Received: 8 August 2023 | Revised: 7 February 2024 | Accepted: 16 March 2024

DOI: 10.1111/clr.14257

ORIGINAL ARTICLE

CLINICAL ORAL IMPLANTS RESEARCH WILEY

Supportive therapy following peri-implantitis treatment: A retrospective study on compliance

Alberto Monje[1,2,3] | Pablo Galindo-Fernández[4] | José Nart[2]

[1]Department of Periodontology and Oral Medicine, University of Michigan, Ann Arbor, Michigan, USA

[2]Department of Periodontology, Universitat Internacional de Catalunya, Barcelona, Spain

[3]Department of Periodontology, University of Bern, Bern, Switzerland

[4]Department of Oral Surgery and Implant Dentistry, University of Granada, Granada, Spain

Correspondence
Alberto Monje, Department of Periodontology, Universitat Internacional de Catalunya, C/Josep Trueta s/n, 08195 – Sant Cugat del Vallès, Barcelona, Spain.
Email: amonjec@umich.edu

Abstract

Background: The compliance rate with supportive therapy following peri-implantitis treatment (SPIT) remains unknown. The present retrospective study was carried out to assess the compliance rate and the factors influencing compliance in a private practice setting.

Materials and Methods: Patients were divided into three groups according to compliance rate: regular compliance (RC ≥2 SPIT/year), erratic compliance (EC <2 SPIT/year), and non-compliance (NC <1 SPIT/year). Overall, 17 patient- ($n=8$) and site-related variables ($n=9$) were explored as potential confounders of compliance. The Chi^2 test was applied to assess the association between categorical variables and determine the odds ratio (OR).

Results: The study comprised 159 patients restored with 1075 implants, of which 469 were treated for peri-implantitis and met the inclusion criteria. A total of 57.2% were RC, 25.8% EC, and 17% NC. The multivariate analysis showed that smoking and grade C periodontitis reduced the likelihood of RC (OR = 0.28, $p<.001$) when compared to complete edentulism or non-smoking. Moreover, age demonstrated being associated with follow-up when SPIT was interrupted in EC and NC (OR = 0.94, $p=.007$).

Conclusion: Comprehensive information, provided prior to peri-implantitis treatment, regarding the importance of adhering to SPIT after peri-implantitis treatment to achieve/maintain peri-implant health, resulted in ~60% regular compliance rate (NCT05772078).

KEYWORDS
dental implants, peri-implantitis, periodontal disease

1 | INTRODUCTION

Supportive measures have been shown to be crucial for securing long-term periodontal stability and preventing tooth loss (Axelsson et al., 2004). Likewise, peri-implant maintenance therapy tailored according to the patient risk profile has been shown to be beneficial for preventing peri-implantitis (Costa et al., 2023; Monje et al., 2016). Long-term data evidenced that patients not adhering to preventive maintenance therapy after implant placement were exposed to a greater proportion of sites with bleeding upon probing, a greater mean deepest pocket probing depth, and a higher frequency of implants with at least one site with pocket depth ≥6 mm (Roccuzzo

et al., 2014). However, it is interesting to note that a recall frequency of once every 5–6 months in low-risk profile patients was found to be five times more effective in protecting from peri-implantitis than a single maintenance appointment every 12 months (Leone et al., 2023; Monje et al., 2017).

There is a lack of knowledge on the long-term effectiveness of peri-implantitis therapy. The goal from a biological perspective is to shift from an anaerobic environment associated to inflammation to an aerobic ecosystem found under healthy conditions (Roccuzzo et al., 2021). Hence, the achievement of pocket closure (≤5 mm) has been regarded as the primary therapeutic endpoint to prevent disease progression (Ichioka et al., 2023; Serino et al., 2021). In addition, its success has been shown to be influenced by site- and patient-specific factors. In this regard, the implant surface features (Berglundh, Wennstrom, & Lindhe, 2018) or the soft tissue characteristics (Monje, Pons, et al., 2022) proved significant on evaluating disease resolution after different therapeutic modalities. It is not surprising that poor plaque control at baseline and during follow-up after peri-implantitis treatment further impacts upon the prevalence of disease recurrence (Ichioka et al., 2023; Monje et al., 2023). Moreover, SPIT has been found to be pivotal in maintaining hard and soft tissue stability over the long term (Stiesch et al., 2023).

Despite the marked influence of maintenance upon the prevention of peri-implantitis and disease progression after therapy, compliance is unsatisfactory. Several clinical studies included in a systematic review with follow-up periods of 1–10 years found the rate of compliers to be variable (3.3%–86.8%), with smoking habit and a history of periodontal disease being critical predictors of the level of compliance. Moreover, inadequate information/motivation was found to be the main patient-reported reason for non-compliance (Amerio et al., 2020). It is notorious that a lack of information and motivation was by far the main reason reported by patients in explaining the lack of compliance (Monje, Perez, et al., 2022). Nonetheless, the vast majority of patients (74%) have no knowledge about peri-implant disease (Insua et al., 2017). Therefore, it is essential to educate patients and enhance their understanding of the disease in order to secure effective compliance with supportive care.

The aim of the present retrospective study was to assess the level of compliance with SPIT and the factors influencing therapeutic compliance. Given the relevance of SPIT in long-term stability, the data derived from this study may assist the clinician in better understanding the suitability of providing peri-implantitis treatment according to the individual patient profile.

2 | MATERIALS AND METHODS

A retrospective study was conducted in accordance with the Declaration of Helsinki on human studies, following approval from the *Gerencia del Area de Salud de Badajoz* (#622023). Patients received and signed a written informed consent accepting that information concerning their personal data and treatment information could be managed for research purposes. Patient data were anonymized. The study was registered and approved by www.clinicaltrials.gov (NCT05772078). The manuscript is reported according to the STROBE statement.

2.1 | Study population

Patients were consecutively recruited at the CICOM Institute (Badajoz, Spain) from September 2017 to May 2022. Patients were eligible to participate if diagnosed with peri-implantitis. The case definition of peri-implantitis initially considered was according to Sanz & Chapple (Sanz et al., 2012), though later the definition proposed by workgroup 4 of the 2017 World Workshop on the Classification of Periodontal and Peri-Implant Diseases and Conditions was adopted (Berglundh, Armitage, et al., 2018). Recruited patients that did not meet these criteria were retrospectively excluded. Only patients that agreed to attend SPIT with our hygienists and that were not referred by other centers were included. A minimum follow-up period of 12 months after peri-implantitis treatment made the patients eligible to participate in the study.

2.2 | Eligibility criteria

The following inclusion criteria were applied: partially or completely edentulous patients aged 18–90 years at the time of the intervention and rehabilitated with implant-supported, fixed prostheses or implant-supported overdentures; smokers or non-smokers; absence of infectious disease at the time of implant placement; and absence of systemic disorders or medications known to alter bone metabolism. Subjects were excluded if they were pregnant at the time when the intervention was suggested; if they presented uncontrolled medical conditions or diseases (e.g., diabetes mellitus with glycosylated hemoglobin [HbA1c] >8%) at the time when the intervention was suggested; or if they presented zygomatic or pterygoid implants. Patients that were referred for treatment to our center and were subsequently followed-up on by the referring dentist were also excluded. All patients received comprehensive verbal information, including recall frequency and cost associated to SPIT, prior to treatment concerning the importance of adhering to SPIT to achieve/maintain peri-implant health following peri-implantitis treatment. Patients that disagreed to participate in SPIT were not treated and therefore, not included in the analysis.

2.3 | Study groups

The patients were divided into three groups according to the level of compliance with SPIT, as described elsewhere (Monje et al., 2017). In general, for the first year immediately after peri-implantitis treatment, the patients were enrolled in a 3–4 month recall program.

Later on, the suggested program depended upon the patient risk profile. In this regard, for low-risk profile patients, a recall interval of every 5–6 months was scheduled. On the other hand, for high-risk profile patients (smokers, uncontrolled hyperglycemia during follow-up, full-mouth plaque index ≥20% and/or full-mouth bleeding index ≥20% at the time of SPIT appointment, and implants exhibiting disease progression/recurrence) were assigned to a 3–4 month recall interval. Thus, the level of compliance was categorized as follows:

- Regular compliance (RC ≥2 SPIT/year): Patients that adhered to the recommended SPIT recall interval.
- Erratic compliance (EC <2 SPIT/year): Patients that failed to attend the recommended SPIT interval.
- Non-compliance (NC <1 SPIT/year): Patients that discontinued the recommended SPIT interval.

Patients discontinuing recommended SPIT during follow-up but who later resumed the suggested intervals were categorized as EC. The interruption of SPIT after peri-implantitis treatment for EC and NC was recorded and coded as follows: 1: < year, 2: 1–2 years, 2: 2–4 years, 3: ≥5 years. Patients were scheduled for SPIT immediately after completing the previous maintenance and were reminded of the appointment 1 week before (telephone call) and 1 day before (via text) the appointment.

2.4 | Interventions

Oral hygiene instructions were provided as part of the initial examination. All eligible patients diagnosed with peri-implantitis underwent non-surgical therapy at least 6 weeks prior to re-evaluation. Ultrasound debridement, curettes and air polishing devices were used for scaling and debridement of the peri-implant sulcus. If after re-evaluation it was noted that disease persisted (pocket depth ≥6 mm and profuse bleeding and/ suppuration), surgical treatment was advised. The surgical modality varied according to the configuration of the defect, the implant position and/or the soft tissue characteristics.

2.5 | Supportive peri-implant therapy protocol

A review of the patient medical and dental/implant history was made, followed by a clinical evaluation of the implant(s). Probing was routinely performed by the hygienists at 6 sites and later supervised by the periodontist (AM) as a double check. A periapical radiograph was taken to evaluate the peri-implant bone-level in case pocket probing depth was reported ≥6 mm with clinical signs of inflammation. Briefly, during the regular SPIT appointments, oral hygiene was instructed and motivation by the hygienist. Once the full-mouth plaque index was shown to the patient by means of biofilm disclosure, professionally performed oral hygiene measures were adopted. In general, maintenance included the removal of plaque and calculus utilizing curettes, air-polishing devices, and ultrasound. In addition, interdental brushes with nylon-coated core wire along with floss with a stiffened end were used to thoroughly remove any biofilm attached to the interproximal complex. An exploration instrument was used to check the complete removal of biofilm. Chlorhexidine 0.12% was provided to rinse for 30–40 s after therapy was concluded. Behavioral changes (smoking cessation, oral hygiene instructions and systemic factors counseling) and motivation were further reinforced at each recall appointment.

2.6 | Assessment of variables

The following patient-related variables were documented and subsequently included in the analysis:

- Age (years)
- Gender (male or female)
- Smoking habit at the time of assessment (N: non-smokers, FS: former smokers, S: current smokers)
- Disease/medication at the time of assessment during follow-up (N: no, AD: antidepressant medication, CT: chemotherapy RT: radiotherapy, RA: rheumatoid arthritis, DM: diabetes mellitus, CD: cardiovascular disease, HT: arterial hypertension, BP: bisphosphonates)
- Baseline diagnosis of periodontitis: stage and grade in the context of the 2017 World Workshop on the Classification of Periodontal and Peri-Implant Diseases and Conditions (Tonetti et al., 2018)
- Complete edentulism (E)
- Distance (km) from the usual place of residence of the patient to the practice, checked using Google Maps
- Patient occupation coded according to the CNO-11 ("Classification for the Spanish National Occupations (CNO-11)," 2010).

In addition, the following implant- and disease-related variables were included in the analysis:

- Overall number of implants (n)
- Number of implants where peri-implantitis therapy was applied (n)
- Location of the implants where therapy was applied (AM: anterior maxilla, am: anterior mandible, PM: posterior maxilla, pm: posterior mandible)
- Implant follow-up (months)
- Therapy follow-up (months)
- Type of intervention (NS: non-surgical, RES: respective, REC: reconstructive (entailing combined therapy), STC: soft tissue conditioning)
- Implant survival (yes/no)
- Evidence of progressive bone loss (>1 mm) after peri-implantitis treatment (yes/no)
- Evidence of residual pockets (≥6 mm) after peri-implantitis treatment (yes/no)

2.7 | Statistical analysis

Data were analyzed using the SPSS version 15.0 and R 3.5.1 statistical packages. A descriptive analysis was carried out to describe the pertinent data. Inferential analysis by means of ordinal logistic regression was conducted to analyze the effect of the variables on the level of compliance at patient-level. Wald's Chi^2 test was applied to assess the association between independent variables and to provide the raw odds ratio (OR). Then, significant ($p < .05$) variables were then entered into a multiple model to estimate adjusted OR. Forced entry and stepwise provided the same results. AIC was calculated in order to assess the improvement of the multiple compared to simple models. Predicted probabilities for each category (RC, EC, NC) were estimated. Pearson, deviation, and parallel lines tests were conducted to assess the goodness of fit and proportionality of odds. The significance level was set at 5% ($\alpha = 0.05$).

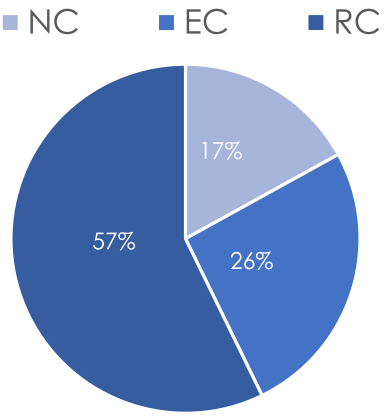

FIGURE 1 Level of compliance with supportive peri-implant therapy. EC, erratic compliance; NC, no compliance; RC, regular compliance.

3 | RESULTS

Overall, data were collected from 161 patients with 1079 implants (mean implants per patient: 6.7 ± 3.5), with a mean follow-up of 138.2 months after placement. Of these implants, 473 were diagnosed with peri-implantitis (mean implants per patient: 2.9 ± 2.2) and received therapy accordingly, with a mean follow-up of 35.3 ± 16.3 months (range 12–65 months). Two patients (4 implants) died in the course of follow-up and were thus excluded from the analysis (Table S1). A total of 39 males (24.5%) and 120 females (75.5%) with a mean age of 62.3 ± 10.4 years of age (range 28–89) were finally included. In the course of follow-up, 20 patients reported changes in their medical history, with antidepressant use (30%) being the most common modification. In the other hand, 16.5% and 26.6% reported being former and current smokers, respectively. The mean distance to the study center was 41.9 ± 47.8 km. With regard to level of occupation, 38.9% were identified as corresponding to type 2 (professionals with a medium to high degree of scientific and/or intellectual training). In turn, generalized stage IV (54.7%) and grade B (57.9%) were the most frequent diagnoses of periodontitis. The most common procedure was REC (47.5%), followed by RES + STC (34%).

3.1 | Factors influencing compliance

In total, 57.2% of the patients were RC, 25.8% were EC and 17% were NC (Figure 1). Few of the explored variables showed statistically significant correlations to the level of compliance in the univariate analysis (Tables 1–3). Current smoking was decreased the likelihood of compliance compared to NS (OR = 0.21, $p < .001$) (Figure 2). However, no notable differences were noted between current smoker and former smoker status. Furthermore, grade C periodontitis decreased the likelihood of compliance with SPIT (OR = 0.28, $p < .001$). In addition, the follow-up period after therapy was also seen to reach statistical significance (OR = 0.97, $p < .003$). In other words, the odds for definition as RC decreased as the time after peri-implantitis treatment increased. The multivariate analysis showed the interaction between current smoking and grade C periodontitis to decrease the likelihood of RC (OR = 0.28, $p < .001$) when compared to FS and NS. Follow-up after peri-implantitis treatment also showed a significant association with EC or NC (OR = 0.96, $p = .003$). As such, longer follow-up decreased the likelihood of compliance. In fact, current smoker or former smoker status and being diagnosed with grade C periodontitis increased the likelihood of being EC or NC during follow-up (Figure 3). The goodness of fit of the model was accepted according to Pearson and deviation tests ($p = .729$). Proportionality of odds was accepted according to the parallel lines test ($p = .546$). AIC was estimated at 289.5, reducing at 8% compared to simple models. On assessing follow-up when SPIT was interrupted by EC and NC, the variable age showed a significant association. In other words, the older the patient was, the shorter the interruption of SPIT (OR = 0.94, $p = .007$).

4 | DISCUSSION

Maintenance therapy has been shown to be pivotal to primary and secondary peri-implantitis prevention (Monje et al., 2016). Likewise, supportive care has been suggested to be critical to securing long-term health in the treatment of peri-implantitis (Stiesch et al., 2023). Findings derived from this retrospective study shed light on the compliance rate after different therapeutic modalities applied to manage this disorder. Specifically, it was shown that approximately 60% of the patients undergoing therapy regularly comply with SPIT according to the recommended periodicity. On the other hand, approximately 40% did not comply with SPIT as instructed prior to therapy. In this sense, current smoking and grade C periodontitis demonstrated more erratic profiles regarding adherence to SPIT. In addition, gender (favoring males) showed a tendency but did not reach statistical significance ($p = .07$). Moreover, follow-up after peri-implantitis, treatment further showed an

TABLE 1 Association of patient-related variables with level of compliance.

	EXP(B)	IC 95%	*p*-Value
Gender			
Threshold NC	0.32	0.17–0.61	.001**
Threshold EC	1.21	0.65–2.22	.539
Male	1		
Female	1.89	0.94–3.78	.070
Age	1.01	0.97–1.03	.717
Threshold NC	0.28	0.05–1.71	.165
Threshold EC	1.03	0.17–6.16	.971
Smoking habit			<.001***
Threshold NC	0.11	0.06–0.19	<.001***
Threshold EC	0.46	0.29–0.72	.001
NS	1		
FS	0.79	0.33–1.97	.612
S	0.21	0.10–0.43	<.001***
Job	0.98	0.85–1.14	.878
Threshold NC	0.20	0.10–0.41	<.001***
Threshold EC	0.68	0.36–1.30	.239
Pathology/medication			
Threshold NC	0.18	0.12–0.29	<.001***
Threshold EC	0.68	0.48–0.96	.026*
No	1		
Yes	0.52	0.22–1.21	.123
Distance	0.99	0.99–1.01	.907
Threshold NC	0.19	0.12–0.32	<.001***
Threshold EC	0.72	0.48–1.10	.124
Stage			
Threshold NC	0.22	0.13–0.38	<.001***
Threshold EC	0.82	0.52–1.30	.396
E+I+II+III	1		
IV	1.18	0.64–2.17	.584
Grade			<.001***
Threshold NC	0.14	0.06–0.35	<.001***
Threshold EC	0.59	0.27–1.35	.215
E	1		
A/B	1.24	0.48–3.08	.633
C	0.28	0.10–0.73	.010*

* $p \leq 0.05$; ** $p < 0.05 \geq 0.001$; *** $p < 0.001$.

impact upon the compliance rate. In other words, the longer the treatment was delivered, the lower the compliance rate. Hence, motivational strategies entailing more persuasive communication methods is advocated for these risk profiles, with the aim of enhancing the compliance rate.

The compliance rates reported during supportive therapy after periodontal therapy range from approximately 3%–90% (Amerio et al., 2020), and are very similar to the results reported in general medicine (approximately 5%–100%) (DiMatteo, 2004). In this sense, it is important to highlight that the definition of compliance may vary

TABLE 2 Association of site-related variables with level of compliance.

	OR	IC 95%	*p*-Value
Number of implants	1.00	0.92–1.09	.942
Threshold NC	0.21	0.10–0.43	<.001***
Threshold EC	0.76	0.39–1.48	.420
Follow-up implants	0.99	0.99–1.01	.326
Threshold NC	0.13	0.05–0.35	<.001***
Threshold EC	0.49	0.20–1.22	.121
Number of implants PI	1.08	0.93–1.27	.285
Threshold NC	0.26	0.14–0.47	<.001***
Threshold EC	0.95	0.56–1.62	.854
Follow-up implants PI	0.97	0.95–0.98	.003**
Threshold NC	0.07	0.03–0.16	<.001***
Threshold EC	0.26	0.12–0.57	.001**
Location AM			
Threshold NC	0.21	0.13–0.34	<.001***
Threshold EC	0.76	0.52–1.11	.154
No	1		
Yes	1.35	0.68–2.74	.381
Location PM			
Threshold NC	0.20	0.12–0.34	<.001***
Threshold EC	0.73	0.47–1.14	.161
No	1		
Yes	1.11	0.59–2.07	.739
Location AM			
Threshold NC	0.18	0.11–0.28	<.001***
Threshold EC	0.63	0.44–0.91	.014*
No	1		
Yes	0.67	0.33–1.41	.294
Location PM			
Threshold NC	0.20	0.12–0.33	<.001***
Threshold EC	0.71	0.47–1.09	.113
No	1		
Yes	1.07	0.57–2.03	.817
Intervention			.857
Threshold NC	0.29	0.06–1.95	.200
Threshold EC	1.07	0.16–7.06	.945
NS			
REC	1.48	0.17–10.25	.686
RES	1.11	0.12–8.28	.919
RES+REC	1.57	0.18–11.09	.646
Survival	0.55	0.11–1.98	.375
Threshold NC	0.12	0.03–0.46	.002
Threshold EC	0.43	0.11–1.63	.209
Progressive bone loss (≥1 mm)	1.44	0.54–4.32	.477
Threshold NC	0.21	0.14–0.33	<.001***
Threshold EC	0.78	0.56–1.08	.135
Residual pocket (≥6 mm)			
Threshold NC	0.20	0.13–0.32	<.001***
Threshold EC	0.74	0.52–1.05	.092
No	1		
Yes	0.94	0.43–1.95	.868

* $p \leq 0.05$; ** $p < 0.05 \geq 0.001$; *** $p < 0.001$.

across studies. In fact, many of the studies reported in the literature do not suggest an a priori defined recall but rather a degree of regular attendance to supportive therapy (Demetriou et al., 1995; Fardal, 2006; Fenol & Mathew, 2010; Gokulanathan et al., 2014; Novaes Jr. & Novaes, 2001). Other authors, instead, provide more flexible definitions of RC, including patients who attend supportive care at least once a year (Famili & Short, 2010; Galgut, 1991). If our data were adjusted to such a case definition, the RC rate would be about 80%. However, in the context of implant therapy, a minimum recall frequency of once every 5–6 months has been suggested to be critical in order to prevent peri-implantitis (Costa et al., 2023; Leone et al., 2023).

Data on preventive therapy after implant placement have evidenced high rates of compliance. Cardaropoli et al. showed compliance at 5 years of follow-up to be approximately 77%, being higher in implant carriers when compared to patients not rehabilitated with implant-supported prostheses (Cardaropoli & Gaveglio, 2012). Likewise, Frisch et al., in a three-year retrospective study, recorded a compliance rate of about 87%. No risk profiles according to patient- and site-related factors were found to be associated to erratic attitudes in terms of compliance (Frisch et al., 2014). Zeza et al. reported a compliance rate of approximately 70% at 5 years of follow-up, the figure being higher in patients that received periodontal therapy before implant therapy than in those who did not (Zeza et al., 2017). Monje et al., using the same definition of compliance as in the current study, reported a compliance rate of approximately 40%. It should be noted that many of the patients included in this study did not receive recommendations in terms of the frequency of SPIT prior to implant placement (Monje et al., 2017). Costa et al., in a long-term prospective study, found that at the 11-year assessment to test the influence of compliance upon the incidence of biological complications, approximately 33% of the patients were RC, while about 30% were EC (Costa et al., 2023). All these studies coincide that the longer the implants were followed up on, the lower the compliance rate. Therefore, our findings referred to patients adhering to SPIT after peri-implantitis treatment are consistent with the documented evidence on preventive maintenance therapy.

Studies have been made of potential confounders of erratic or non-compliance. In this regard, inadequate motivation, bad experiences, maintenance by the general dentist, distance to practice, or economic problems have been regarded as the most common reasons for lack of compliance (Amerio et al., 2020). Moreover, gender (males), age (advanced), history of periodontal disease (no), extent of periodontal disease (severe), smoking habit (current smoker), plaque control (poor), level of education (low), monthly income (low), brushing (no), use of an inter-dental brush or dental floss (no), use of fluoride toothpaste (no), consumption of sugar-containing drinks (yes), or knowledge about oral healthcare (low), have also demonstrated associations with erratic attitudes towards preventive maintenance therapy (Monje et al., 2017; Ojima et al., 2005; Perrell-Jones & Ireland, 2016; Ramseier et al., 2014; Si et al., 2016; Soolari & Rokn, 2003). Our findings are thus in partial accordance with these data. After peri-implantitis treatment, smokers and patients with advanced (grade C) periodontitis tended to be less prone to RC. Moreover, the association with the male gender showed a tendency, but did not reach statistical significance ($p = .07$). These findings might be explained by poor patient consideration or belief of the impact of their actions/habits upon their health (Courtenay, 2000), and in the case of smoking, they

TABLE 3 Association of patient- and site-related variables with level of compliance.

	OR	IC 95%	*p*-Value
Smoking habit I periodontitis grade			<.001***
Threshold NC	0.04	0.01–0.16	<.001***
Threshold EC	0.21	0.06–0.68	.009**
NS + edentulous	1		
NS + A/B	1.51	0.27–15.9	.450
FS + E	1.79	0.49–4.35	.559
FS + A/B	1.02	0.28–3.71	.974
S + C	0.28	0.09–0.84	.027*
Follow-up	0.96	0.95–0.98	.009**

* $p \leq 0.05$; ** $p < 0.05 \geq 0.001$; *** $p < 0.001$.

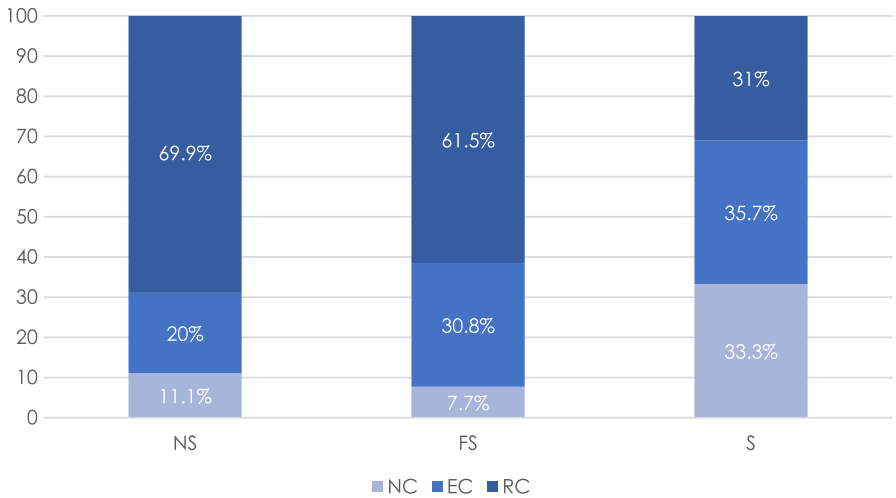

FIGURE 2 Level of compliance according to smoking habit. EC, erratic compliance; NC, no compliance; RC, regular compliance.

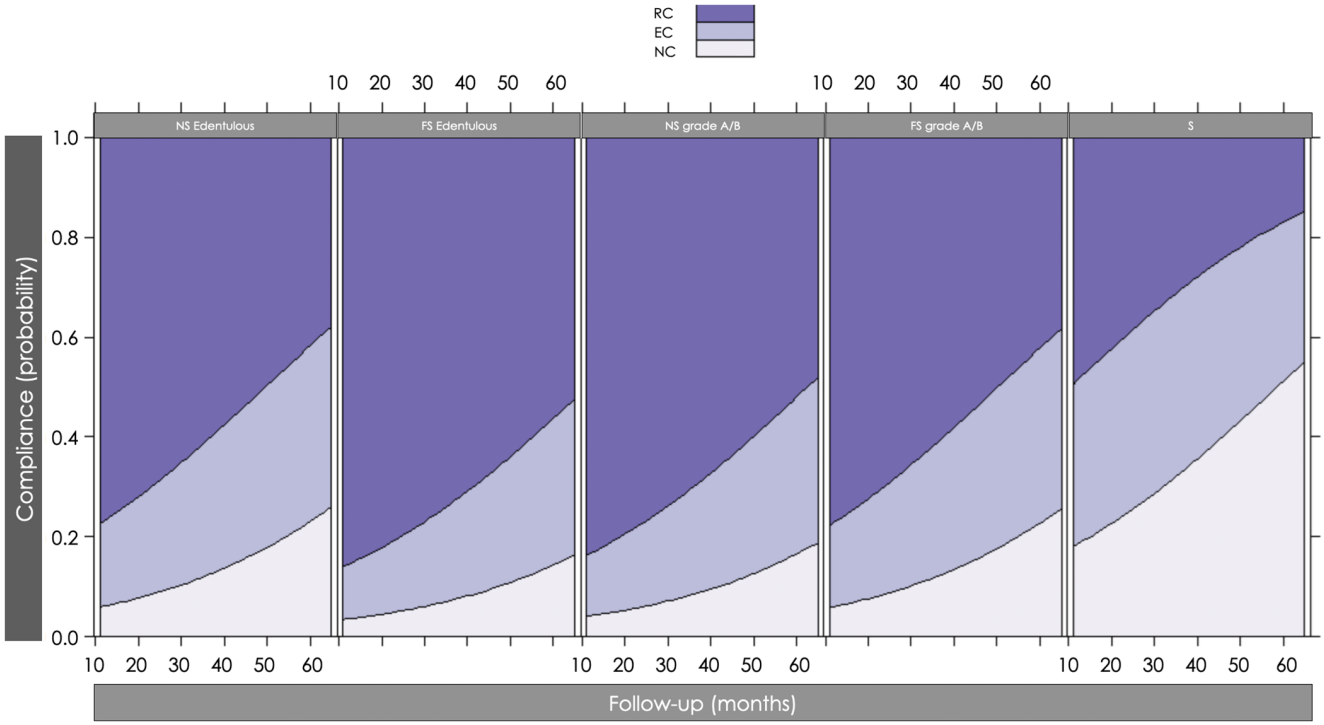

FIGURE 3 Predicted probability for each category of compliance according to follow-up for the variables demonstrating statistical significance in the multivariate analysis.

might also reflect patient shame for not following the advice to stop smoking (Monje et al., 2017). Therefore, it is speculated that these patients might be less favorable candidates to receive therapy. In addition, it was shown that during follow-up, patient age also confounds the compliance rate. The efforts and communicative strategies advocated for these risk profiles should be more comprehensive and uniform, seeking to effectively persuade patients to regularly attend SPIT.

To the best of our knowledge, this is the first study focusing on the compliance rate following peri-implantitis treatment. Future studies must provide long-term data. In addition, communication strategies must be tested to enhance the knowledge, understanding and comprehension of peri-implantitis (Monje, Perez, et al., 2022), and to improve awareness of the systemic (Blanco et al., 2021) and local sequelae/consequences of this inflammatory condition (Monje et al., 2019).

5 | CONCLUSIONS

Comprehensive information, provided prior to peri-implantitis treatment, regarding the importance of adhering to SPIT following peri-implantitis treatment to achieve/maintain peri-implant health, resulted in ~60% regular compliance rate. Patient-related factors such as age, smoking habit, and grade of periodontitis showed significant associations with compliance rate. Moreover, follow-up after peri-implantitis treatment was associated to the compliance rate. Hence, motivational strategies must be periodically implemented to enhance the adherence of high-risk profile patients to long-term regular compliance.

AUTHOR CONTRIBUTIONS

AM and JN conceived the idea and developed the project. PGF helped in data collection and in analyzing existing literature. AM took the lead in writing the manuscript.

ACKNOWLEDGEMENTS

The authors thank Mrs. Mamen Tomé (CICOM Monje Institute, Badajoz, Spain) and Ursula Sánchez (CICOM Monje Institute, Badajoz, Spain) for assisting in data collection.

CONFLICT OF INTEREST STATEMENT

The authors have no direct conflicts of interest to declare.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

ORCID

Alberto Monje https://orcid.org/0000-0001-8292-1927

REFERENCES

Amerio, E., Mainas, G., Petrova, D., Giner Tarrida, L., Nart, J., & Monje, A. (2020). Compliance with supportive periodontal/peri-implant therapy: A systematic review. *Journal of Clinical Periodontology*, *47*(1), 81–100. https://doi.org/10.1111/jcpe.13204

Axelsson, P., Nystrom, B., & Lindhe, J. (2004). The long-term effect of a plaque control program on tooth mortality, caries and periodontal disease in adults. Results after 30 years of maintenance. *Journal of Clinical Periodontology*, *31*(9), 749–757. https://doi.org/10.1111/j.1600-051X.2004.00563.x

Berglundh, T., Armitage, G., Araujo, M. G., Avila-Ortiz, G., Blanco, J., Camargo, P. M., Chen, S., Cochran, D., Derks, J., Figuero, E., Hämmerle, C. H. F., Heitz-Mayfield, L. J. A., Huynh-Ba, G., Iacono, V., Koo, K. T., Lambert, F., McCauley, L., Quirynen, M., Renvert, S., … Zitzmann, N. (2018). Peri-implant diseases and conditions: Consensus report of workgroup 4 of the 2017 world workshop on the classification of periodontal and Peri-implant diseases and conditions. *Journal of Periodontology*, *89*(Suppl 1), S313–S318. https://doi.org/10.1002/JPER.17-0739

Berglundh, T., Wennstrom, J. L., & Lindhe, J. (2018). Long-term outcome of surgical treatment of peri-implantitis. A 2-11-year retrospective study. *Clinical Oral Implants Research*, *29*(4), 404–410. https://doi.org/10.1111/clr.13138

Blanco, C., Linares, A., Dopico, J., Pico, A., Sobrino, T., Leira, Y., & Blanco, J. (2021). Peri-implantitis, systemic inflammation, and dyslipidemia: A cross-sectional biochemical study. *Journal of Periodontal & Implant Science*, *51*(5), 342–351. https://doi.org/10.5051/jpis.2100920046

Cardaropoli, D., & Gaveglio, L. (2012). Supportive periodontal therapy and dental implants: An analysis of patients' compliance. *Clinical Oral Implants Research*, *23*(12), 1385–1388. https://doi.org/10.1111/j.1600-0501.2011.02316.x

Classification for the Spanish National Occupations (CNO-11). (2010). National Institute of Statistics, 1591/2010.

Costa, F. O., Costa, A. M., Ferreira, S. D., Lima, R. P. E., Pereira, G. H. M., Cyrino, R. M., Oliveira, A. M. S. D., Oliveira, P. A. D., & Cota, L. O. M. (2023). Long-term impact of patients' compliance to peri-implant maintenance therapy on the incidence of peri-implant diseases: An 11-year prospective follow-up clinical study. *Clinical Implant Dentistry and Related Research*, *25*(2), 303–312.

Courtenay, W. H. (2000). Constructions of masculinity and their influence on men's well-being: A theory of gender and health. *Social Science & Medicine*, *50*(10), 1385–1401. https://doi.org/10.1016/s0277-9536(99)00390-1

Demetriou, N., Tsami-Pandi, A., & Parashis, A. (1995). Compliance with supportive periodontal treatment in private periodontal practice. A 14-year retrospective study. *Journal of Periodontology*, *66*(2), 145–149. https://doi.org/10.1902/jop.1995.66.2.145

DiMatteo, M. R. (2004). Variations in patients' adherence to medical recommendations: A quantitative review of 50 years of research. *Medical Care*, *42*(3), 200–209. https://doi.org/10.1097/01.mlr.0000114908.90348.f9

Famili, P., & Short, E. (2010). Compliance with periodontal maintenance at the University of Pittsburgh: Retrospective analysis of 315 cases. *General Dentistry*, *58*(1), e42–e47.

Fardal, O. (2006). Interviews and assessments of returning non-compliant periodontal maintenance patients. *Journal of Clinical Periodontology*, *33*(3), 216–220. https://doi.org/10.1111/j.1600-051X.2006.00891.x

Fenol, A., & Mathew, S. (2010). Compliance to recall visits by patients with periodontitis - is the practitioner responsible? *Journal of Indian Society of Periodontology*, *14*(2), 106–108. https://doi.org/10.4103/0972-124X.70829

Frisch, E., Ziebolz, D., Vach, K., & Ratka-Kruger, P. (2014). Supportive post-implant therapy: Patient compliance rates and impacting factors: 3-year follow-up. *Journal of Clinical Periodontology*, *41*(10), 1007–1014. https://doi.org/10.1111/jcpe.12298

Galgut, P. N. (1991). Compliance with maintenance therapy after periodontal treatment. *Dental Health*, *30*(6), 3–7.

Gokulanathan, S., Balan, N., Aravind, R. J., & Thangavelu, K. (2014). Patient compliance and supportive periodontal therapy: Study among young adults of Namakkal district. *Journal of Pharmacy & Bioallied Sciences*, *6*(Suppl 1), S171–S173. https://doi.org/10.4103/0975-7406.137443

Ichioka, Y., Trullenque-Eriksson, A., Ortiz-Vigon, A., Guerrero, A., Donati, M., Bressan, E., Ghensi, P., Schaller, D., Tomasi, C., Karlsson, K., Abrahamsson, I., Dionigi, C., Regidor, E., Berglundh, T., & Derks, J. (2023). Factors influencing outcomes of surgical therapy of peri-implantitis: A secondary analysis of 1-year results from a randomized clinical study. *Journal of Clinical Periodontology*, *50*, 1282–1304. https://doi.org/10.1111/jcpe.13848

Insua, A., Monje, A., Wang, H. L., & Inglehart, M. (2017). Patient-centered perspectives and understanding of Peri-Implantitis. *Journal of Periodontology*, *88*(11), 1153–1162. https://doi.org/10.1902/jop.2017.160796

Leone, F. D., Blasi, G., Amerio, E., Valles, C., Nart, J., & Monje, A. (2023). Influence of the level of compliance with preventive maintenance therapy upon the prevalence of Peri-implant diseases: A cross-sectional study. *Journal of Periodontology*, *95*, 40–49. https://doi.org/10.1002/JPER.23-0048

Monje, A., Aranda, L., Diaz, K. T., Alarcon, M. A., Bagramian, R. A., Wang, H. L., & Catena, A. (2016). Impact of maintenance therapy for the prevention of Peri-implant diseases: A systematic review and meta-analysis. *Journal of Dental Research*, *95*(4), 372–379. https://doi.org/10.1177/0022034515622432

Monje, A., Perez, A., Vera-Rodriguez, M., Nart, J., Catena, A., & Petrova, D. (2022). Comprehension and recall of information about factors associated with peri-implantitis: A randomized controlled trial. *Journal of Periodontology*, *93*(1), 89–99. https://doi.org/10.1002/JPER.21-0018

Monje, A., Pons, R., Amerio, E., Wang, H. L., & Nart, J. (2022). Resolution of peri-implantitis by means of implantoplasty as adjunct to surgical therapy: A retrospective study. *Journal of Periodontology*, *93*(1), 110–122. https://doi.org/10.1002/JPER.21-0103

Monje, A., Pons, R., Insua, A., Nart, J., Wang, H. L., & Schwarz, F. (2019). Morphology and severity of peri-implantitis bone defects. *Clinical Implant Dentistry and Related Research*, *21*(4), 635–643. https://doi.org/10.1111/cid.12791

Monje, A., Pons, R., Vilarrasa, J., Nart, J., & Wang, H. L. (2023). Significance of barrier membrane on the reconstructive therapy of peri-implantitis: A randomized controlled trial. *Journal of Periodontology*, *94*(3), 323–335. https://doi.org/10.1002/JPER.22-0511

Monje, A., Wang, H. L., & Nart, J. (2017). Association of Preventive Maintenance Therapy Compliance and Peri-Implant Diseases: A cross-sectional study. *Journal of Periodontology*, *88*(10), 1030–1041. https://doi.org/10.1902/jop.2017.170135

Novaes, A. B., Jr., & Novaes, A. B. (2001). Compliance with supportive periodontal therapy. Part II: Risk of non-compliance in a 10-year period. *Brazilian Dental Journal*, *12*(1), 47–50.

Ojima, M., Kanagawa, H., Nishida, N., Nagata, H., Hanioka, T., & Shizukuishi, S. (2005). Relationship between attitudes toward oral health at initial office visit and compliance with supportive periodontal treatment. *Journal of Clinical Periodontology*, *32*(4), 364–368. https://doi.org/10.1111/j.1600-051X.2005.00677.x

Perrell-Jones, C., & Ireland, R. S. (2016). What factors influence patient compliance with supportive periodontal therapy in a general practice setting? *British Dental Journal*, *221*(11), 701–704. https://doi.org/10.1038/sj.bdj.2016.904

Ramseier, C. A., Kobrehel, S., Staub, P., Sculean, A., Lang, N. P., & Salvi, G. E. (2014). Compliance of cigarette smokers with scheduled visits for supportive periodontal therapy. *Journal of Clinical Periodontology*, *41*(5), 473–480. https://doi.org/10.1111/jcpe.12242

Roccuzzo, A., Stahli, A., Monje, A., Sculean, A., & Salvi, G. E. (2021). Peri-Implantitis: A clinical update on prevalence and surgical treatment outcomes. *Journal of Clinical Medicine*, *10*(5), 1107. https://doi.org/10.3390/jcm10051107

Roccuzzo, M., Bonino, L., Dalmasso, P., & Aglietta, M. (2014). Long-term results of a three arms prospective cohort study on implants in periodontally compromised patients: 10-year data around sandblasted and acid-etched (SLA) surface. *Clinical Oral Implants Research*, *25*(10), 1105–1112. https://doi.org/10.1111/clr.12227

Sanz, M., Chapple, I. L., & Working Group 4 of the VIII European Workshop on Periodontology. (2012). Clinical research on peri-implant diseases: Consensus report of working group 4. *Journal of Clinical Periodontology*, *39*(Suppl 12), 202–206. https://doi.org/10.1111/j.1600-051X.2011.01837.x

Serino, G., Wada, M., Mameno, T., & Renvert, S. (2021). Two- and ten-year follow-up of patients responding and non-responding to the surgical treatment of peri-implantitis: A retrospective evaluation. *Clinical Oral Implants Research*, *32*(4), 410–421. https://doi.org/10.1111/clr.13711

Si, W., Wang, H., Li, Q., Zhao, X., & Pan, Y. (2016). Effects of different factors influencing clinical compliance of Chinese patients with chronic periodontitis. *Quintessence International*, *47*(8), 643–652. https://doi.org/10.3290/j.qi.a35701

Soolari, A., & Rokn, A. R. (2003). Adherence to periodontal maintenance in Tehran, Iran. A 7-year retrospective study. *Quintessence International*, *34*(3), 215–219.

Stiesch, M., Grischke, J., Schaefer, P., & Heitz-Mayfield, L. J. A. (2023). Supportive care for the prevention of disease recurrence/progression following peri-implantitis treatment: A systematic review. *Journal of Clinical Periodontology*, *50*(Suppl 26), 113–134. https://doi.org/10.1111/jcpe.13822

Tonetti, M. S., Greenwell, H., & Kornman, K. S. (2018). Staging and grading of periodontitis: Framework and proposal of a new classification and case definition. *Journal of Clinical Periodontology*, *45*(Suppl 20), S149–S161. https://doi.org/10.1111/jcpe.12945

Zeza, B., Pilloni, A., Tatakis, D. N., Mariotti, A., Di Tanna, G. L., & Mongardini, C. (2017). Implant patient compliance varies by periodontal treatment history. *Journal of Periodontology*, *88*(9), 846–853. https://doi.org/10.1902/jop.2017.160528

SUPPORTING INFORMATION

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

How to cite this article: Monje, A., Galindo-Fernández, P., & Nart, J. (2024). Supportive therapy following peri-implantitis treatment: A retrospective study on compliance. *Clinical Oral Implants Research*, *00*, 1–9. https://doi.org/10.1111/clr.14257