Clinical Audit of Minimally Invasive Nonsurgical Techniques in Active Periodontal Therapy

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Abstract

Aims: Periodontitis is one of the most widespread diseases worldwide. Many efforts have been made to increase the efficacy of periodontitis therapy as much as possible. Recently, minimally invasive nonsurgical techniques (MINST) were introduced in the periodontal field as an alternative to minimally invasive surgical techniques (MIST). This clinical audit aims to evaluate the results of MINST in the initial phase of treatment for periodontitis.

Materials and methods: One hundred seven patients with periodontitis who were treated with MINST between 2013 and 2017 and reevaluated after 2 months were included in this clinical audit. The primary outcome analyzed was the proportion of pocket closure. The secondary outcomes were tooth extraction before active periodontal therapy, full-mouth plaque score (FMPS) change, full-mouth bleeding score (FMBS) change, average probing pocket depth (PPD) reduction, and average clinical attachment level (CAL) gain between the baseline and reevaluation values.

Results: A total of 2,407 teeth were included in the analysis. At the patient level, the treatment resulted in a mean pocket closure rate of 71.6 ± 15.7% for sites with an initial PPD ≥5 mm. The treatment was statistically significantly ($p < 0.001$) more effective with respect to the primary outcome compared with expected values reported in a recent meta-analysis (57%). The subgroup analysis revealed statistically significant differences between single and multirooted teeth and between shallow (5–6 mm) and deep pockets (≥7 mm) at the baseline.

Conclusion: Nonsurgical periodontal therapy with MINST achieved satisfactory results that were better than expected based on the scientific literature. Single-rooted and shallow pockets showed the best proportion of pocket closure at the reevaluation after treatment.

Clinical significance: Minimally invasive nonsurgical techniques can be the treatment of choice when approaching periodontally diseased patients with nonsurgical periodontal therapy.

Keywords: Clinical audit, Periodontitis, Supportive periodontal therapy, Tooth loss.

The Journal of Contemporary Dental Practice (2020): 10.5005/jp-journals-10024-2815

Introduction

Noncommunicable diseases (NCDs) are the leading causes of death and disability in humans. They are responsible for over two-thirds of all deaths, 80% of which occur in low- and middle-income countries. The four main NCDs are cancer, diabetes, chronic respiratory diseases, and cardiovascular diseases.

Oral diseases, such as caries and periodontitis, are prominent NCDs. The status of the mouth influences diet and nutrition, particularly in children and the elderly, while oral conditions and tooth loss have significant negative impacts on people's quality of life, affecting both the functional and psychological statuses. Noncommunicable diseases share the same risk factors, such as the use of tobacco, alcohol abuse, physical inactivity, and excessive consumption of saturated fats and refined sugars.

The specific actions preventing NCDs are conforming to the priorities and the strategies of the World Health Organization (WHO) and are based on the control of common risk factors.

Periodontitis affects more than 50% of the population worldwide. The severe form of periodontitis is classified as the sixth most widespread disease worldwide, affecting 743 million people (10.8%), with a peak in incidence at approximately 38 years.[1] Moreover, the comprehensive data on disease prevalence have not changed since 1990.[2] However, the treatment of periodontitis requires both behavioral changes and complete professional infection control to promote the healing of periodontal tissues.[3] An improvement in patients' oral hygiene, together with significant changes in the lifestyle and proper compliance with a regular

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supportive periodontal therapy (SPT), has proven to be the most critical positive prognostic factors for preventing tooth loss.[4,5] On the other hand, active periodontal therapy (APT) is a well-known biological approach to treat periodontal disease.[6]

Active periodontal therapy is traditionally performed through the use of root planing (RP) that is defined in the National Library of Medicine's Medical Subject Headings (MeSH) as "a procedure for smoothing of the roughened root surface or cementum of a tooth after subgingival curettage or scaling, as part of periodontal therapy." Nevertheless, the real need for such an invasive treatment was already questioned at the beginning of the 1980s.[7] Periodontal debridement is defined in MeSH as the "removal or disruption of

dental deposits and plaque-retentive dental calculus from tooth surfaces without deliberate removal of cementum as done in root planning and often in dental scaling."

Periodontal debridement achieves the same decontamination level of the root surface, with the advantage of being more conservative by preserving the dental structure. It also requires a shorter treatment time and provides greater comfort to the patient.[8–10]

Recently, minimally invasive nonsurgical technique (MINST) has been developed as a technique in which periodontal debridement is performed predominantly using ultrasonic instruments with small tips in association with magnifying vision aids.

This technique adheres to the medical community principle of achieving efficacy and reducing morbidity.[9] Minimally invasive nonsurgical technique has been successfully tested in the treatment of deep periodontal pockets.[11,12] To the best of our knowledge, information is not available on the use of MINST in the first phase of periodontal infection control.

This audit aims to determine whether the use of MINST during APT is consistent with the outcomes reported in the scientific literature. In particular, the primary objective of the audit is to compare the proportion of pocket closure, achieved with MINST in the study population with the outcome presented in the scientific literature.

MATERIALS AND METHODS

This report originated from a clinical audit performed in a private clinic located in Milan (Italy) over a period ranging from November 2013 to August 2017 and carried out according to the Healthcare Quality Improvement Partnership (HQIP—https://www.hqip.org.uk) guidelines. All clinical and data analysis procedures were performed in strict accordance with ethical principles, including the World Medical Association Declaration of Helsinki of 1975 as revised in 2013 and in particular the European Union Good Clinical Practice Directive (Directive 2005/28/EC). Before data collection, all patients were informed about the purposes of the audit and provided consent to use their clinical data anonymously.

Selection Criteria

Patients were included in the clinical audit if all the following criteria were met:

- Not pregnant
- A diagnosis of moderate to severe chronic periodontitis[13,14] involving at least four teeth with >4 mm probing pocket depth (PPD) and clinical attachment level (CAL) loss and evidence of radiographic bone loss
- No periodontal treatment was received in the previous 6 months
- The presence of infrabony defects
- Treatment with a one-stage full-mouth ultrasonic debridement (FMUD) performed using MINST without any adjunctive antiseptics, antibiotics, host-modulating agents, or lasers
- A clinical reevaluation was performed 2 months after the completion of the periodontal treatment
- Written informed consent was provided

Demographic Variables

The following demographic parameters were registered: (i) age, (ii) gender, (iii) diabetic status, and (iv) smoking status.

A smoker was defined as a patient smoking more than 10 cigarettes per day.

Patients were considered to have uncontrolled diabetes if their Hb1ac level was >7%.

Clinical Procedures

A total of 107 patients were included in this study. A baseline periodontal assessment was performed prior to the periodontal treatment. Full-mouth clinical measurements of PPD and recession (REC) were recorded at six sites per tooth using a manual periodontal probe; the digital chart calculated the CAL. A dichotomous full-mouth bleeding score (FMBS) and full-mouth plaque score (FMPS) were recorded. Tooth mobility[15] and furcation involvement[16] were also recorded.

Before the APT, all patients underwent specific training on personalized self-performed oral hygiene.

Teeth with a poor prognosis[17] were extracted immediately before the APT.

Under local anesthesia, periodontal debridement of the root surface was performed in a single session under magnification loupes (4.3×) with a combination of glycine air polishing devices (G-APDs) and a piezoelectric device with specific thin and delicate tips. The biofilm and calculus were removed, avoiding RP and gingival curettage, i.e., minimizing the trauma to the soft and hard tissues. Debridement control was performed with an explorer to increase tactile sensitivity.

Follow-up examinations were performed at 7, 21, and 42 days after the one-stage FMUD to assess the oral hygiene performance, eventually providing counseling reinforcement and residual supragingival biofilm control.

The same clinical measurements recorded before the FMUD were collected 2 months after treatment (reevaluation) (Fig. 1). All procedures were carried out by two operators (C. G. and C. D.).

Primary Outcome

The clinical primary outcome variable was the "pocket closure," which is defined as the proportion of sites with a pathological PPD at the baseline examination and a physiological PPD at the 2-month re-evaluation.

Probing pocket depth was considered physiological if ranged from 1 to 4 mm.

For the subgroup analysis of pocket closure, the initial PPD and single/multirooted teeth were analyzed.

Upper premolars and molars were considered multirooted teeth, and lower premolars, canines, and incisors were considered single-rooted teeth.

Secondary Outcomes

The following secondary outcomes were analyzed:

- The number of teeth with a poor prognosis that were extracted before the APT
- Changes in the FMPS and FMBS between the baseline and reevaluation
- Average PPD reduction and CAL gain between the baseline and reevaluation

Data Analysis

All data were input into a digital database and checked for entry errors. Qualitative variables are reported as proportions, whereas quantitative variables are presented as the means and standard deviations. The 95% confidence intervals (95% CI) are reported in brackets.
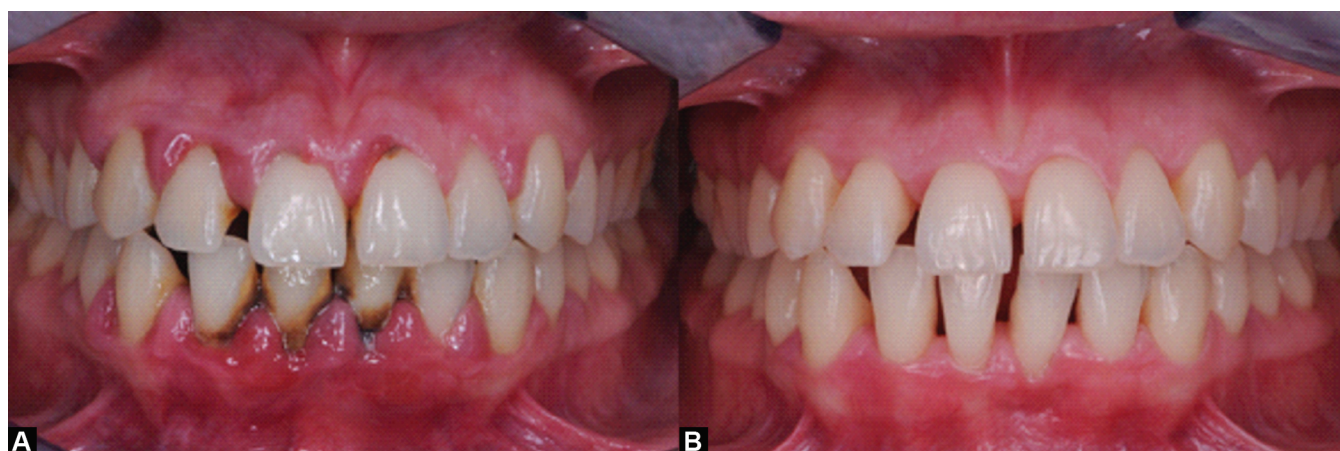
Figs 1A and B: Intraoral clinical photo before (A) and after (B) the active periodontal therapy

Table 1: Demographic variables of the audit population and baseline characteristics of the analyzed teeth

Patients (n°)	107	Teeth at baseline (n°)	2,450
Mean age (years)	54.8 ± 12	Extracted teeth prior to APT (n°)	43
Gender (male/female)	43/64	Total analyzed sites (n°)	14,442
Smokers (n°)	20	Multirooted analyzed sites (n°)	5,778
Patients with diabetes (n°)	9	Single-rooted analyzed sites (n°)	8,664
		Physiological sites at baseline (n°)	10,597

The results from the present audit have been compared with the most recent published data by Suvan and coworkers in 2019.[18] In particular, the pooled estimation (57%) of the proportion of pocket closure at 3/4 months retrieved from the meta-analysis was considered as comparator.[18]

The Student's t test and a linear regression model were used for statistical analyzes.

The patient was considered a statistical unit. Therefore, the mean values for each patient were calculated and considered when reporting the results. Statistical significance was set to $p < 0.05$. The R package (https://www.r-project.org) was used for the statistical analysis.

RESULTS

A total of 107 patients who were treated with one-stage full-mouth disinfection using the MINST approach and reevaluated 2 months after therapy were included in this study. The demographic characteristics of the patients included in this study are summarized in Table 1.

Sixty percent of the 107 patients were women and had a mean age of 54.8 years (range 26–81 years); 19% were smokers, and 7% were diagnosed with diabetes.

A total of 2,450 teeth were examined at baseline. Forty-three were considered to have a poor prognosis and were extracted prior to the APT; 51% of these poor prognosis teeth were extracted for periodontal reasons. Therefore, 2,407 teeth were analyzed at reevaluation, for 14,442 sites: 5,778 sites belonged to multirooted teeth and 8,664 sites belonged to single-rooted teeth. A total of 10,597 initial sites with an initial pocket depth ≤4 mm were considered physiological, and the stage did not change in the reevaluation (Table 1).

Primary Outcome

The data for the primary outcome of "pocket closure" are presented in Figures 2 and 3. At the patient level, the treatment resulted in a mean pocket closure rate of 71.6 ± 15.7% (95% CI = 68.6–74.6%) for sites with initial PPD ≥5 mm. These data were compared with the standard results for pocket closure reported in the scientific literature, which is 57%.[18] The difference between the expected value and the value from this audit was statistically significant ($p < 0.001$).

Seven of 107 patients (6.5%) healed from periodontitis, as they achieved the objective of 100% pocket closure.

According to the subgroup analysis of periodontal pockets stratified by the initial PPD, shallow defects (PPD = 5–6 mm) showed better healing than deep defects (PPD ≥ 7 mm), with a mean pocket closure rate of 80.1 ± 14.3% (95% CI = 77.4–83.9%) and 39.0 ± 29.7% (95% CI = 33.0–45.1%), respectively. The difference between groups was statistically significant ($p < 0.001$). As shown in Figure 4, a greater PPD before APT resulted in a lower percentage of pocket closure at the reevaluation. This correlation was statistically significant ($p < 0.001$).

Considering the multirooted elements, the mean percentage of pocket closure at the patient level decreased to 66.0 ± 18.8% (95% CI = 62.4–69.7%), with an average of 35.5 ± 30.3% (95% CI = 29–41.9%) in deep defects (initial PPD ≥ 7 mm) and 74.3 ± 18.7% (95% CI = 70.7–77.9%) in shallow defects, i.e., initial PPD = 5–6 mm (Fig. 3). This difference between groups was statistically significant ($p < 0.001$). In single-rooted teeth, an analysis of the primary outcome resulted in 86.4 ± 16.0% (95% CI = 83.2–89.7%) of healed sites, with an average of 53.5 ± 38.6% (95% CI = 42.8–64.1%) and 91.1 ± 12.7% (95% CI = 88.5–93.6%) of healed sites in the deep and shallow defects, respectively (Fig. 2). Again, the difference between groups was statistically significant ($p < 0.001$).
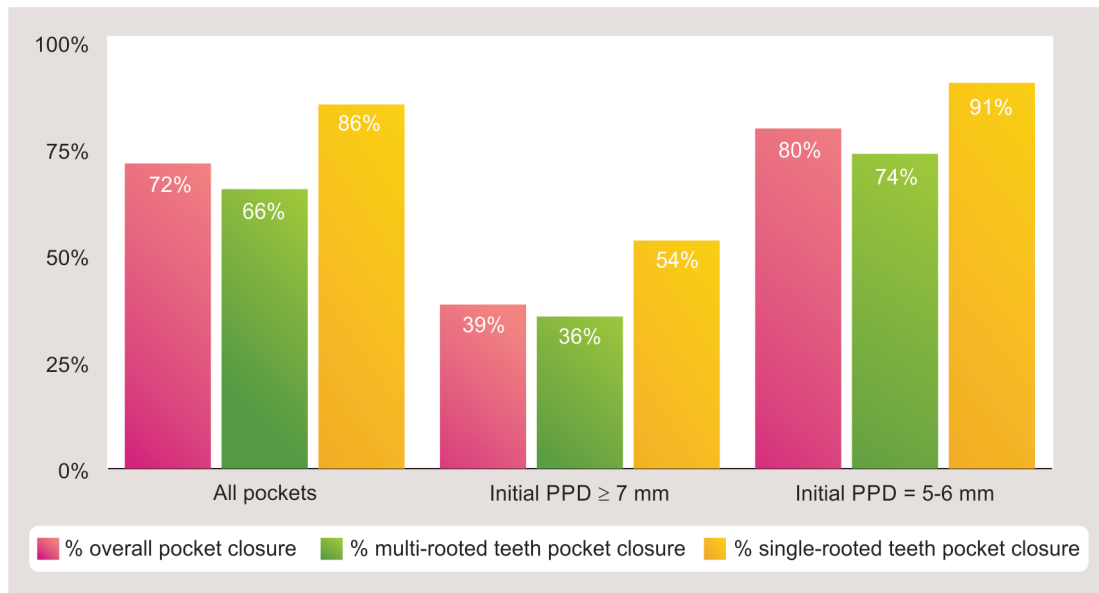
Fig. 2: Mean proportion of pocket closure in all pockets, deep pockets (PPD ≥ 7 mm) and shallow pockets (PPD = 5–6 mm)
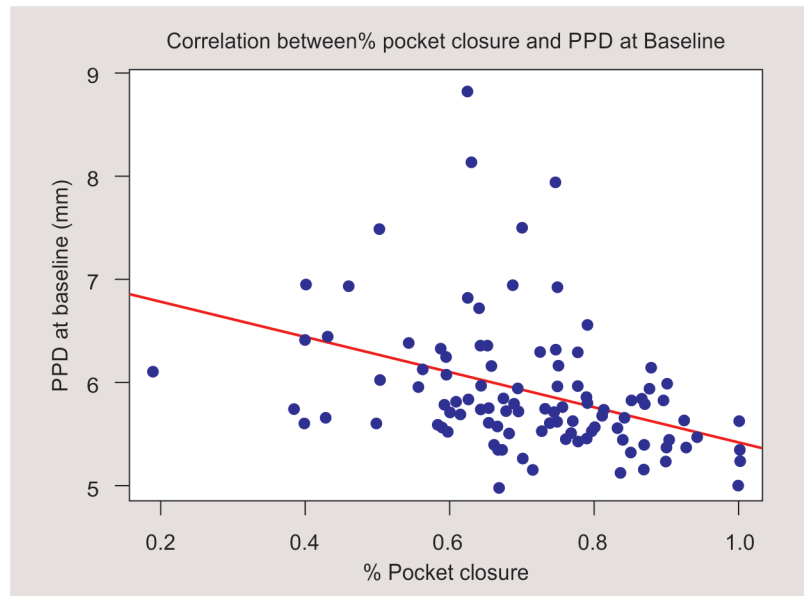

Fig. 3: Graphic representation of the linear regression analysis of the mean value of PD at baseline and the percentage of pocket closure for each patient

Secondary Outcomes

Mean values and standard deviations of the initial PPD, PPD at reevaluation, PPD reduction, and CAL gain are depicted in Table 2 for the whole sample and the subgroups of (1) shallow (PPD = 5–6 mm) and deep pockets (PPD ≥ 7 mm) and (2) single-rooted and multirooted teeth.

At the reevaluation, the overall mean PPD reduction was 2.1 ± 0.6 mm. This value was compared with the standard result for the mean PPD reduction reported in the scientific literature,[19] which is 1.18 mm. The difference between the expected value and the value from the present study was statistically significant ($p < 0.001$). In the subgroup analysis, the mean decreases observed in the shallow and deep pockets were 1.9 ± 0.5 and 2.9 ± 1.2 mm, respectively. Differences in the PPD reduction and CAL gain between shallow and

deep pockets were statistically significant for both single-rooted and multirooted teeth (for p values, see Table 2).

Differences in the initial PPD and tooth morphology were also observed regarding surrogate parameters. The single-rooted teeth with deep pockets showed an average PPD reduction of 3.4 ± 1.4 mm, whereas the multirooted teeth with shallow pockets showed a PPD reduction of 1.7 ± 0.5 mm.

The data for the level of oral hygiene during the study are shown in Figure 4. After the first visit (baseline), the average FMPS was 66.4 ± 23.6%. At the reevaluation, the patients' oral hygiene improved consistently: the average final FMPS was 21.3 ± 15.1%.

A similar decrease in FMBS values was observed from an initial proportion of 59.4 ± 23.1% at baseline to 19.6 ± 11.6% at the reevaluation (Fig. 4).

Table 2: Mean values and standard deviations reported in mm of initial probing pocket depth (PPD), PPD at reevaluation, PPD reduction, and CAL gain

| | *Overall* | 5–6 mm baseline PPD | | ≥7 mm baseline PPD | |
		Single-rooted	*Multirooted*	*Single-rooted*	*Multirooted*
Baseline PPD (mm)	5.89 ± 0.65	5.26 ± 0.21	5.36 ± 0.18	7.67 ± 0.96	7.85 ± 0.76
Final PPD (mm)	3.80 ± 0.57	3.08 ± 0.60	3.70 ± 0.51	4.29 ± 1.37	5.08 ± 1.17
PPD reduction (mm)	2.09 ± 0.64	2.17 ± 0.59**	1.66 ± 0.52***	3.38 ± 1.43**	2.76 ± 1.08***
CAL gain (mm)	1.62 ± 0.70	1.66 ± 0.72§	1.22 ± 0.77	2.56 ± 1.61§	2.27 ± 1.46*

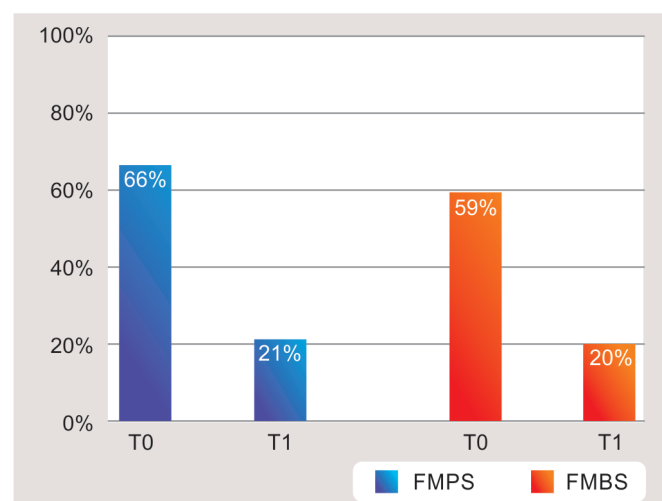*$p < 0.001$; **$p < 0.001$; ***$p < 0.001$. §$p = 0.002$

Fig. 4: Mean proportion of full-mouth plaque score and full-mouth bleeding score recorded before the ATP (T0) and at the reevaluation (T1)

DISCUSSION

According to the present audit, an initial MINST approach with one-stage FMUD plus G-APD resulted in a substantial improvement in the periodontal health of patients with moderate and severe chronic periodontitis.

The primary outcome well establishes this improvement, showing an average pocket closure rate of 72% for sites with an initial PPD >4 mm.

These data revealed better performance of MINST compared with the expected standard results derived from the systematic review authored by Suvan and coworkers.[18] Unfortunately, an official guideline that might indicate the standard performance of nonsurgical periodontal therapy is unavailable. The Italian Ministry of Health stated in 2017 in the "Clinical recommendations in dentistry" that the APT should achieve an improvement in surrogate endpoints, such as reductions in PPD and FMPS, without specifying the magnitude of the improvement.[20] However, the proportion of pocket closure could be considered a better surrogate endpoint. Using the new classification system, a patient with healed periodontitis is defined as presenting a PPD ≤4 mm in all sites and a FMBS <10%.[21] Therefore, we used a threshold for pocket closure of PPD ≤4 mm. The pooled estimation of the proportion of pocket closure at 3/4 months reported in a recent systematic review was 57%.[18] We, therefore, considered this estimation of the pocket closure rate as the standard outcome for the nonsurgical therapy in this audit.

Only 6.5% of our patients healed from periodontitis, as they achieved the 100% pocket closure. Van der Weijden recently reported the nonsurgical periodontal therapy outcomes for more than 1,000 patients. Thirty-nine percent of patients analyzed in this retrospective study achieved the treatment objective of PPD ≤5 mm. However, the considered threshold for pocket closure included a PPD of 5 mm, which differs from the value used in the present study and the value that should be considered nonpathological.[21]

Nonsurgical SRP is an effective treatment modality for periodontal disease, as evidenced by marked reductions in the clinical signs and symptoms of the disease after treatment.[8,19,22,23]

Nevertheless, the ultimate goal of instrumentation is to perform periodontal debridement.[9,24]

As shown in several studies, this goal is easier to achieve with the use of small ultrasonic tips instead of manual instruments.[12,25,26] Indeed, the use of a thin periodontal probe-like tip provides advantages in terms of accessibility to deep periodontal pockets and efficacy in removing subgingival plaque/calculus compared with conventional ultrasonic tips and hand instruments.[27,28]

Moreover, Q-SRP requires a longer time to complete than FMUD and induces more postoperative discomfort in patients, particularly in terms of dental hypersensitivity.[18,29,30]

The adjunct use of G-APD together with the MINST approach was included during the FMUD. The purpose is to reduce invasiveness in biofilm control, minimizing the damage to all treated surfaces. According to the recent literature, fine air powders show the same efficacy at removing biofilm to ultrasonic instruments but result in less abrasive power on both oral tissues and restorative dental materials.[31–36]

As shown in Figure 3, the potential proportion of pocket closure is inversely proportional to the initial PPD. Periodontal pocket healing ranged from 87% in the subgroup with a PPD of 5 mm to only 26% when the initial PPD was ≥9 mm and performed slightly better than the Q-SRP treatment reported in the literature.[37]

Multirooted teeth presented a proportion of pocket closure that was 20% less than single-rooted teeth, a decrease from 86% to 66%. These data are consistent with the multilevel analysis performed by Tomasi et al.[38]

Considering the secondary outcomes of our study, the overall mean PPD reduction and CAL gain were 2.2 and 1.7 mm, respectively. As mentioned above, the magnitude of PPD reduction is not presented in any guidelines and, therefore, the best reference was a 1.18-mm PPD reduction reported in a systematic review.[19]

Two systematic reviews, from Tunkel et al. and Hallmon and Rees, examining non-MINST subgingival debridement in patients with chronic periodontitis described an average mean PPD reduction of approximately 1 mm and CAL gain of 0.7 mm, which is less effective than our results.[6,23] A potential explanation for this difference is the delicacy of debridement and less trauma in oral tissues, resulting in the formation of a more stable blood clot during the healing phase.

In the present clinical audit, greater values for the PPD reduction and CAL gain were observed following the treatment of deep pockets compared with shallow pockets (Table 2).

These significant improvements in the outcomes of deep pockets are confirmed by the results of the MINST approach reported in the literature. Ribeiro et al.[11] described the effects of MINST on the treatment of deep infrabony defects, obtaining mean values for the PPD reduction and CAL gain of 3.13 ± 0.67 and 2.56 ± 1.12 mm, respectively. Nibali et al. retrospectively analyzed 35 infrabony defects treated with MINST and obtained similar results (a 3.12-mm PPD reduction and 2.78-mm CAL gain).[12]

This study has shown the good results of MINST for the treatment of periodontal disease. However, it should always be kept in mind the retrospective nature of the presented data.

Conclusion

Within the limitations of this observational study, we concluded that the use of a single session of FMUD plus G-APD and careful instructions regarding patient-performed plaque control appear to be an efficacious method to treat chronic periodontitis. Single-rooted shallow pockets showed the best proportion of pocket closure after treatment.

Additional well-designed trials are needed to verify the actual potential of MINST utilizing FMUD and G-APD in the initial treatment of periodontal disease.

Clinical Significances

The minimal invasive nonsurgical techniques are an efficacious treatment for chronic periodontitis. Minimally invasive nonsurgical techniques can be the treatment of choice when approaching periodontally diseased patients with nonsurgical periodontal therapy.

Acknowledgments

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