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Disease recurrence during supportive therapy following peri-implantitis treatment: A retrospective study

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Abstract

Aim: Supportive therapy is key to prevent disease recurrence after peri-implantitis treatment. The primary objective was to quantify disease recurrence during supportive peri-implant therapy (SPIT) after peri-implantitis treatment. A secondary objective was to assess the success/failure of cumulative interceptive supportive therapy (CIST) after peri-implantitis treatment.

Methods: Compliers (whether regular or erratic) with SPIT after peri-implantitis treatment during ≥12 months were retrospectively evaluated. CIST was prescribed whenever residual pockets ≥6 mm concomitant with profuse bleeding on probing (disease recurrence) were identified. Patient- and implant-related factors were analyzed to explore their associations with disease recurrence and the need for CIST.

Results: Disease recurrence was considered in 28 patients (40 implants). Of these, 14 patients (23 implants) further demonstrated radiographic evidence of progressive bone loss (≥1 mm). This represented an overall disease recurrence following peri-implantitis treatment of ~20% and ~10% at patient and implant levels, respectively. Smokers, patients diagnosed at baseline with periodontitis grade C, and males were significantly more prone to exhibit recurrence. Patients undergoing CIST due to instability were not likely to respond favorably (~70% continued to exhibit residual pockets).

Conclusion: Disease recurrence during SPIT following peri-implantitis treatment on selected cases is ~20%. Patients undergoing CIST due to instability are not likely to respond favorably.

KEYWORDS
dental implant, dental maintenance, peri-implantitis, periodontal disease, supportive therapy

1 | INTRODUCTION

The effectiveness of peri-implantitis treatment is viewed with skepticism by clinicians and researchers, due to the rather disappointing long-term outcomes achieved by applying a wide range of treatments. This might be attributed in part to the vague consensus found in the literature on what methods are efficient for decontaminating the implant surface and what maneuvers or instruments and biomaterials are appropriate for managing the soft and hard tissues.[1] In any case, regardless of the therapeutic modality used, the primary endpoint in the management of peri-implantitis is the reduction of pocket probing depth. In fact, the odds for disease progression are 10-fold lower in cases where pocket depth is reduced to <6 mm.[2] Other surrogate parameters such as the reduction of bleeding on probing and/or the minimization of mucosal recession have also been advocated as indicators of success in the treatment of peri-implantitis.[3]

Some prognostic indicators of therapeutic success have been suggested in the literature.[4] For instance, peri-implantitis-related bone defect configuration/severity, implant position, implant surface characteristics, or peri-implant soft tissue characteristics have been found to be relevant for achieving disease resolution and/or for gaining marginal bone level.[5–11] In addition, self-administered and professionally administered measures for plaque control are considered critical in order to maintain peri-implant health. The reported middle- and long-term outcomes evidence the role of supportive peri-implant therapy (SPIT) in securing peri-implant tissue stability after peri-implantitis treatment.[12] However, conclusive data on the frequency and protocols for SPIT are lacking. In fact, it has been pointed out that disease recurrence may occur anyway and can imply implant failure/removal.[12]

Cumulative interceptive supportive therapy (CIST) was proposed for the effective arrestment of peri-implant diseases.[13] The original protocol advocated for different non-surgical or surgical approaches with or without local and systemic antibiotics according to clinical and radiographic parameters indicative of disease.[13] Long-term data suggested a need for CIST due to disease recurrence in 18% of periodontally healthy patients and 66% of severely periodontally compromised patients.[14] The protocols recommended, nevertheless, are out-of-date, and recent scientific data do not support the applications of various measures suggested in the original protocol.[13] In addition, the need for CIST after peri-implantitis treatment is scantly reported in the literature. Hence, the primary aim of this retrospective study was to assess disease recurrence during SPIT following peri-implantitis treatment and to analyze the effectiveness of CIST due to disease recurrence in subsequently reaching/maintaining peri-implant health.

2 | 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 an informed consent document accepting that their personal data and treatment information could be used for research purposes. Patient data were anonymized. The study was registered and approved by www.clinicaltrials.gov (NCT05772078). The manuscript is reported in accordance with the STROBE statement.

2.1 | Study population

The patient database was retrospectively assessed at the CICOM Institute (Badajoz, Spain) from September 2017 to May 2022. Patients were eligible to participate if diagnosed with peri-implantitis. These were screened and exported to a spreadsheet by a dental hygienist. The case definition of peri-implantitis initially considered was according to Sanz and Chapple,[15] 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.[16] Recruited patients that did not fulfill these criteria were retrospectively excluded. Only patients that committed to attend to SPIT with our hygienists and who 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. From this cohort, only compliers (whether regular or erratic) with SPIT were included (Table 1). All included cases were treated by non-surgical means seeking to reduce pocket depth. Whenever pocket closure was not achieved at re-assessment (6–8 weeks), surgical therapy was performed. The surgical modality applied, whenever needed, was primarily decided by the configuration (contained defects underwent reconstructive therapy, while non-contained defects were managed by means of resective therapy) and defect depth (intrabony defects ≥3 mm were treated by means of reconstructive therapy, while intrabony defects <3 mm were managed in terms of resective therapy). Areas outside of the reparative potential or bony housing were subjected to implantoplasty. Generally speaking, implant removal of peri-implantitis implants upon diagnosis was decided in agreement with the patient based on expendability from biomechanical needs (i.e., implants not strictly needed to support a prosthesis), inadequate implant position that would preclude access for oral hygiene (i.e., implants close to each other or too far outside of the bony housing), and severity (>50%). If implants exhibited advanced peri-implantitis and the patients were not willing to undergo implant removal, they were informed about the lower predictability of the procedure. Additionally, patients that did not enhance plaque control or did not respond favorably to self-performed oral hygiene methods during the initial screening or after non-surgical therapy were not deemed candidates to move on to the surgical phase. Periodontitis, whenever present, was managed as part of the initial (non-surgical) treatment of peri-implantitis. None of the patients that underwent surgical therapy to manage peri-implantitis had residual ≥6 mm pockets with concomitant bleeding on probing in their teeth, unless corrective surgical periodontal therapy was scheduled to be managed simultaneously with the surgical treatment of peri-implantitis.

2.2 | Supportive peri-implant therapy recall

The patients were divided into two groups according to the level of compliance with SPIT, as described elsewhere.[17] In general lines, 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 was conditioned by the patient's risk profile. In this regard, for low-risk patients (full-mouth plaque index <20%, non-smokers, and periodontal/peri-implant stability), a recall interval of 5–6 months was scheduled. On the other hand, high-risk patients (smokers, uncontrolled hyperglycemia during follow-up, full-mouth plaque index ≥20% and/or full-mouth bleeding index ≥20%, and implants exhibiting disease progression/recurrence) were scheduled for a recall interval of 3–4 months. Hence, the periodicity according to

TABLE 1 Demographic characteristics of the patients included in the study.

	N
Total peri-implantitis patients	132
Gender	
Male	29
Female	103
Age	62.8 ± 10
Smoking	
Non-smoking	80
Former smoking	24
Smoking	28
Systemic disease	
No	115
Yes	17
Distance (km)	41 ± 48
Stage	
Edentulous	21
I	1
II	2
III	34
IV	74
Grade	
Complete edentulous	21
A	83
C	28
Implants (*n*)	6.7 ± 3.5
Peri-implantitis implants (*n*)	3.0 ± 2.2
Peri-implantitis treatment follow-up (*n*)	35 ± 16
Location (AM)	38
Location (PM)	60
Location (am)	28
Location (pm)	55
Peri-implantitis locations (*n*)	
1	91
2	34
3	1
4	6
Therapeutic modality	
Only NS	3
REC	62
RES	21
RES + REC	46

the risk profile was re-evaluated at every SPIT appointment. The level of compliance was categorized as follows:

- Regular compliance (RC ≥2 SPIT/year): patients that complied with the recommended SPIT recall interval.
- Erratic compliance (EC <2 SPIT/year): patients that failed to comply with the recommended SPIT recall interval.

Patients were scheduled for SPIT immediately after finishing previous maintenance and received a reminder of the appointment one week before (telephone call) and one day before (text) the visit.

2.3 | Supportive peri-implant therapy

Briefly, during the regular SPIT appointments, oral hygiene was instructed and motivated by the hygienist. Once the full-mouth plaque index was shown to the patient by means of biofilm disclosure (whenever plaque control was not deemed satisfying), professionally performed oral hygiene measures were adopted. In general lines, maintenance included the removal of plaque and calculus using curettes, air-polishing devices, and ultrasound instruments. 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 exploratory 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 due to its antiseptic effect. Behavioral changes (smoking cessation, oral hygiene instructions, and counseling on systemic factors) were further reinforced at each recall appointment. Disease recurrence was defined as pocket depth ≥6 mm with profuse bleeding on probing.

2.4 | Cumulative interceptive supportive therapy

CIST was considered when pocket depth was ≥6 mm concomitant with profuse bleeding on probing with or without radiographic evidence of progressive bone loss. The CIST strategy varied according to residual pocket depth. In general lines, if the peri-implant pocket ranged from 6 to 8 mm with profuse bleeding on probing but without suppuration, deep curettage was performed under local anesthesia, with submucosal irrigation of chlorhexidine 0.12% as antiseptic. If the pocket was ≥6 mm together with immediate suppuration upon probing or >8 mm with or without suppuration, access was gained by means of a full-thickness flap using diode laser or scalpel. If abundant keratinized mucosa was present, the incision was made para-marginal beveled aiming at resecting epithelium and thinning the connective tissue while removing the granulation tissue. Otherwise, a marginal internal beveled incision was carried out to thin the connective tissue and remove the granulation tissue. The latter was removed either with a diode laser or using curettes. The implant surface was decontaminated using only mechanical means with curettes, ultrasound instruments, and/or air polishers, with saline irrigation. The flap was apically positioned by means of vertical mattress suturing. Thereafter, the patients were enrolled in a 3–4 month recall program with SPIT during the first year after CIST. CIST was considered unsuccessful if pocket depth during SPIT was ≥6 mm with or without progressive bone loss (≥1 mm considering the standard error of measurement).[18]

In patients whose progressive bone loss was noticed radiographically, implant removal was recommended.

2.5 | Assessment of variables

The following patient-related variables were documented and 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; LS: light smokers <10 cig/day; and HS: heavy smokers ≥10 cig/day)
- Disease/medication at the time of assessment or during follow-up (N: no; AD: antidepressant medication; CT: chemotherapy; RT: radiotherapy; RA: rheumatoid arthritis; DM: diabetes mellitus; CD: cardiovascular disease; HT: arterial hypertension; and 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[19]
- Complete edentulism (E)
- Distance (km) from the usual place of residence of the patient to the clinic (checked using Google Maps)
- Occupation (coded according to the CNO-11)[20]

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

- Overall number of implants
- Number of implants where peri-implantitis therapy was applied
- Location of the implants where therapy was applied (AM: anterior maxilla; am: anterior mandible; PM: posterior maxilla; and pm: posterior mandible)
- Follow-up of implants (months)
- Follow-up of therapy (months)
- Type of intervention (NS: non-surgical; RES: resective; REC: reconstructive [entailing combined therapy]; and 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)

On the other hand, in recurrent cases requiring CIST, the following parameters were moreover recorded:

- Number of implants requiring CIST
- Follow-up when CIST was carried out (months)
- Outcome of CIST (F: failure to resolve the inflammation; S: success in reducing pocket depth <6 mm)
- Whether implant removal was performed (yes/no). Implant removal was proposed to the patients if CIST failed to resolve the disease, with a demonstrated residual pocket ≥6 mm in combination with progressive bone loss. Bleeding on probing (irrespective of profuseness) was not considered as a factor for recommending implant removal, provided the pocket depth was reduced, and progressive bone loss (>1 mm) was not evidenced during follow-up. Implant removal was always performed in agreement with the patient
- Prosthesis design (FNH: fixed non-hybrid – only white esthetics; FH: fixed hybrid – with pink esthetics; OD: overdenture; and SC: single crown)
- Local confounders not ideally accommodated (PR: prosthesis-related, demanding high technical skills for performing interproximal access; STR: soft tissue-related, when the band of keratinized mucosa was narrow or inexistent; implant-related, when the implant was in an evidently inadequate position)
- Plaque control during follow-up when CIST was performed (good: <20% full-mouth plaque index; fair: 20%–50% full-mouth plaque index; and poor: >50% full-mouth plaque index)

2.6 | Statistical analysis

The data were analyzed using the SPSS version 15.0 and R 4.3.2 statistical packages. A descriptive analysis was carried out to describe the pertinent data. Inferential analysis based on simple binary logistic regression was performed to analyze the influence of the variables on disease recurrence and the need for CIST at patient level. The Wald chi-square test was used to assess associations between independent variables and to provide raw odds ratios (ORs). Significant ($p < .05$) and relevant ($p < .1$) variables were subsequently entered into a multiple model to estimate the adjusted ORs. Binary logistic regression models were carried out through generalized estimating equations (GEEs) to assess the outcome of implant survival. The logit model testing the association between the outcome and independent variables afforded a statistical power of 84.6% in detecting OR = 2.3 as significant in a sample representing a probability of therapeutic success (no disease recurrence) of 25% and 50%, with a 95% confidence interval.

3 | RESULTS

Data from 161 patients that were followed for ≥12 months after treatment were screened and retrieved from the system ($n_{implants} = 1079$). Rate of disease compliance was analyzed and published elsewhere.[21] Non-compliers ($n = 27$, 17%) with SPIT were excluded. A total of 134 patients that complied (whether RC or EC) with SPIT following peri-implantitis treatment were included in the study. Overall, there were 30 males (22.4%) and 104 females (77.6%). In total, data from 900 implants were retrospectively collected. Two patients died (1 male and 1 female;

overall $n_{implants}=4$) in the course of follow-up and were thus excluded from the analyses. Hence, data from 132 patients were included in the analysis ($n_{implants}=896$). Mean age was 62 ± 10 years. Twenty-eight patients were smokers. Of the included implants, 99 were removed due to hopeless prognosis and 397 exhibiting peri-implantitis received treatment aimed at resolving the inflammatory disorder. The mean duration of follow-up was 35 ± 16 months after peri-implantitis treatment (Table 1). CIST was considered in 28 patients ($n_{implants}=40$) due to disease recurrence. Interestingly, out of the 28 patients where disease recurred, 23 implants (57.5%) in 14 patients (50%) demonstrated progressive bone loss (≥1 mm). The remaining 17 implants (42.5%) in 14 patients (50%) only showed deep pockets (≥6 mm) with profuse bleeding on probing. This represents a frequency of disease recurrence following peri-implantitis treatment of ~20% and ~10% at patient and implant levels, respectively (Figure 1). Collectively, 64.2% of the patients exhited moderate (≥25%–50% marginal bone loss), 25% advanced (≥50% marginal bone loss), and 10.8% mild (<25% marginal bone loss) peri-implantitis bone-related defect severity.

3.1 | Disease recurrence

Three variables were significantly associated with disease recurrence after peri-implantitis treatment: gender (male), smoking (current smoking), and the grade of periodontitis at baseline (grade C). Females were about 1/3 less likely to exhibit recurrence when compared to males (OR=0.34; $p=.01$). Likewise, current smokers presented a fourfold greater risk for recurrence versus non-smokers (OR=4.49; $p=.003$). Lastly, patients diagnosed at baseline with grade C periodontitis tended to recur four times more often when compared to patients with grade A periodontitis (OR=4.6; $p=.01$). The adjusted model for assessing the risk of recurrence according to gender, grade of periodontitis at baseline, and smoking habit further yielded strong statistical significance for smokers ($p=.006$). This means that patients diagnosed at baseline with grade A periodontitis and non-smokers were 80% less likely to exhibit disease recurrence (OR=0.23; $p=.006$) when compared to smokers that exhibited grade C periodontitis (Table 2).

3.2 | Outcomes of cumulative interceptive supportive therapy

Disease arrestment (pocket depth <6 mm and no further bone loss) after CIST was achieved in 28.6% ($n_{patients}=8$, $n_{implants}=11$) of the treated patients (95% CI: 14–48.9). In 71.4% ($n=20$) of the patients, disease recurred/progressed after CIST. Of these failed cases, in 13 patients ($n_{implants}=20$) it was opted to maintain the implants under supportive care, while in 7 patients ($n_{implants}=9$) removal was advocated due to mobility and/or advanced bone loss. None of the variables that were explored demonstrated being statistically significant with implant survival (Table 3). In fact, 12 of the patients in whom CIST failed showed poor plaque control. On the other hand, 7 of the patients in which CIST proved successful presented fair or good plaque control. The majority of the patients in whom CIST failed presented local confounders ($n=12$), particularly prosthesis-related confounders ($n=10$). Most of the failed CISTs ($n=12$) exhibited moderate peri-implantitis defects (≥25%–50% marginal bone loss). Disease recurrence/progression and implant removal after CIST were more frequent in FP, whether FH or FNH ($n=16$) when compared to OD or SC.

4 | DISCUSSION

Peri-implant maintenance therapy has been regarded as crucial for the primary and secondary prevention of peri-implantitis.[22] In this regard, SPIT is a key contributor to achieving hard and soft tissue stability after peri-implantitis treatment.[12] The present study found that disease recurrence, defined as ≥6 mm pocket depth concomitant

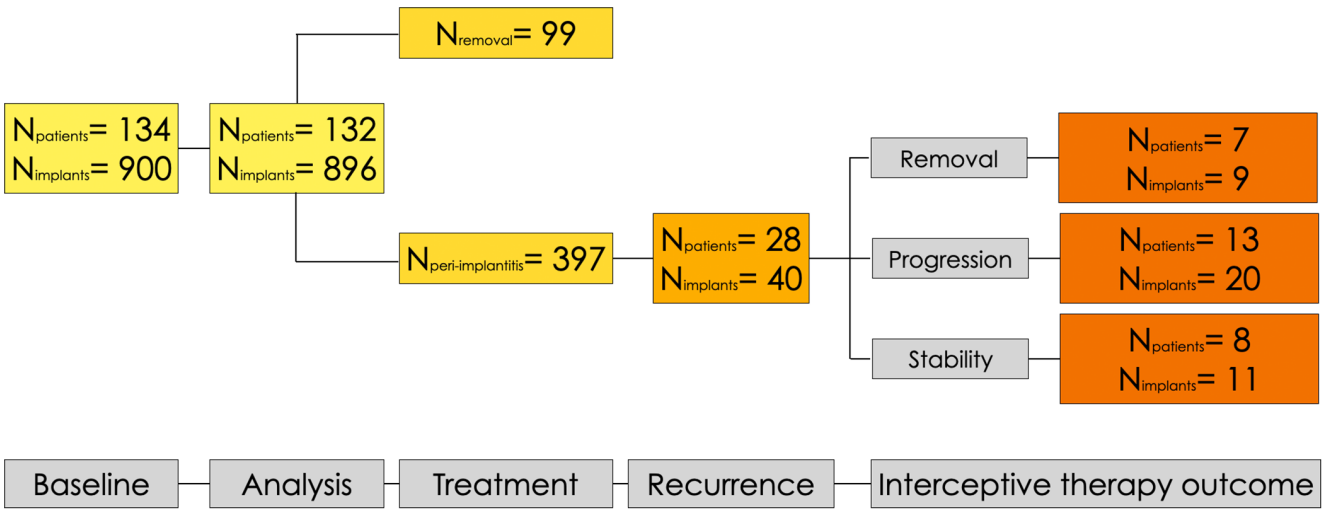


FIGURE 1 Flowchart of the study and treatment outcomes of peri-implantitis and cumulative interceptive supportive therapy.

TABLE 2 Disease recurrence according to the simple and multiple binary logistic models. Non-adjusted and adjusted odds ratios (ORs) and 95% confidence interval (95% CI).

	OR	95% CI	*p*-value
Simple			
Gender			
Male	1		
Female	0.34	0.14–0.84	.019*
Age (years)	1.00	0.96–1.04	.883
Smoking			.010*
Non-smoking	1		
Former smoking	1.67	0.48–5.23	.389
Smoking	4.49	1.70–12.14	.003**
Smoking vs. former smoking	2.68	0.81–9.91	.116
Systemic disease			.986
No	1		
Yes	1.01	0.27–3.09	.985
Distance (km)	1.00	0.99–1.01	.483
Periodontitis stage			.845
Edentulous	1		
III	0.53	0.13–2.17	.372
IV	1.01	0.33–3.43	.986
Grade			.008**
Edentulous	1		
A	0.48	0.15–1.70	.229
C	2.26	0.67–8.45	.200
C vs. A	4.68	1.77–12.65	.002**
Implants (*n*)	1.04	0.92–1.17	.503
Peri-implantitis implants (*n*)	1.06	0.87–1.26	.490
Therapeutic modality			
NS	1		.825
REC	0.61	0.05–13.71	.697
RES	0.47	0.04–11.59	.575
RES + STC	0.42	0.04–9.70	.501
Compliance			
EC	1		
RC	0.64	0.27–1.55	.310
Location (*n*)	1.48	0.90–2.43	.115
Location (AM)			
No	1		
Yes	0.97	0.37–2.39	.954
Location (PM)			
No	1		
Yes	1.43	0.62–3.35	.403
Location (am)			
No	1		
Yes	1.30	0.46–3.37	.598
Location (pm)			
No	1		
Yes	1.74	0.75–4.10	.194
Multiple			
Gender			
Male	1		
Female	0.39	0.15–1.04	.055
Smoking + grade			.059
Non-smoker + edentulous	1		
Smoker + grade C	2.91	0.72–15.07	.158
Grade A	0.66	0.08–3.37	.578
Former smoker + edentulous	3.16	0.30–31.25	.852
Former smoker + grade A	0.84	0.13–5.37	.311
Grade A vs. smoker + grade C	0.23	0.08–0.65	.006**
Former smoker + grade A vs. smoker + grade C	0.29	0.06–1.15	.097

Note: *$p < 0.05$; **$p < 0.01$.

with profuse bleeding on probing, following treatment occurred in ~20% and ~10% at patient and implant levels, respectively, in patients under SPIT. Nevertheless, only ~30% of the cases requiring CIST to restore health eventually proved successful as shown in Figure 2. Implant failure/removal occurred in 9 implants after providing CIST. It is relevant to point out that 99 implants were removed as part of initial treatment due to unfavorable/hopeless prognosis. This would result in an overall implant failure rate of 12% (108 implants removed). Additionally, patients received treatment to manage periodontitis, whenever diagnosed, as part of the initial therapy. Therefore, patients included in the present study were periodontally stable during SPIT (periodontal pockets <6 mm). Moreover, the vast majority of the patients were NS (only 20% were smokers, where LS were dominant). This stresses the importance of case selection to succeed in the treatment of peri-implantitis.

The risk of disease recurrence has been explored in relation to different therapeutic modalities in patients subjected to SPIT. Charalampakis et al. (2011), in a 9-month to 13-year retrospective study, found that disease recurrence/progression occurred in ~55% of the treated patients. It is interesting to note that smoking and smoking dose were correlated with the failure of peri-implantitis treatment.[23] Hence, our findings agree that smoking contributes to failure and the subsequent need for CIST. Moreover, Heitz-Mayfield et al. (2018), in a 5-year prospective study, noted that disease recurrence occurred in 37% of the patients.[24] Roccuzzo et al. (2021) reported disease recurrence in ~54% of the patients treated by reconstructive means. It should be mentioned that the patients included in the study mentioned above were compliers and non-compliers with SPIT. As a matter of fact, it was noticed that peri-implant complications and implant failure occurred more frequently

TABLE 3 Implant survival according to the simple binary logistic model with generalized estimating equations (GEEs). Non-adjusted and adjusted odds ratios (ORs) and 95% confidence interval (95% CI).

	Simple		
	OR	95% CI	*p*-value
Gender			
Male	1		
Female	0.96	0.89–1.04	.963
Age (years)	0.95	0.91–1.00	.066
Smoking			.830
Non-smoker	1		
Former smoker	0.98	0.88–1.10	.982
Smoker	1.02	0.92–1.12	.751
Systemic disease			
No	1		
Yes	1.03	0.94–1.12	.569
Distance (km)	1.00	1.00–1.01	.712
Stage			.336
Edentulous	1		
III	1.11	0.91–1.37	.301
IV	1.14	0.95–1.37	.160
Grade			.337
Edentulous	1		
A	1.14	0.95–1.38	.157
C	1.12	0.93–1.36	.241
Implants (*n*)	0.99	0.98–1.00	.225
Peri-implantitis implants (*n*)	1.00	0.99–1.01	.568
Therapeutic modality			.402
REC	1		
RES	0.86	0.69–1.08	.201
RES + STC	1.01	0.95–1.07	.793
Compliance			
EC	1		
RC	1.01	0.92–1.10	.890
Location (*n*)	0.97	0.94–1.01	.208
Location (AM)			
No	1		
Yes	0.85	0.91–1.12	.852
Location (PM)			
No	1		
Yes	0.97	0.89–1.06	.484
Location (am)			
No	1		
Yes	0.94	0.82–1.08	.371
Location (pm)			
No	1		
Yes	1.00	0.92–1.10	.938

in non-compliers.[25] We excluded this cohort of patients from our study, as it could have biased the outcomes owing to the poor control of these patients. Mercado et al. (2018), in a prospective 3-year cohort study, demonstrated that ~44% of the cases were unsuccessful as they showed progressive bone loss, residual pockets with bleeding on probing, or mucosal recession ≥0.5 mm when applying surgical reconstructive treatment.[26] Carcuac et al. (2020), in a 1- to 5-year prospective study, found that 44% of the implants examined displayed disease recurrence (bone loss >1 mm, need for surgical retreatment, or implant loss). More promising outcomes were documented by Serino et al. (2021), who in a 10-year examination of a retrospective study showed that 84% of the implants in which health was achieved following surgery remained healthy during the entire observation period, while 29% of all treated implants showed disease progression. Moreover, it was noticed that 11 implants failed over the entire follow-up period.[2] Romandini et al. (2023), recently, demonstrated that surgical retreatment was needed in ~25% of the patients after a mean time period of 4.5 years.[27] Our findings, therefore, agree with the above regarding the frequency of disease recurrence or the need for CIST. It is relevant to note that the remaining ~80% of patients that did not require CIST should not be dogmatically considered completely successful cases, since bleeding on probing could be present in <6 mm pockets (peri-implant stability was defined as the lack of residual pockets ≥6 mm, regardless of the presence of bleeding). Nevertheless, we are of the opinion that pocket closure is the best indicator of stability, as evidenced elsewhere (Figure 3),[2,9] as bleeding is not sensitive in foreseeing progressive bone loss. In contrast, other authors have proposed other criteria, including implant mobility, only presence of bleeding on probing, the presence of suppuration, and/or excessive soft tissue inflammation, in defining disease recurrence.[23,28,29] This is an issue that should be more extensively addressed in future studies.

Bacterial plaque is the cause of underlying peri-implantitis and its recurrence.[30] The present study showed that CIST tended to fail more frequently in patients with poor plaque control (60%, $n = 12$). In addition, local predisposing/triggering factors have been linked to disease occurrence.[31] Findings from this retrospective study evidenced that 60% ($n = 12$) of the patients in whom CIST failed to achieve stability were associated with local confounders. In this sense, in 50% ($n = 10$) of the cases, prosthesis-related factors were involved that could not be ideally addressed during the initial phase and could be attributable to plaque accumulation and, ultimately, to disease recurrence. This is in line with the results published by de Tapia et al. (2022), highlighting the role of prosthesis modification in securing treatment success in patients with peri-implant diseases.[28]

Implant failure has been proposed as endpoint in the treatment of peri-implantitis. Berglundh et al. (2018) reported an implant failure rate of ~4%.[32] Likewise, Heitz-Mayfield (2018) demonstrated that failure occurred in 17% of the patients previously subjected to surgical anti-infective therapy.[24] Similarly, Roccuzzo et al. (2020) found that reconstructive therapy resulted in an overall implant failure rate of 33%, with implant surface topography being a critical

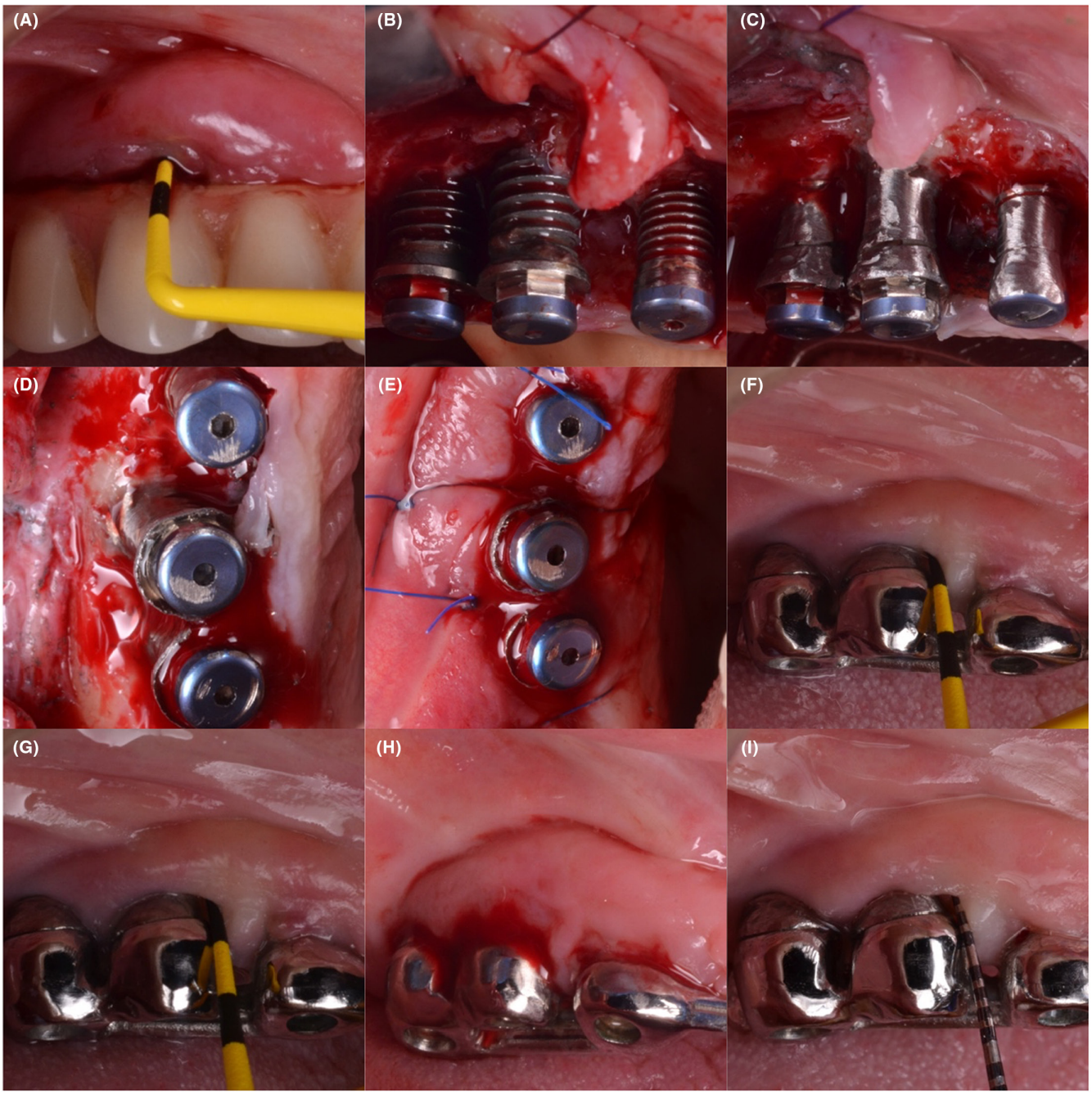
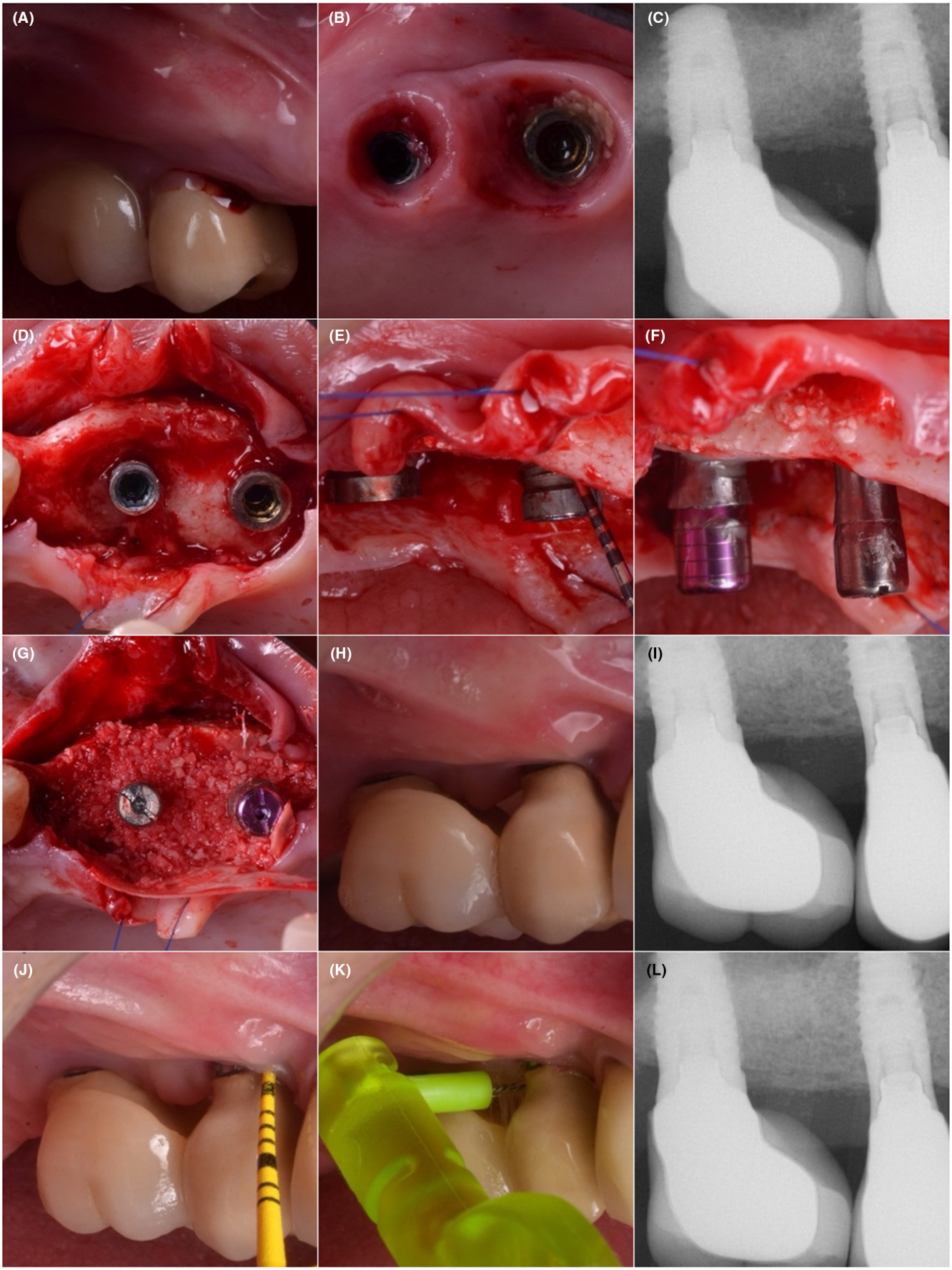


FIGURE 2 Peri-implantitis case illustrating successful management after CIST at 36-month follow-up. (A) Clinical image displaying profuse bleeding on probing and deep pockets; (B) upon full-thickness flap elevation, a negative bone architecture is noted with shallow intrabony defects (<3 mm); (C) osteoplasty was carried out to achieve a flat bone architecture; (D) occlusal view; (E) occlusal view of vertical mattress suturing technique seeking pocket elimination; (F) 12-month follow-up showing disease resolution; (G) 24-month follow-up showing disease resolution; (H) disease recurrence where an increase in pocket depth (≥6 mm) and profuse bleeding on probing were present at 26-month follow-up; (I) disease resolution at 48-month follow-up after interceptive therapy using diode laser.

FIGURE 3 Peri-implantitis case illustrating successful management of peri-implantitis by means of combined therapy in a regular complier. (A) Clinical image at baseline showing suppuration and profuse bleeding on probing; (B) occlusal view after prosthesis removal; (C) periapical radiograph showing moderate peri-implantitis exhibiting a crater-like defect; (D) intraoperative occlusal view illustrating partially contained defect configuration; (E) frontal view exhibiting the moderate severity; (F) implantoplasty was performed as an adjunctive measure for surface decontamination/modification above the reparative potential; (G) a barrier membrane and bone graft were used to reconstruct the intrabony components; (H) clinical disease resolution at 18-month follow-up; (I) marginal bone level stability at 18-month follow-up; (J) disease resolution at 48-month follow-up; (K) mucosal recession facilitates self-performed oral hygiene measures; (L) marginal bone stability at 48-month follow-up.



variable in anticipating survival.[33] In this sense, our data suggested that the failure rate seems to be reasonably low in patients undergoing peri-implantitis treatment. It should be noted that this does not represent the overall failure rate, since non-compliers with SPIT and implants removed upfront due to unfavorable prognosis were excluded from the analysis.

This study is not without shortcomings. It is important to note that because of the retrospective nature of the study, the variables could not be collected in a homogeneous manner (i.e., periapical X-rays were not always parallelized, and multiple probes were used during regular check-ups). Moreover, findings from this study are representative of selected cases where the operator deemed them suitable to respond favorably based on disease severity, implant position, and patient's risk profile. It is noteworthy that 99 implants were removed after diagnosis so the favorable outcomes might be, in part, attributable to the removal of implants with hopeless prognosis instead of providing treatment to arrest peri-implantitis. Additionally, multiple interventions carried out to manage peri-implantitis were examined. However, this variable did not yield statistical significance. Furthermore, recurred cases might be attributed to the failure to achieve success after therapy. On the other hand, as a strength of this study, the sample size was larger than in other medium- and long-term studies. Thus, it is advisable for future studies to address the accuracy of diagnostic parameters following the treatment of peri-implantitis in order to foresee hard and soft tissue stability. In light of the poor outcomes (~30%) obtained during CIST, it is further advisable to explore effective interventions to arrest disease progression.

5 | CONCLUSIONS

The frequency of disease recurrence following peri-implantitis treatment on selected cases is ~20% in patients under supportive care. Patients undergoing interceptive therapy due to instability are not prone to respond favorably.

CONFLICT OF INTEREST STATEMENT

The authors disclose no direct conflict of interest with the instruments listed in this paper.

DATA AVAILABILITY STATEMENT

The authors confirm that the data supporting the findings of this study are available within the article and its Supplementary Materials.

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