical entity that may develop into peri-implantitis, so early recognition and proper diagnosis of peri-implant disease are highly important in the treatment.

The presence study aimed to evaluate the clinical outcome (probing depth PD, bleeding on probing BoP, plaque index PI) following treatment of peri-implantitis with a single non-surgical approach using a glycine powder air-polishing (GPAP) or an ultrasonic device over 2 months.

Thirty implants were enrolled and randomly assigned to test (GPAP) and control (ultrasonic device) groups. Significant differences were found in the mean of the clinical outcome evaluation, but further observations of larger sample size of patients are needed.

Keywords: Peri-implantitis; Dental Implants; Air-Polishing Device; Glycine; Non-Surgical Treatment.

Introduction

The consensus report of the World Workshop on the Classification of Periodontal and Peri-Implant Diseases and Pathological Conditions, which met in 2017 in Chigaco, defines peri-implantitis as a biofilm-associated pathological condition involving the peri-implant tissues, characterized by inflammation of the mucosa and progressive loss of bone support (1,2).

Cigarette smoke [3], radiation therapy [4], poor patient compliance [5,6], and susceptibility to periodontal disease are outlined as the main risk factors predisposing to peri-implant disease [8]; recent evidence has also highlighted the role of local factors, such as the width of keratinized mucosa around the implant (9), the excess cement (10) and the prosthetic emergency profile of the reconstruction, which elements exacerbate peri-implant inflammation(12,13).

To date, no reliable evidence suggests the most effective treatment for peri-implantitis (14).

Correct oral hygiene instructions (OHI) are unanimously considered the most necessary

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and effective procedure for controlling and reducing oral bacterial biofilm (15). However, the morphological characteristics of implant-supported dental prosthetic rehabilitations can limit the implementation of optimal self-performed plaque control (16).
Whereas the mechanical removal of the biofilm, therefore professional non-surgical therapy in association with adequate home plaque control, proves to be the gold standard in maintaining peri-implant health and treating peri-implant pathologies (17), additional auxiliary therapies can improve clinical outcomes.
The non-surgical treatment of peri-implant disease is generally carried out through correct debridement of the fixture's surface, with the aim of reducing inflammation of the peri-implant tissues (18). Although various mechanical removal methods have been described in the literature, there is no unanimous consensus on defining a preferred decontamination method, which, therefore, remains one of the main topics of discussion (19).
Latest reviews have shown that curettes, ultrasonic instruments, and abrasive powders conveyed with air-polishing devices are the most common instruments used for debridement of the implant surface (20),21).
Recent in vitro studies, however, have investigated different methods of remediation of implant surfaces affected by peri-implantitis (22), demonstrating that air-polishing devices have greater decontaminating potential than ultrasonic curettes and scalers (23),(24).
These air-polishing devices (APD) have been part of everyday clinical practice for many years now as tools that offer a valid therapeutic possibility in maintaining periodontal health (25).
Since the onset of peri-implant mucositis is dependent on biofilm formation, ADPs have the potential also to be used in cases of peri-implantitis (26).
Glycine powder, a non-toxic and water-soluble compound, has been shown not to modify the implant surface profile under scanning electron microscope (SEM) (27).
Several clinical studies have detected a significant improvement in parameters such as probing depth (PD), bleeding on probing (BoP), and microbiological tests carried out after treatment of implant sites affected by peri-implantitis with glycine powder conveyed via air polishing (GPAP) (28), (29), (30).
However, it is still a topic of discussion that GPAP does not show superior performance when compared to other methodologies, such as manual instrumentation via curettes, ultrasonic scalers, or treatments using YAG (Yttrium Aluminum Garnet) lasers or Erbium lasers (28), (29), (30).
On the other hand, it is also essential to take into consideration the patient's degree of satisfaction with the treatment received in order to determine more precisely whether there is greater comfort and an individual preference in practicing one technique rather than another; several studies highlight how there is a lower degree of discomfort for the patient when undergoing treatment via APD compared to a traditional ultrasound technique (31).
Our study would like to contribute by evaluating the clinical effects on the health of peri-implant tissues in sites affected by peri-implantitis after a single phase of non-surgical treatment using two compared methodologies: glycine powder conveyed via air-polish device (GPAP) and Ultrasonic Instrumentation.

Materials and methods

Study Design

After the application of the eligibility criteria (Table 1), the implants considered suitable n=30 are divided into two groups (Flowchart) and instrumented using the Combi Touch Mectron multifunctional prophylaxis device®:

- TEST GROUP (GPAP) n=15: the implants of the test group are treated with a debridement session via GPAP, explicitly using the Air-Polishing Slim handpiece (Mectron®) with 120° inclination. The PERIO subgingival tip was applied around each side of the implant (mesial, buccal, distal, lingual, or palatal), conveying the glycine powder (Glycine

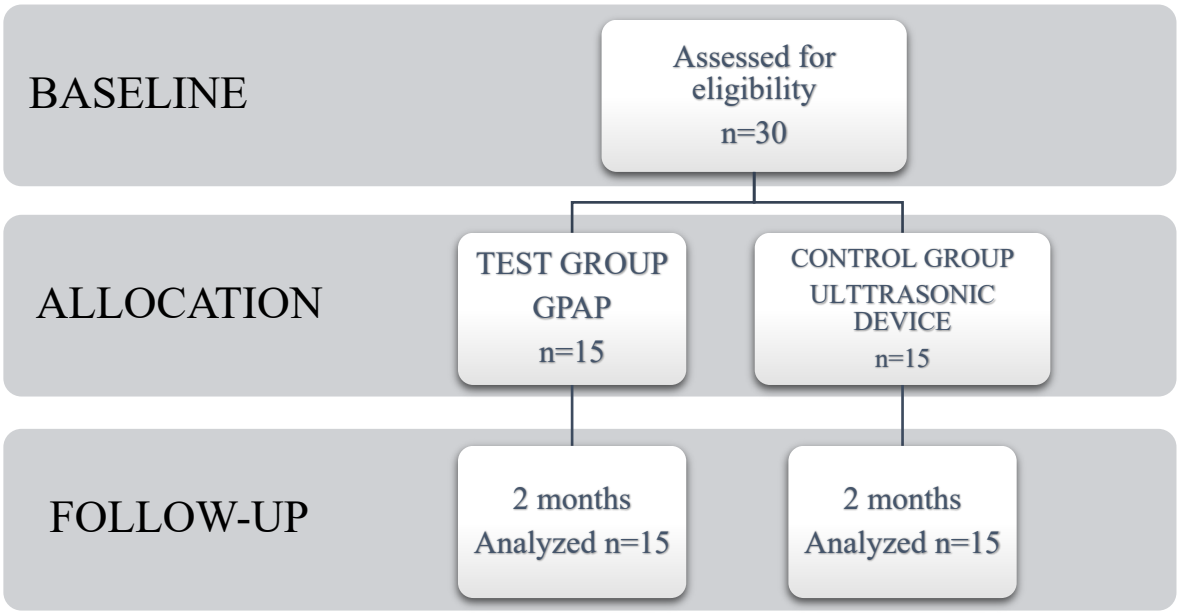

Figure 1. Flowchart of the study protocol

Table 1. Eligibility criteria

INCLUSION CRITERIA	EXCLUSION CRITERIA
PRESENCE OF ONE IMPLANT LOADED AT LEAST 1 YEAR PRIOR TO THEIR REFERRAL	HEAVY SMOKERS > 15 CIGARETTES/DD
EVIDENCE OF PERI-IMPLANT MUCOSITIS OR PERI-IMPLANTITIS WITH PD≥4 mm COMBINED WITH BLEEDING WITH OR WITHOUT SUPPURATION	UNCONTROLLED SYSTEMIC DISEASE (es. DM)
	IMPLANT MOBILITY

Powder, Mectron®) in the sulcus for at least 5 seconds (32), as specified by the manufacturer, or until the clinician deemed the area properly cleaned.

- CONTROL GROUP (ULTRASOUND) n=15: the control group implants are treated using an ultrasound handpiece, Slim Piezoelectric Scaler (Mectron®), with P3 model titanium tip (Perio Universal insert, Mectron®).

Clinical Variables

The clinical parameters of each implant were recorded in the periodontal chart (periodontal chart, Perio-tools®) at baseline and after two months in re-evaluation (follow-up), accompanied by periapical radiography (Figure 2):

- PD PROBING DEPTH measured as the distance between the gingival margin and the clinical extent of the sulcus/pocket, in six points for each implant
- BOP BLEEDING ON PROBING value 0: no bleeding on probing; value 1: bleeding on positive probing after insertion of the probe.
- PI PLAQUE INDEX value 0: no plaque accumulation; value 1: detection of plaque accumulation using the periodontal probe.

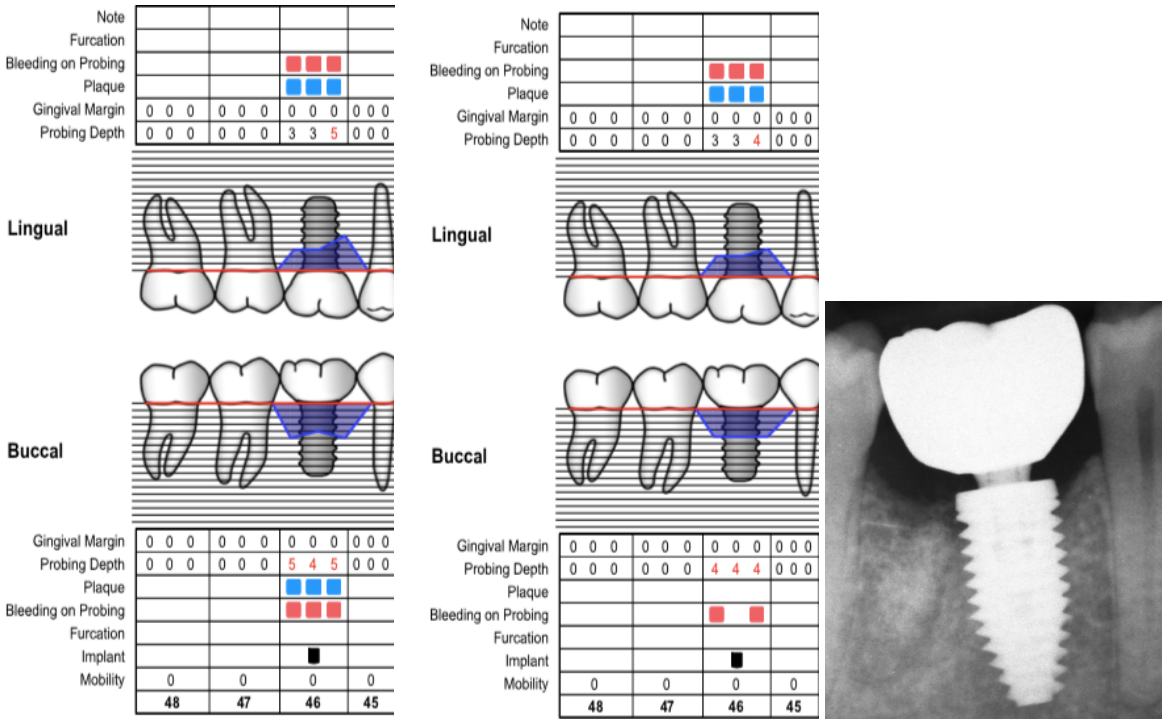

Figure 2. example of data collection in the periodontal chart at baseline and after 2 months (periodontal chart, Periotools®) with a digital periapical radiography.

Probing depth, bleeding on probing, and plaque index were measured at 6 implant sites (mesiobuccal, buccal, distobuccal, mesio-lingual or palatal, lingual or palatal, disto-lingual or palatal) using a periodontal probe (UNC 15, HuFriedy®, Chicago, IL, USA) with gentle pressure (approximately 0.20 N).

Randomization

Once the entry criteria had been confirmed, the subjects were entered into the study and assigned an implant number. Assignment to the test group (GPAP) or the control group (ultrasonic device) was made using computerized randomization.
A staff member not involved in the examination or treatment of the implants prepared and placed cards with group identification in numbered envelopes.
The clinician responsible for the treatment broke the envelope seal to give the therapy according to either group test or control.

Data extraction

n=30 implants divided into 2 groups were analyzed, and the following data were collected
at baseline and 8 weeks after treatment (Tables 2, 3): probing depth (PD), bleeding on probing (BoP), and plaque index (PI). Mean values and standard deviation (mean; SD) for the clinical parameters were calculated for each implant of the two groups.
Following baseline treatment, all patients in both groups were motivated with individual instructions for home oral hygiene (33), with the use of a manual or electric toothbrush, a toothpaste containing sodium fluoride, individualized interdental hygiene devices about the individual width of the interproximal space (34).

Table 2. Baseline and after 2-months clinical variables recorded for implant n=1 in the test group (GPAP)

IMPLANT N° 1	PRE			POST		
SITE	PD	BoP	PI	PD	BoP	PI
DV	2	1	1	2	0	0
V	2	1	1	2	0	0
MV	4	1	1	3	1	1
DO	5	1	1	4	1	0
OR	4	1	1	4	1	0
MO	5	1	1	4	1	0
MEAN	3.67	100%	100%	3.17	67%	17%
SD	1.3	0%	0%	0.98	52%	41%

Table 3. Baseline and after 2-months clinical variables recorded for implant n=1 in the control group (ultrasonic device)

IMPLANT N° 1	PRE			POST		
SITE	PD	BoP	PI	PD	BoP	PI
DV	3	0	0	3	0	1
V	3	0	0	3	0	0
MV	4	1	1	3	1	0
DO	4	1	1	3	0	0
OR	3	0	0	3	0	0
MO	4	1	1	4	1	1
MEAN	3.5	50%	50%	3.17	33%	33%
SD	0.55	55%	55%	0.41	52%	52%

Statistical analysis

Once the period of collecting clinical parameters at follow-up was completed, the data obtained were entered into a database to obtain a homogeneous and easily findable archive.
The average of the values recorded on the six sites for each implant was calculated and used for all clinical parameters. PD was measured millimeters, while dichotomous variables (BoP and PI) were expressed as percentages (Table 4).
The data were then analyzed, divided into groups based on the relationships to be investigated; the variables were defined using descriptive statistics, mean values, and percentages.
The data has been represented with graphs, histograms, and tables to facilitate understanding.

Results

Sample description

Thirty implants were enrolled in this study. Each implant received treatment according to the randomization. Fifteen implants were treated with the glycine air-polish device (GPAP, test group), and fifteen implants were treated using the ultrasonic device (US, control group).
Mean local implant bleeding on probing at baseline was 94,44% in the test group and 91,11% in the control group. Local bleeding on probing varied between the groups during the study period and was reduced between baseline and two months in both groups to 57,78% (test) and 72,22% (control). The mean local plaque index was 93,33% (test) and 92,22% (control) at baseline and was reduced in both groups to 34,44% (test) and 38,89% (control) at the end of the study (Figure 3).

Table 4. summary table of the clinical parameters examined and their variations in the two groups

	TEST GROUP		CONTROL GROUP	
	PRE	POST	PRE	POST
PD	4,044 mm	3,600 mm	3,911 mm	3,733 mm
BoP	94.44%	57.78%	91.11%	72.22%
PI	93.33%	34.44%	92.22%	38.89%

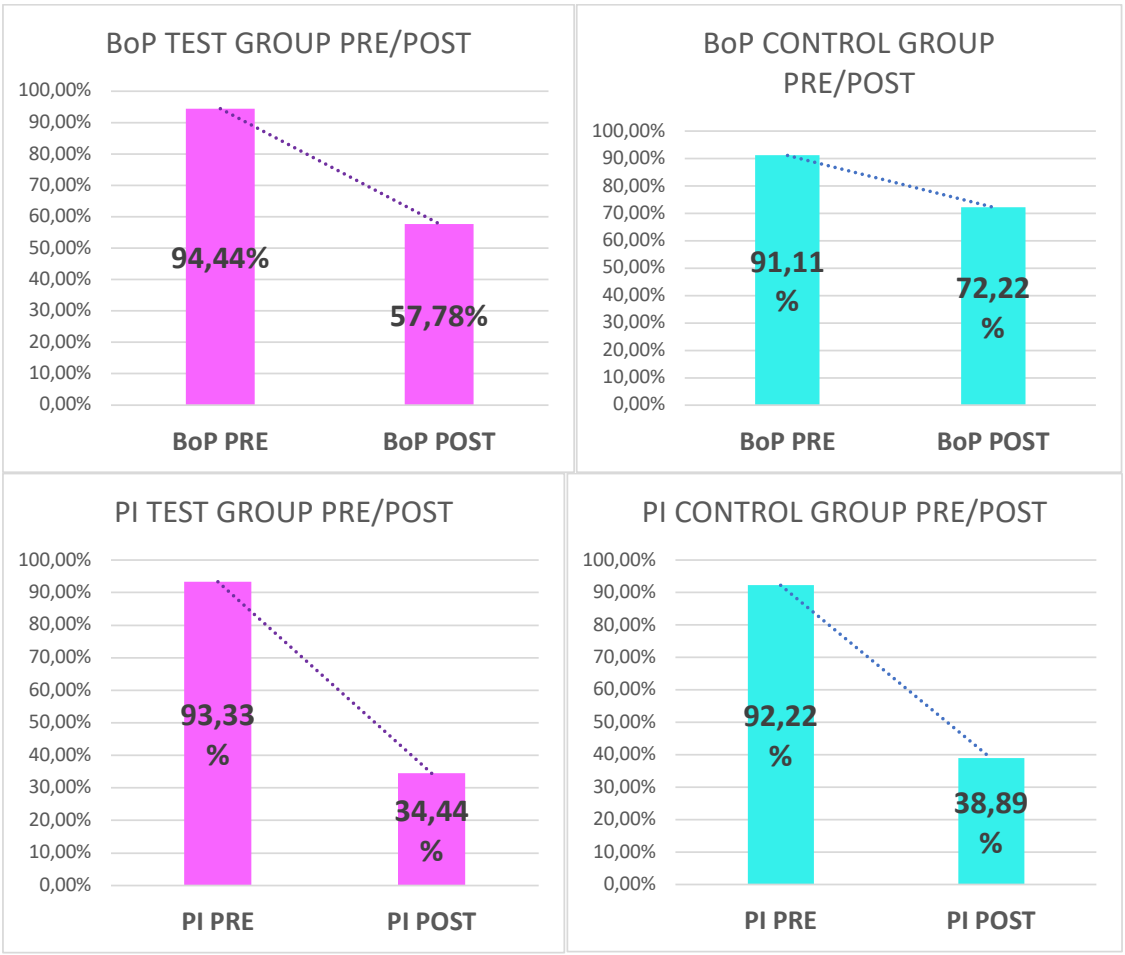

Figure 3. Changes in mean bleeding and plaque score in test and control groups at baseline (pre) and after 2 months (post).

The mean PD was 4,044 mm for test group implants and 3,911 mm for the control group. Mean PD varied between the two groups during the study period and was reduced between baseline and two months in both groups to 3,6 mm in the test group and 3,733 mm in the control group (Figure 4).
The mean PD of each implant was analyzed in both the test and control groups at baseline and after two months (Figs. 5, 6).

Implant pockets were grouped into sites, analyzed for both groups, and divided as follows:

- PD ≤ 2 mm
- 3 mm ≤ PD < 4 mm
- 4 mm ≤ PD < 5 mm
- PD ≥ 5 mm

The percentage of implant pockets in the test group (GPAP) with ≤ 2 mm in probing depth at baseline (pre)

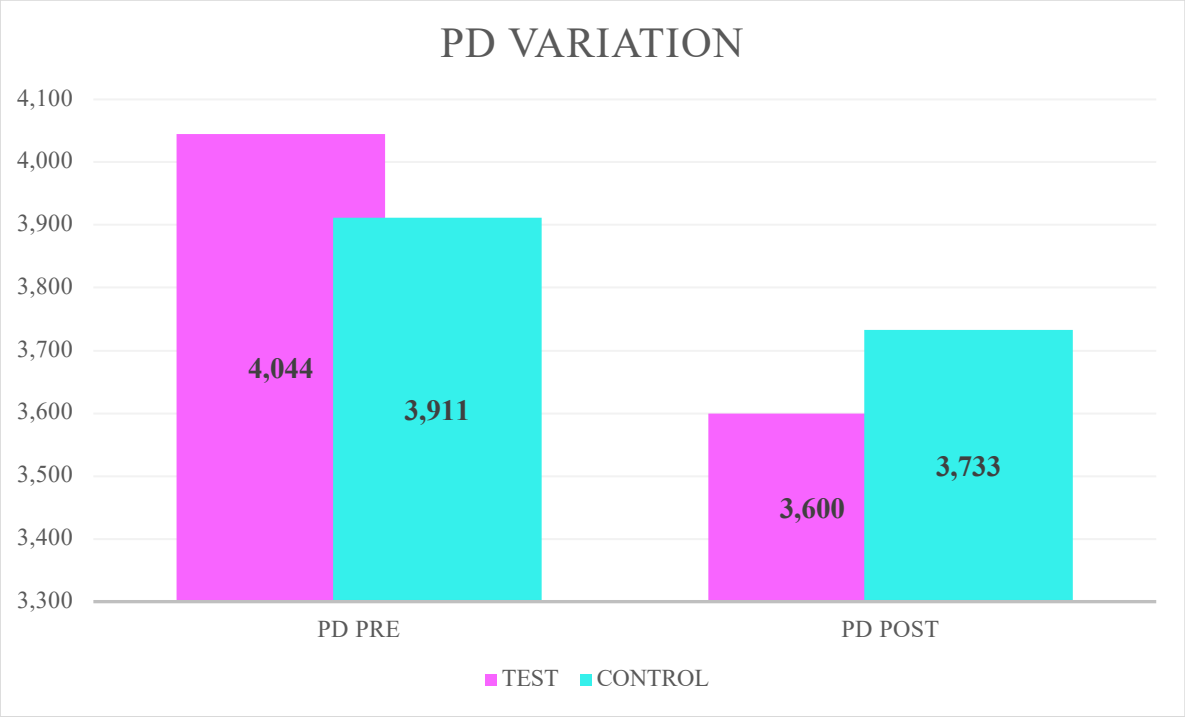

Figure 4. PD changes in mm between the test and control group at baseline and after two months.

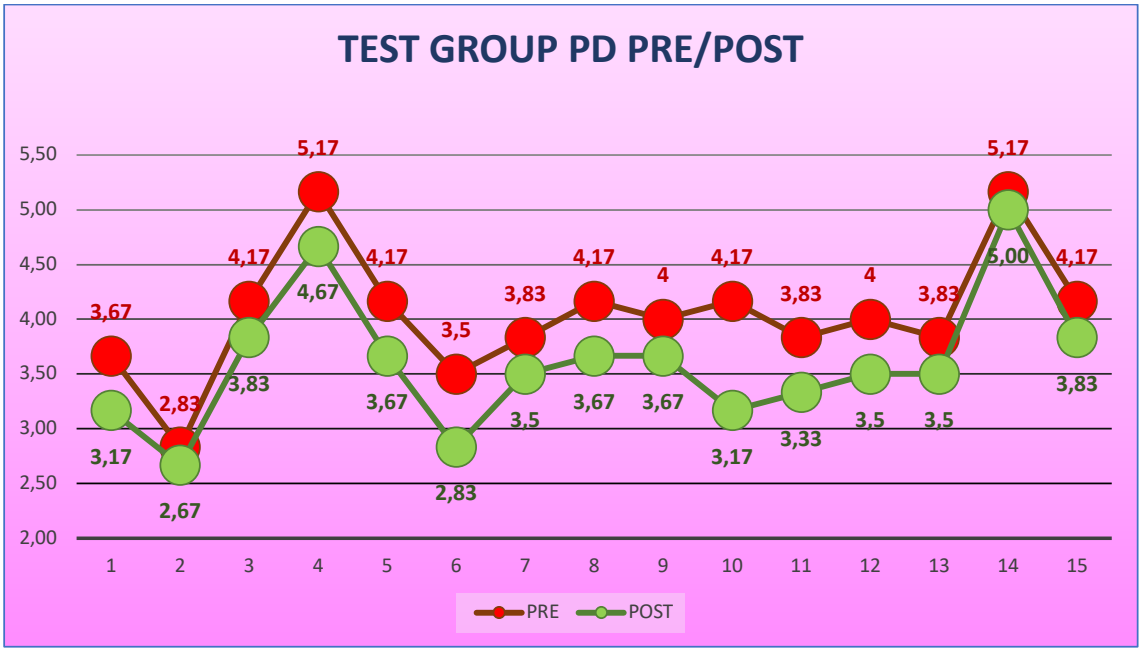

Figure 5. Mean PD variation for each implant at baseline (red) and after two months (green) in the test group (GPAP).

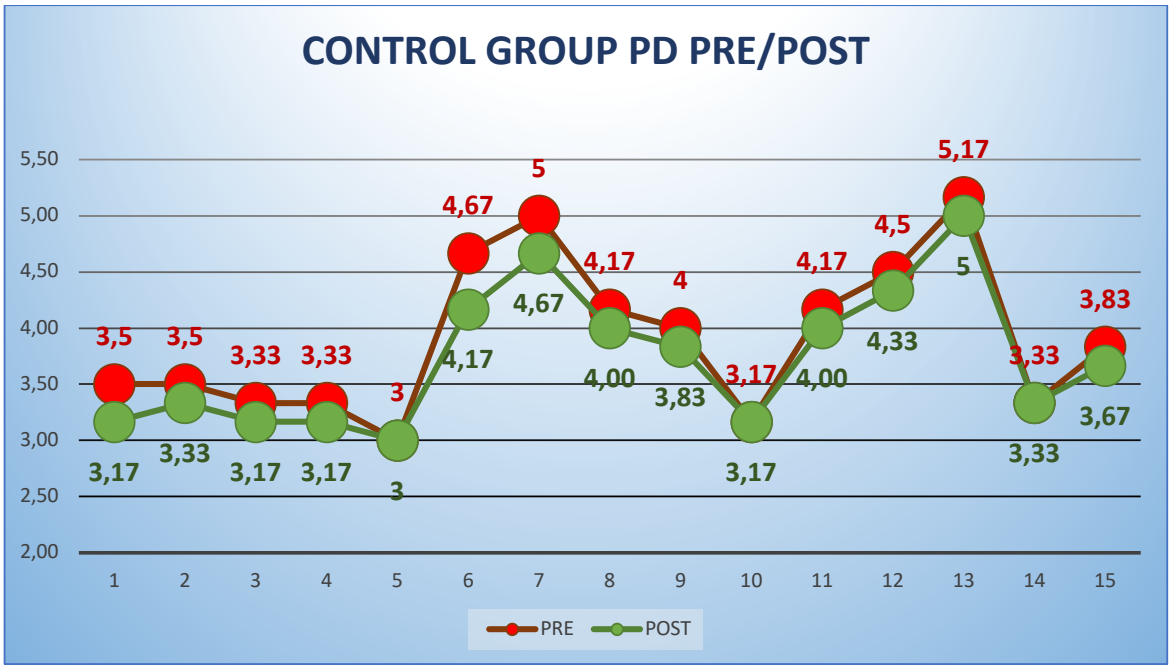

Figure 6. Mean PD variation for each implant at baseline (red) and after two months (green) in the control group (US).

was 5,56% (5 sites), with 3 mm ≤ PD < 4 mm was 21,11% (19 sites), with 4 mm ≤ PD < 5 mm was 41,11% (37 sites) and with PD ≥ 5 mm was 32,22% (29 sites). At the two-month follow-up (post) the number of sites ≤ 2 mm were increased to 12,22% (11 sites), with 3 mm ≤ PD < 4 mm to 30% (27 sites), with 4 mm ≤ PD < 5 mm to 44,44% (40 sites) and the number of sites ≥ 5 mm were reduced to 13,33% (12 sites) respectively (Table 5, Figure 7).

The percentage of implant pockets in the control group (US) with ≤ 2 mm in probing depth at baseline (pre) was 4,44% (4 sites), with 3 mm ≤ PD < 4 mm was 31,11% (28 sites), with 4 mm ≤ PD < 5 mm was 36,67% (33 sites) and with PD ≤ 5 mm was 27,78% (25 sites). At the two-month follow-up (post), the number of sites ≤ 2 mm was reduced to 3,33% (3 sites), with 3 mm ≤ PD < 4 mm were increased to 42,22% (38 sites), with 4 mm ≤ PD < 5 mm reduced to 34,44% (31 sites) and the number of sites ≥ 5 mm were reduced to 20% (18 sites) respectively (Table. 6, Figure 8).

No significant difference in the number of sites with 0-4 mm and 4 mm ≤ PD < 5 mm existed between the two groups.

The number of diseased sites (PD ≥ 5 mm) was reduced the most in the test group, from 29 to 12 sites, compared to the control group, from 25 to 18. There was a percentage difference between baseline (pre) and two-month follow-up (post) of 18,89% for the GPAP group and only 7,78% for the ultrasonic group (Figs. 9, 10).

Discussion

The present study reports the results of evaluating a single non-surgical approach to managing peri-implantitis using two different techniques: glycine powder delivered via an air-polishing device (GPAP) and Ultrasonic Instrumentation.

Air-polishing techniques are used in many dentistry fields that require removing bacterial biofilm. They assume considerable importance in the clinical management of periodontitis and peri-implantitis, given that these pathologies are considered a public health problem at a global level. The data available in the literature suggests that the prevalence of peri-implantitis is between 16% and 25% of patients with implants (35).

Table 5. Percentage and number of site variation in PD in the test group (GPAP) between baseline and follow-up at two months.

TEST GROUP	PD PRE		PD POST	
	No	%	No	%
≤ 2mm	5	5.56%	11	12.22%
3mm ≤ PD < 4mm	19	21.11%	27	30.00%
4mm ≤ PD < 5mm	37	41.11%	40	44.44%
≥ 5 mm	29	32.22%	12	13.33%

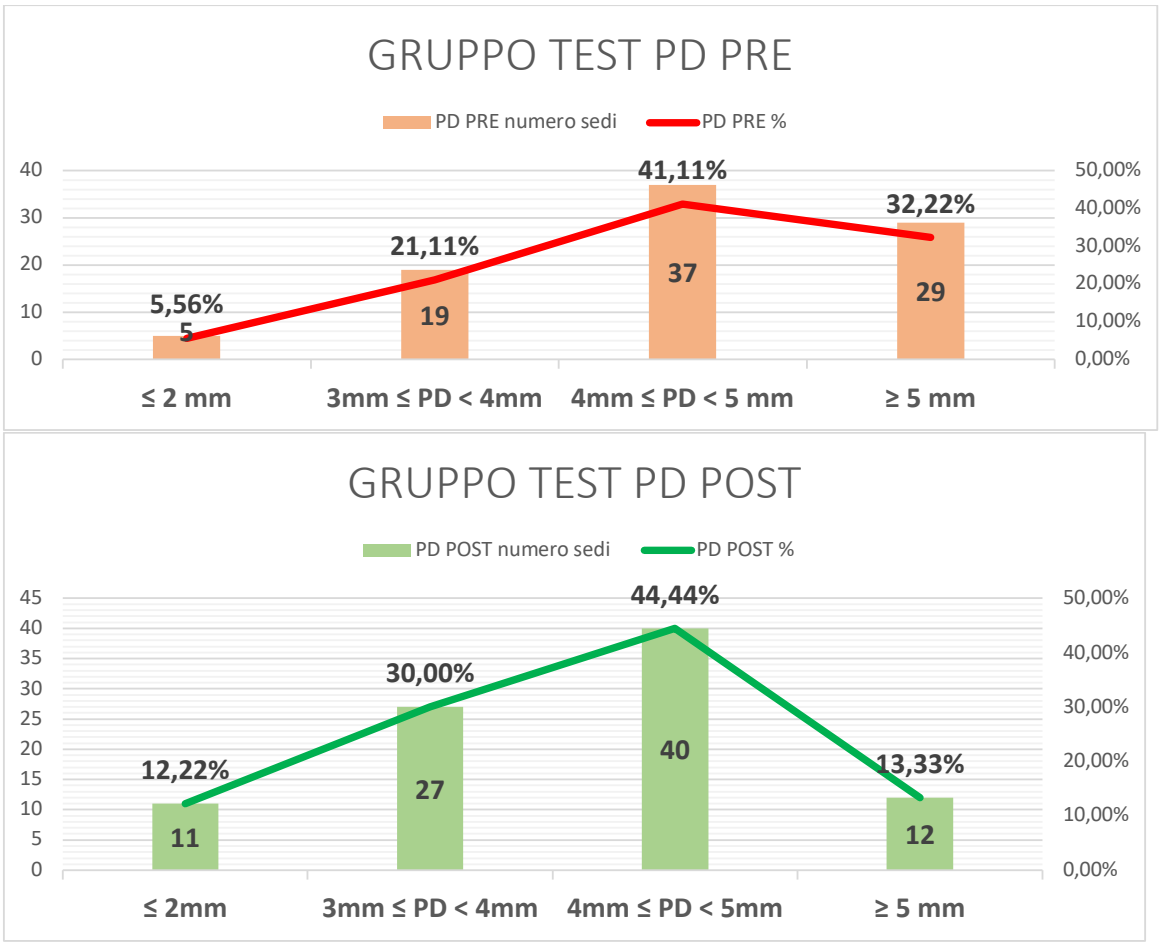

Figure 7. Percentage and number of sites variation in PD in the test group (GPAP) between baseline (red graph) and follow-up at two months (green graph).

Table 6. Percentage and number of site variation in PD in the control group (US) between baseline and follow-up at two months.

CONTROL GROUP	PD PRE		PD POST	
	No	%	No	%
≤ 2mm	4	4.44%	3	3.33%
3mm ≤ PD < 4mm	28	31.11%	38	42.22%
4mm ≤ PD < 5mm	33	36.67%	31	34.44%
≥ 5 mm	25	27.78%	18	20.00%

Many studies have ascertained the cause-effect relationship between the colonization of bacterial plaque and the pathogenesis of peri-implant disease (36). Thus, it is proven that the removal of bacterial biofilm is an essential prerequisite for the management and therapy of peri-implant diseases.
Various techniques have been proposed for treatment, such as mechanical and ultrasonic instrumentation or laser. Air-polishing powder procedures have been widely adopted in the therapy of peri-implantitis, showing no adverse side effects (37-38). On the contrary, several in vitro studies have shown that using substances with high abrasive power (e.g., sodium bicarbonate) can cause alterations in the surface characteristics of the implant fixtures and on the surface of natural teeth (39).
A less aggressive technique that uses glycine powder expresses excellent effectiveness in
Removal of the bacterial biofilm, compared to the methods mentioned above, reduces the biological trauma on the soft tissues, resulting in greater comfort for the patient, and above all, it does not cause alterations to the implant surface (40).
Glycine powder, when compared with other air-polishing powders, does not produce any alteration to the surface characteristics of titanium, as described by many in vitro studies, and this property is not influenced by the distance and angle of the flow of the air polishing (41), (42).

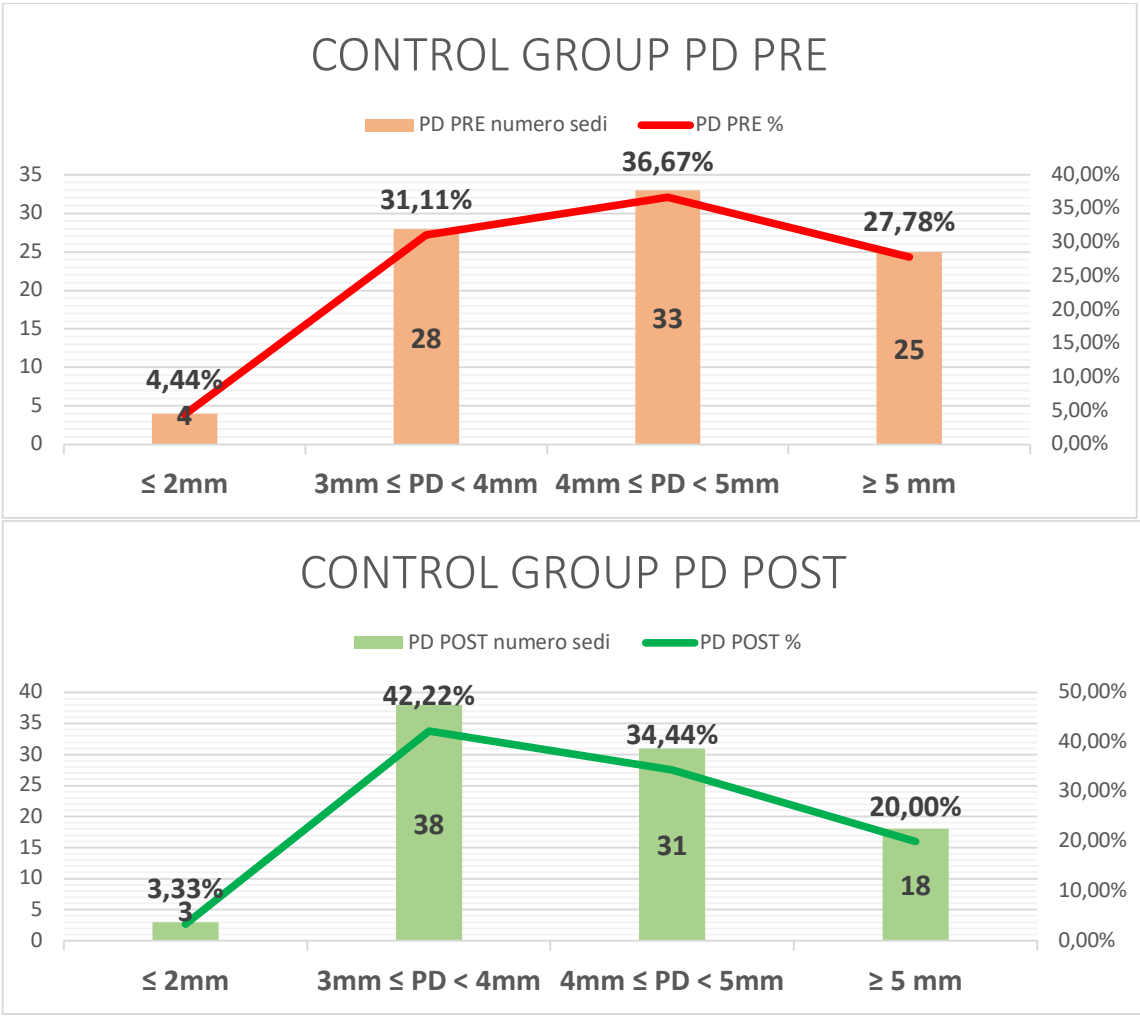

Figure 8. Percentage and number of sites variation in PD in the control group (US) between baseline (red graph) and follow-up at two months (green graph)

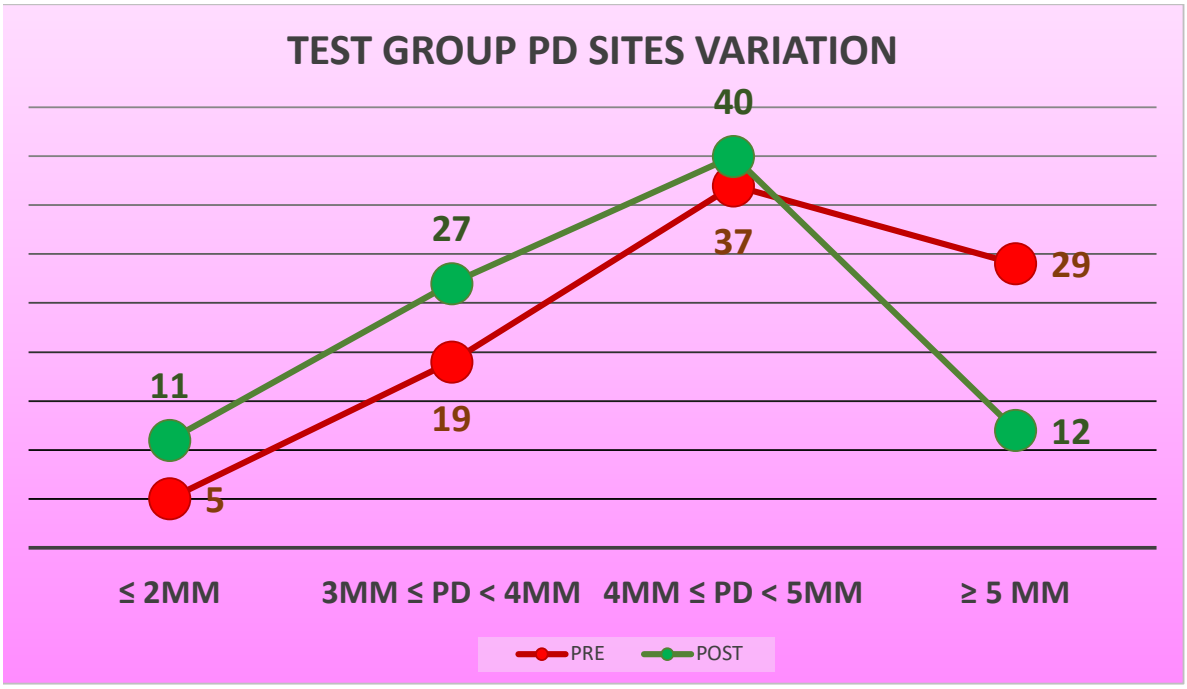

Figure 9. Changes in PD for each analyzed site in test group.

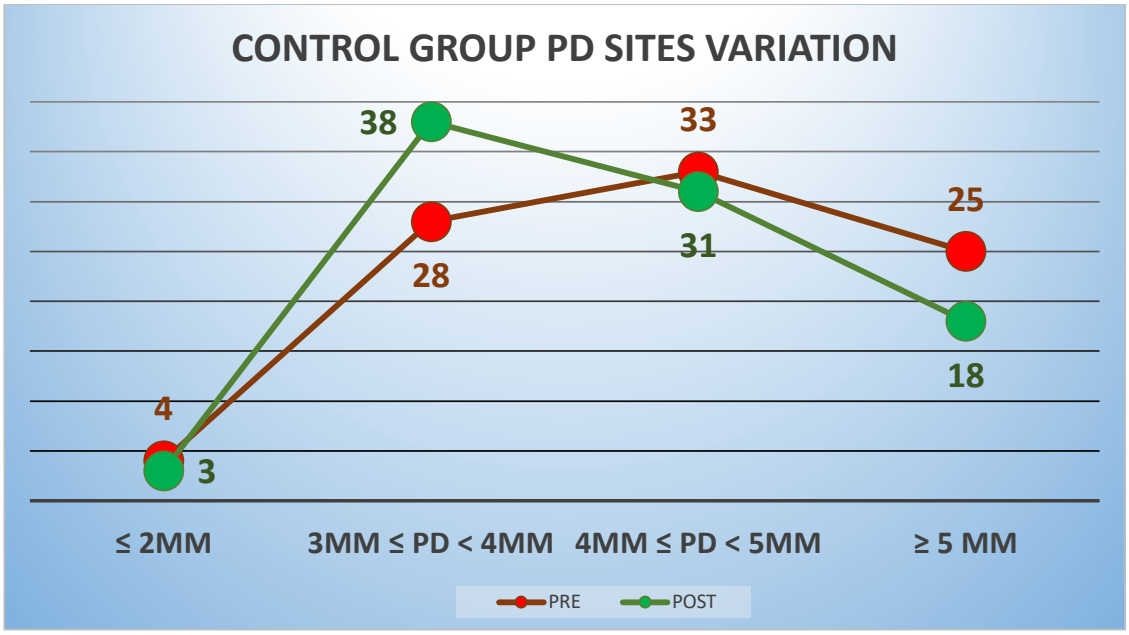

Figure 10. Changes in PD for each analyzed site in control group.

These characteristics, which reduce alterations at the titanium surface level, could lead to less development and formation of biofilm. In this study, a marked difference in PI values is observed between the two groups, despite the baseline measurement being similar (in the test group, the percentage drops from 93.33% to 34.44% with a difference of 58.89%, while in the PI control group it varies from 92.22% to 38.89%, with a difference between before and after of 53.33%). In addition to the absence of superficial alterations, the ability of glycine powder to inhibit the formation of bacterial biofilm should also be further investigated.

The discrepancy noted between the two groups regarding probing depth variation (Fig. 4) could be attributed more to the minimal differences in PD values at baseline. While many studies (43) focus on the treatment of severe peri-implantitis, the present research mostly included patients with initial to moderate lesions while still being in line with the results of many other works that investigated the effectiveness of GPAP for the treatment of peri-implant pathologies (44,45). Ji et al. identified a significant reduction in PD and BoP through this type of treatment, even if they failed to find additional beneficial effects of GPAP compared with traditional ultrasonic instrumentation (46,47). Similarly, Riben-Grundstrom et al. demonstrated in their study a constant improvement in PD and BoP parameters. Still, they suggested that both causal therapy modalities are reliable tools in the non-surgical treatment of peri-implant pathologies (48-51).

Our study has, therefore, demonstrated that professional biofilm removal strategies, in particular the use of glycine powder conveyed via an air-polishing device (GPAP) and associated with professional individualized oral hygiene instructions, reduce the extent of bleeding on probing (BoP) and plaque index (PI) at two months re-evaluation (Figure 11).

To summarize, the present study shows that both clinical procedures can improve inflammatory conditions with a superior benefit in the test group (GPAP) after the two-month follow-up in terms of BoP and PI. Furthermore, the use of glycine conveyed with an air-polish device (GPAP) leads to a significant improvement in the probing depth over time if compared to the control group (ultrasonic device), and this may be due to a trophic effect of the glycine powder on the peri-implant soft tissues, given by the specific cytoprotective characteristics towards the periodontal tissues (52-55).

In a study by Petersilka et al. (56-57) the author describes the effects on periodontal tissues of air-polishing with glycine powder versus bicarbonate powder and manual instrumentation. Glycine powder has a minimally erosive effect on the gingival epithelium when compared with other methodologies; this research can be considered as a confirmation of the results obtained in our study since a lower traumatic effect on the tissues may have caused the beneficial effects on PD measurements.

Conclusion

GPAP treatment of implant surfaces is, therefore, a promising option in the causal therapy of peri-implantitis and is increasingly used.

The results of the present study demonstrate that it is possible to obtain a significant improvement in sites affected by moderate peri-implantitis using glycine powder, in agreement with many studies carried out in recent years (51, although randomized clinical trials with larger sample sizes are rendered meaningful to further evaluate the long-term effects and peri-implant stability after this non-surgical option treatment in peri-implant disease.

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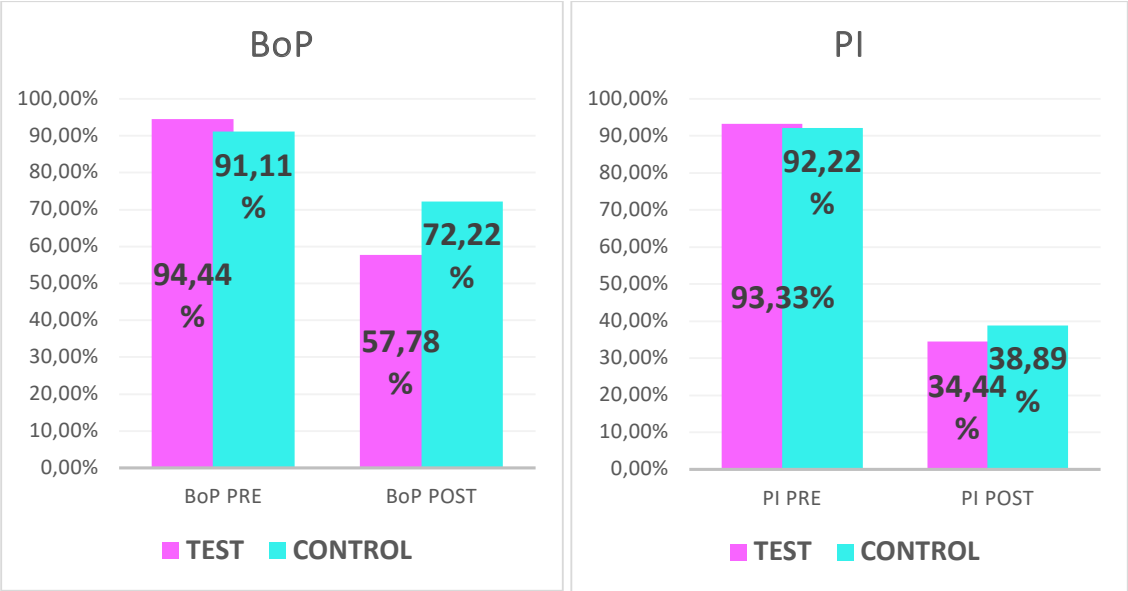

Figure 11. Changes in BoP and PI between test and control group at baseline and after 2-month follow-up.

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