Is Periodontal and Peri-Implant Disease Associated with Fixed Partial Denture Use? A 25-year Prospective Case Series

ABSTRACT

Introduction: The association of the periodontium with the fixed prosthesis is the basis of prosthetic rehabilitation. This prospective case series aimed to evaluate periodontal health through the relation between periodontal/peri-implant disease progression and the use of fixed partial dentures (FPDs). Methods: Probing depth (PD), clinical attachment level (CAL), gingival index (GI), and plaque index (PI) on either teeth or implants were evaluated at up to 25-year follow-up and compared with the baseline. Statistical analysis was performed using the Kaplan-Meier test ($p<0.05$). Results: The prospective evaluation showed that the patients maintained adequate periodontal health. Failure (severe periodontal stages) occurred in 12.5% of patients. The survival rate for 107 teeth/implants was 80.48%. The comparisons for clinical parameters revealed no statistically significant difference ($p> 0.05$). At T1, the measurements for anterior and posterior regions, respectively, were PD =2.7mm and 3.1mm; CAL= 3.3mm and 3.6mm; GI=0.5 (both regions); and PI=0.79 and 0.62. Periodontal/peri-implant disease progression did not relate to the use of prostheses. Conclusions: Patients with more frequent follow-up appointments and lower GI and PI showed periodontal health for longer periods. Patients with different oral hygiene levels present different periodontal disease progression. Periodic hygiene control and motivation are vital factors for extensive oral rehabilitation success.

INTRODUCTION

The association of the periodontium with the prosthetic framework is the basis of prosthetic rehabilitation. Consequently, rehabilitation success requires proper planning considering early periodontal management, hygiene motivation, and periodontal support treatment, aiming at oral health promotion of the underlying periodontal tissues.[1,2] Notwithstanding, the long-term survival of tooth/implant-supported prostheses is high (78 to 98%)[3-8] because technical failures/complications (ceramic fractures and chipping) are usually more frequent than biological complications.[7]

The most frequent biological complications are bleeding, gingival recession,[3] caries, and periapical pathologies.[5,11] Caries are the main cause of biological failure, affecting prosthetic survival in around 32% of the cases.[12,13] Even teeth with periodontal involvement can support extensive fixed dental prosthesis (FDP) for an extended period, with a survival rate

Keywords

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of around 90%.[4,9,10] Recent epidemiological studies discussing the increase in periodontal disease prevalence emphasize that only a small rate of FDP loss is due to periodontal disease.[10,13,14] However, FDP survival occurred only with periodontal disease control and maintenance. Although periodic maintenance of the installed prosthesis plays a crucial role in long-term treatment success and survival, most patients are unaware of periodontal health. They must be informed and closely monitored by the periodontist.[2]

Aiming at improving long-term results, the World Workshop for the Classification of Periodontal and Peri-Implant Diseases and Conditions proposed a new concept in 2017.[15] Monitoring periodontal health by this concept may predict the prognosis in patients seeking prosthetic rehabilitation,[15] enabling even dentists without the ability to use indexes/parameters to score the patient's periodontal situation.[16] The classification of the periodontal situation would help in the treatment decision-making process.

Therefore, this present study aimed to evaluate the progression of periodontal health longitudinally after extensive tooth/implant-supported fixed oral rehabilitation by plotting a survival rate curve based on the baseline and recall parameters of each tooth/implant separately. The null hypothesis was that periodontal/peri-implant disease progression would not be associated with using FDP.

METHODS

ETHICAL ASPECTS

This study was submitted and approved by the Ethics and Research Committee of the Bauru Dental School–University of São Paulo (CAAE: 67610817.2.0000.5417). All procedures followed the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. All subjects were previously informed, read, and signed an informed consent form before starting the clinical procedures.

STUDY DESIGN

Forty patients who attended the Oral Rehabilitation Clinics of the institution between 1989 and 2008 were eligible for the study. Eight of the patients were found and volunteered to attend a complete periodontal examination.

The patients underwent hygiene guidance, plaque disclosure, prophylaxis, and periodontal treatment during the rehabilitation treatment period, if necessary. These measurements lasted until the end of each treatment. In addition, all patients received guidance on seeking adequate periodic periodontal appointments after the rehabilitation treatment completion.

The inclusion criteria were as follows: Patients with extensive oral rehabilitation (either tooth or implant-support FDP) in at least two hemiarches in the mandible and/or maxilla; patients with previous periodontal evaluation. The exclusion criteria included patients with systemic diseases; smokers; pregnant women; alcoholics; drug users; patients taking antidepressants, anti-inflammatory drugs, anticonvulsants, calcium blockers, or any other drug that could interfere with the study results.

CLINICAL EVALUATION

Tooth Parameters

1. Probing depth (PD): Measurement from the gingival margin to the base of the gingival sulcus/periodontal pocket.[17]
2. Clinical attachment level (CAL): Measurement from the cementoenamel junction to the base of the gingival sulcus/periodontal pocket.[17]
3. Gingival index (GI): The gingival tissues around each tooth were evaluated according to the following criteria: 0 = no bleeding; 1 = presence of bleeding.[18]
4. Plaque index (PI): The visible plaque index was assessed according to Ainamo and Bay.[18] The presence of visible plaque on the cervical area of the tooth was assessed on distal-buccal, buccal, mesial-buccal, and lingual surfaces. Plaque index was scored as follows: 0 = no plaque; 1 = presence of plaque.[19]

Implant Parameters

1. Probing depth (PD): Measurement from the gingival margin to the base of the gingival sulcus/periodontal pocket. This procedure also allowed to check bleeding on probing and the presence of exudation or suppuration.[20]
2. Clinical attachment level (CAL): Measurement from the implant platform to the base of the gingival sulcus/periodontal pocket.[20]
3. Gingival Index (GI): The Modified Sulcular Bleeding Index was used.[21] The methodology assesses the presence of mucosal bleeding during or even 10 seconds after the probing procedure around the implant. The criteria for evaluating the index were: 0 = no bleeding; 1 = presence of isolated bloodstains; 2 = presence of a blood line directed to the implant margin; 3 = profuse and prolonged bleeding.
4. Plaque Index (PI): The modified bacterial plaque index, recommended by Mombelli *et al* [21] was used to verify the presence and accumulation of biofilm deposits on the implants. The criteria for evaluating this index are: 0 = absence of bacterial plaque; 1 = plaque recognition only by sliding the probe over the marginal surface of the implant; 2 = presence of visible plaque; 3 = abundant presence of soft deposits.

Six sites per tooth/implant were recorded for PD, CAL, and GI parameters (mesial-buccal, buccal, distobuccal, mesial-lingual, lingual, distolingual), while four sites were recorded for PI (distal-buccal, buccal, mesial-buccal, and lingual surfaces).

A periodontal probe (model COLOR CODED PROBE CP-ISUNC-PCPUNC15, Hu-friedy, California, USA) was used to evaluate all clinical parameters.

The participants were classified according to the new concept, created at the 2017 World Workshop for the Classification of Periodontal and Peri-implant Diseases and Conditions, recommended by the American Academy of Periodontics (AAP), described by Caton *et al.*[16] and adapted from Tonetti, Greenwell, Kornman.[22]

Based on the CAL deepest site, the examiner scored each patient into stages from 1 to 4. The scores were directly proportional to the periodontal disease severity. Success and failure were determined by increasing or decreasing the score according to the patient's periodontal health between T1 and T2. For example, a patient who scored CAL greater than 2 mm at baseline (stage 1) and CAL = 5 mm at recall (stage 3) decreased the periodontal health over the years and was classified as "failure". The patients whose periodontal health scores remained at the same stage or improved were classified as "success".

Similarly, each tooth was scored into stages 1 to 4, based on CAL and PD measurements, adapted from the AAP classification[16] to reduce the likelihood of misclassification. The patient's overall score was based on the parameter means. Thus, a tooth with good periodontal health could be classified as a failure based on the parameters of other failing teeth.

The clinical parameter measurements were verified on the patient's records (T1) and the recall appointment (T2). In addition, all teeth were divided into anterior or posterior regions to obtain the mean values for each analyzed variable for each tooth group at both times.

STATISTICAL ANALYSIS

The Kolmogorov-Smirnov test determined the data normality. Paired t-test (passed normality) or Wilcoxon test (failed normality) compared variables over time (T1-T2) ($p<0.05$). The Kaplan-Meier test analyzed the patients' success or failure classification. The visual representation was obtained by a survival curve.

RESULTS

Forty patients were eligible for further evaluation. Nine of the overall clinical records did not present essential baseline information for the study. Thus, thirty-one patients were available for a new periodontal evaluation. From these, sixteen patients were missed; two had changed their oral rehabilitation prostheses, thus being excluded from the study; five were not available for clinical evaluation (two were affected by serious illnesses and could not take part in the study, one patient died); and two refused to take part *(Figure 1)*. Thus, we opted for a prospective case series design. The study sample included eight

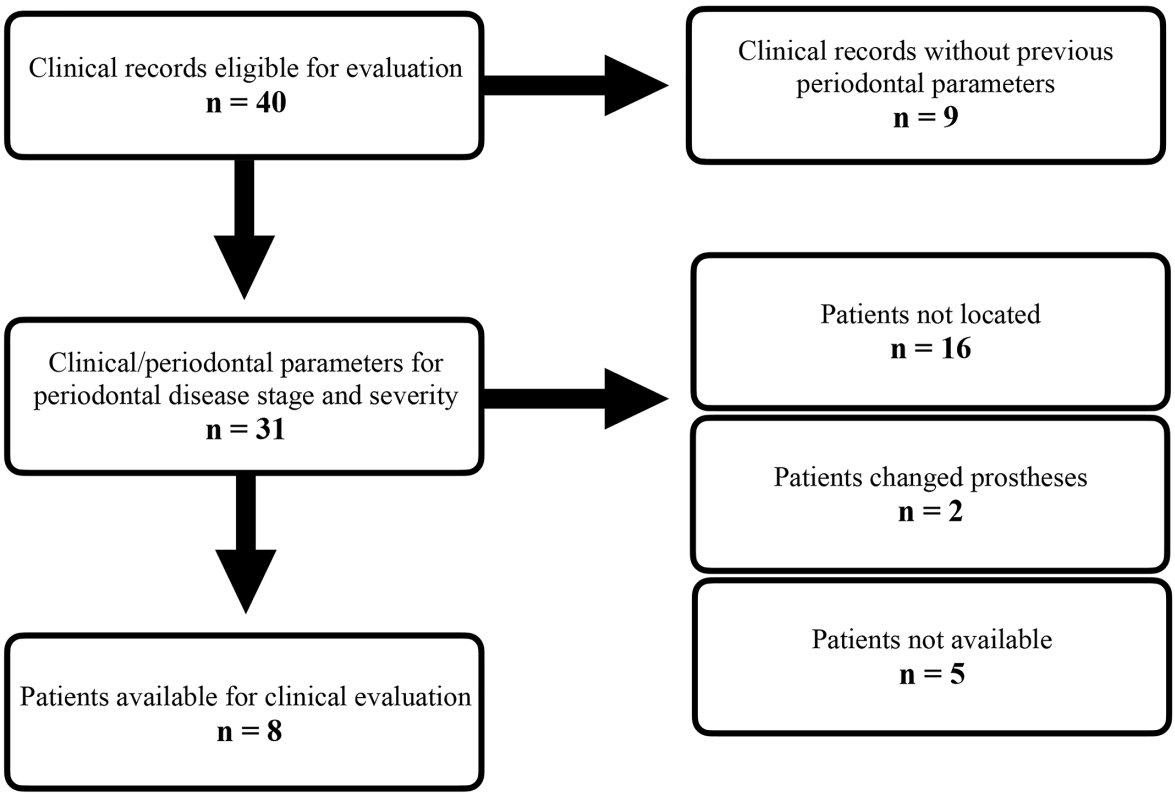

Figure 1: Patient selection flowchart.

patients with a mean age of 72.4 years, a mean follow-up period of 18.6 years, and data from 107 FDP metal-ceramic abutments (18 implants and 89 teeth). All restorations on implants were single elements, had an external hexagonal platform, and used an intermediary abutment. The results of the periodontal clinical parameters obtained at T1 and T2 evaluations are described in Table 1.

At T2, the highest PD mean of abutments was 2.8 mm in the anterior region and 3.5 mm in the posterior region. The highest CAL mean was 4.2 mm in the anterior region and 4.0 mm in the posterior region. The highest GI mean score was 0.63 in the anterior and 0.66 in the posterior regions. The highest PI mean was 0.69 in the anterior region and 0.84 in the posterior region.

Table 2 shows the overall mean ± standard deviation and differences between T1 and T2. Data on PD and CAL were measured in millimeters, while those of GI and PI are an average of periodontal scores. For all parameters, there were no statistically significant differences (P>0.05), indicating that, on average, the prostheses did not cause any worsening in the evaluated indices.

Table 3 displays the progression of the periodontal score. Seven out of the eight participants had the periodontal health considered as success. The success rate of the overall patient situation was 87.5%. The survival curve based on the probability of periodontal success and failure was built by Kaplan-Meier analysis *(Figure 2*). Four abutments were classified as failure. Thus, the survival rate for the 107 teeth/implant abutment was 80.48% during the 25-year follow-up of the periodontal health.

Figure 3A-C illustrates one of the patient's initial phase (T1). Note the general wear due to bruxism. The oral rehabilitation procedure with fixed prostheses on teeth and implants was performed. During all treatment and after periodical appointments, the patient was instructed about proper oral hygiene. Figure 4A-C shows this patient's rehabilitation after 14 years (T2). Note that the gingival recession was similar to that at T1. The situation of occlusal surfaces revealed the stabilization of parafunctional habits.

DISCUSSION

This prospective study showed the clinical findings of eight patients with a mean follow-up period of 18.6 years – ranging from 12 to 24 years. The baseline (T1) and recall (T2) parameters comparison revealed no statistically significant differences. These results suggested that, in general, periodontal/peri-implant health did not worsen. Thus, the null hypothesis was accepted. The progression of periodontal/peri-implant diseases was not related to the use of FPD in this group of long-term maintained patients.

Most studies compare biomechanical, different material behavior, differences in strength between abutments, and other aspects of FDPs.[23-25] However, few studies have evaluated the periodontal condition of prosthetic abutments, which are among the possible biological failures.[13,26] Successful follow-up of the mechanical aspect[3] and periodontal conditions of prostheses[27] have been reported. However, the literature lacks long-term prospective clinical evidence of the periodontal health on the success, survival, and failure rates of extensive oral rehabilitation.

Clinical studies present results from two[27] to 20 years of follow-up.[24,28] Indeed, most studies have a follow-up period of five to 10 years.[30-34] Retrospective studies on metal-ceramic crowns with 20-year follow-up evaluation showed prosthesis survival results between 78%[3] and 90%,[4] which were similar to that found in our study (80.5%). Note that survival and success

Table 1. Periodontal parameter means in T1 (baseline) and T2 (recall), divided into anterior and posterior teeth.

Patient	ANTERIOR TEETH								POSTERIOR TEETH							
	PD1	PD2	CAL1	CAL2	GI1	GI2	PI1	PI2	PD1	PD2	CAL1	CAL2	GI1	GI2	PI1	PI2
1	2.70	2.83	3.00	3.38	0.46	0.19	0.50	0.16	3.08	3.52	3.63	3.75	0.46	0.80	0.33	0.84
2	1.90	2.05	2.02	2.27	0.11	0.11	0.79	0.00	2.65	2.06	3.04	2.47	0.13	0.07	0.62	0.00
3	2.37	2.85	NR	4.26	NR	0.45	NR	0.69	2.25	2.53	NR	4.06	NR	0.20	NR	0.52
4	2.38	2.41	3.19	2.69	0.50	0.63	0.29	0.69	1.83	2.55	1.83	3.55	0.50	0.66	0.16	0.83
5	2.08	1.94	3.33	3.00	NR	0.00	NR	0.33	2.10	2.59	3.50	3.54	NR	0.33	NR	0.33
6	2.13	2.56	NR	3.01	0.31	0.21	NR	0.70	2.16	3.00	0.37	3.68	NR	0.58	NR	0.37
7	2.27	2.16	2.27	2.66	NR	0.25	NR	0.50	2.40	2.55	2.66	3.05	NR	0.25	NR	0.66
8	2.06	2.00	2.06	2.70	NR	0.33	NR	0.50	3.11	2.30	3.26	2.95	NR	0.47	NR	0.57

PD – Probing Depth; CAL – Clinical Attachment Level; GI – Gingival Index; PI – Plaque Index; NR – Not related.

Table 2. Periodontal parameter means. standard deviation, and comparison at T1 (baseline) and T2 (recall), divided into anterior and posterior teeth.

		TIME 1	TIME 2	p
ANTERIOR	PD	2.241 ± 0.248	2.355 ± 0.368	.215
	CAL	2.650 ± 0.592	3.001 ± 0.605	.486
	GI	0.349 ± 0.177	0.275 ± 0.201	.593
	PI	0.52 ± 0.251	0.449 ± 0.263	.593
POSTERIOR	PD	2.451 ± 0.465	2.642 ± 0.445	.393
	CAL	2.618 ± 1.160	3.387 ± 0.517	.244
	GI	0.364 ± 0.203	0.447 ± 0.295	.285
	PI	0.375 ± 0.232	0.519 ± 0.282	.593

PD – Probing Depth; CAL – Clinical Attachment Level; GI – Gingival Index; PI – Plaque Index.

Table 3. Patients' follow-up time, periodontal score at T1 and T2, and classification into success (S) or failure (F), based on AAP.

PATIENT	FOLLOW-UP (years)	SCORE		
		T1	T2	
1	16	2	2	S
2	14	1	2	S
3	25	1	3	F
4	18	2	2	S
5	24	2	2	S
6	12	1	2	S
7	21	1	2	S
8	19	2	1	S

rates are not synonymous when considering clinical evaluations. Success rates mean lacking any problems with aesthetics, functional, or biological parameters within the rehabilitation. Otherwise, survival rates mean the treatment remained with the patient.[30]

The periodontal score developed at the 2018 World Workshop assessed the periodontal health progression of the rehabilitated patients. Periodontal assessment is complex. Thus, we chose to simplify the classification so that the general practitioner/prosthesis specialist could classify the patient. Thus, establishing individualized maintenance guidance for each patient, Ravidà *et al.*[15] also used AAP classification and found that the periodontal score was more related to cigarette use, with a dose-dependent progression. These authors also reported that systemic conditions such as uncontrolled diabetes strongly correlated with progression. In the present study, smokers and individuals with chronic diseases were excluded. Thus, periodontal progression findings were more probably related to oral hygiene status.

Based on CAL and PD results, individual care and periodic appointments are crucial for success. Individuals who underwent hygiene guidance, and periodic maintenance, regardless of rehabilitation installation time, obtained successful results. Other studies showed comparable results.[2,4,35-37] The high success rates may result from periodic plaque control and patient motivation before and during prosthesis construction and installation. Even with an exposed margin, the use of prosthesis

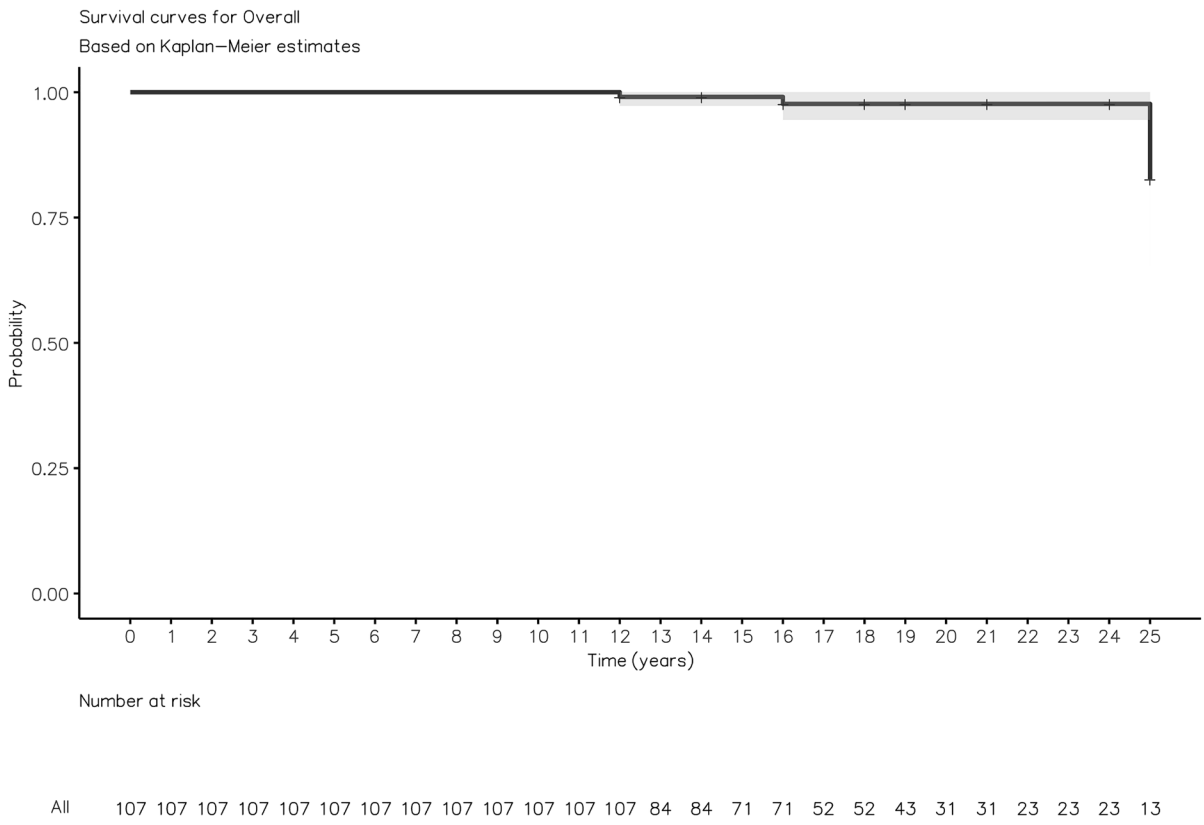

Figure 2: Kaplan-Meier Survival curve for periodontal status adapted from the American Academy of Periodontics (AAP).

is not a conclusive factor for periodontal disease progression.[38] Therefore, it is essential to tailor customized strategies and periodic controls to meet each patient's systemic, environmental, and genetic factors[39] and unique needs.

Bacterial plaque is clearly associated with periodontal/peri-implant disease by estimating greater bone loss and pocket presence in groups with poorer hygiene.[41,42] This fact highlights the importance of satisfactory daily hygiene habits and adequate professional maintenance recalls.[15,42] Periodic controls with professional prophylaxis/scraping and correctly designed prosthesis can aid in the patient's hygiene and are key factors for maintaining periodontal and peri-implant health, providing greater treatment longevity.[43] However, patients do not always perform bacterial plaque control consistently and satisfactorily, even when suggested and instructed by the professional,[44] resulting in periodontal disease progression.

Even with all plaque control procedures and patient motivation guidance before and during the prosthesis installation, plaque occurred on most sites *(Table 1)*. Although the analysis of the periodontal stage showed patients with good hygiene and periodontal status compatible with health, PI was greater than 33%. Plaque occurred in one of every three evaluated sites, six of eight patients, and 68 of 105 pillars, corresponding to 64.7%. These findings corroborate the study of Serino and Strom.[44] Eleven of the eighteen implants evaluated showed signs of peri-implant mucositis (61.1%), overcoming other studies' estimates, ranging from 10 to 45%,[45-47] during a shorter follow-up period.

PD mean ranged from 2.2 mm to 2.6 mm. These mean values were lower than that found by other authors (3.2 mm to 3.6 mm)[48,49] when only four sites per tooth were evaluated. We emphasize that the sample included implants as abutments, which may have increased mean PD values. The results of this study differed from those found by Windael *et al.*,[33] who found a mean PD value of 3.7 mm around implants, a value 1.0 mm higher than the mean obtained in this present study.

CAL has been used both in clinical practice and in longitudinal studies. Clinically, the level of attachment can be obtained by either adding the PD measurement to the gingival recession measurement or subtracting the gingival hyperplasia measurement. Most studies assessing prosthesis success use a different parameter, making comparisons difficult.[6,48,49] This study's results did not show statistically significant differences between the CAL means over time. Clinical attachment loss and gingival recession due to aging have limited evidence.[50,51] However, literature agrees that adults show gingival recession progression due to gingival trauma and abrasion resulting from excessive force during toothbrushing.[51,52,54]

Patients at higher risk of developing periodontal disease are more uncooperative and less compliant with periodic care, and the opposite is true.[37,54] Thus, customized periodontal treatment and monitoring procedures are crucial. In this sense, caution is necessary in using AAP's new classification, considering each periodontal parameter.[24,33,55] Each tooth should be scored alone whenever possible because even in cases classified as periodontal health, a localized periodontal loss may occur due to factors other than periodontal disease.

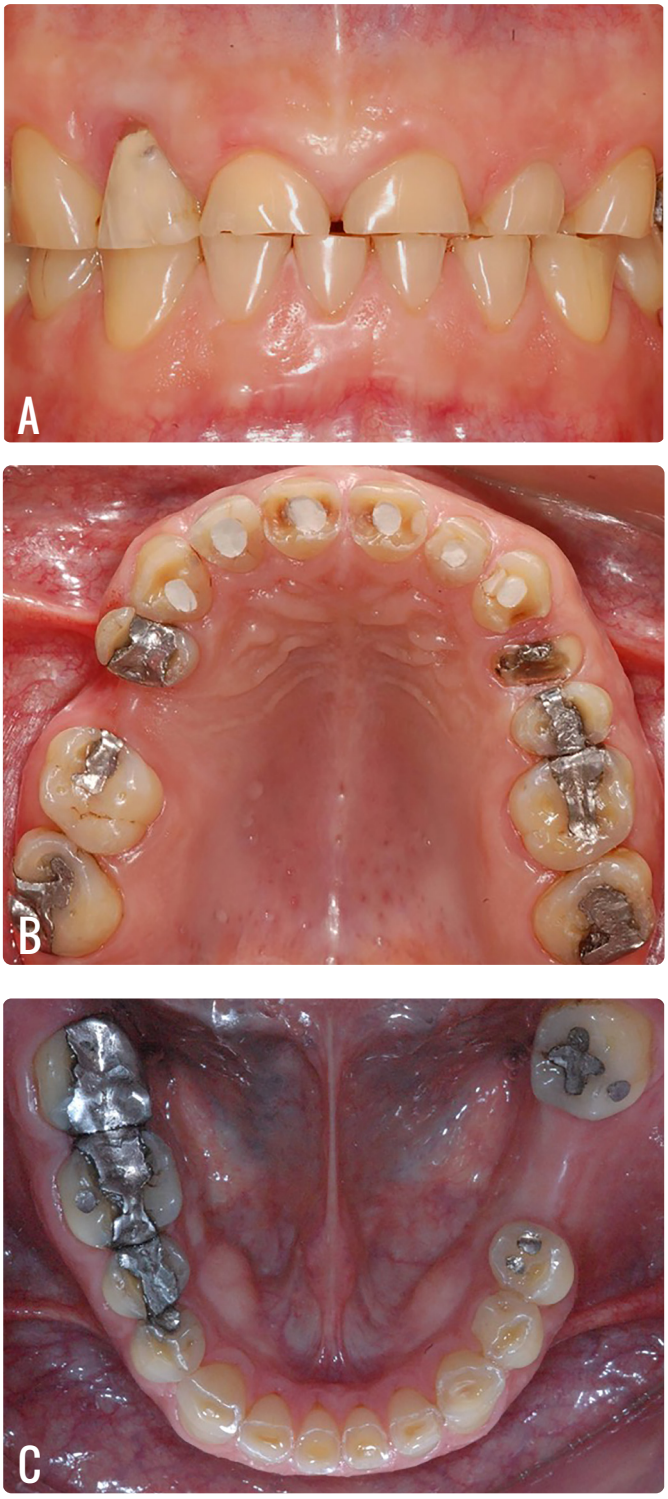

Figure 3: Patient #2 initial phase photographs. A) Frontal view; B and C) maxillary and mandibular occlusal photographs, respectively.

Finally, the new classification of periodontal and peri-implant diseases and conditions was a valuable and straightforward way to classify periodontal disease progression. However, its applicability can mask periodontal disease results because of descriptive values, which cannot be the best tool for daily clinical practice.

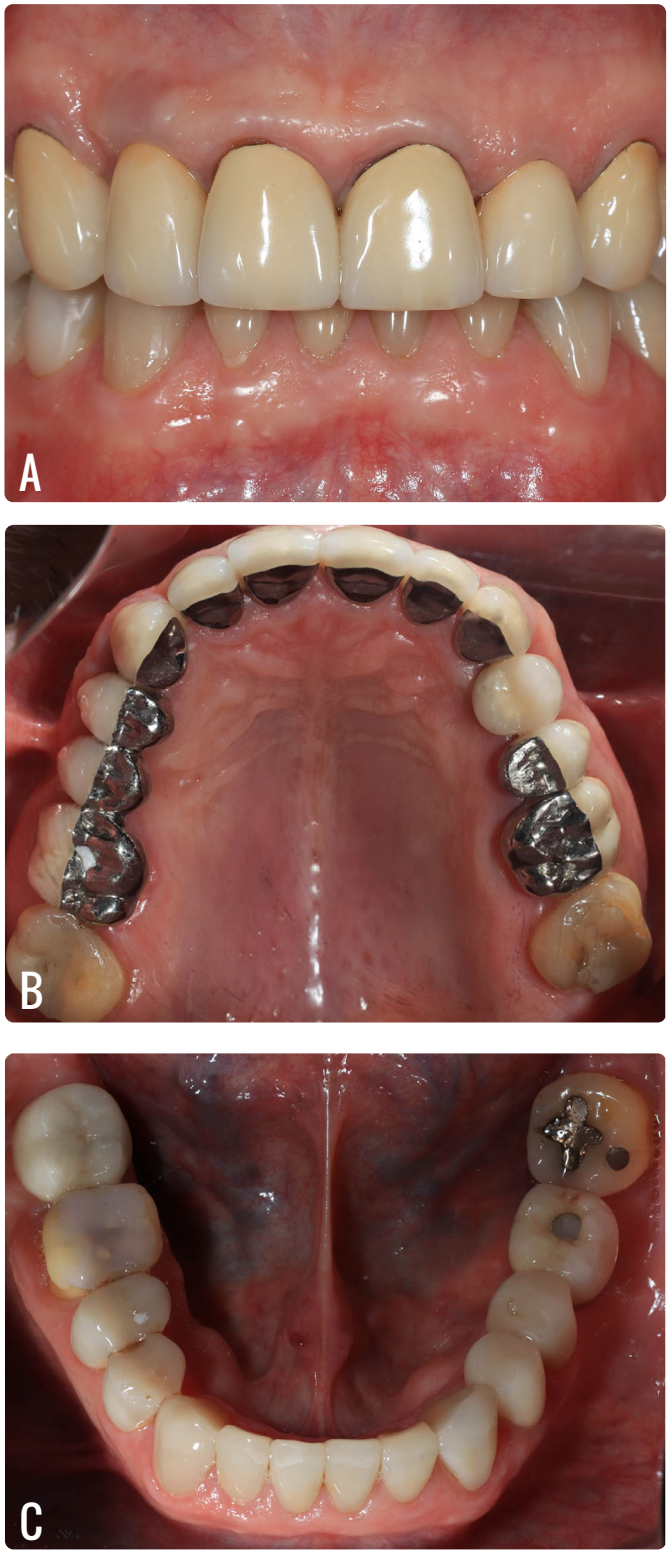

Figure 4: Patient #2 follow-up photographs. A) Fourteen-year follow-up frontal view; B and C) Fourteen-year follow-up maxillary and mandibular occlusal photographs, respectively.

CONCLUSION

This prospective case series study on the periodontal status progression of long-term prosthetic rehabilitation treatment according to new classification of periodontal and peri-implant diseases and conditions revealed that:

1. Periodontal disease progression was not related to the use of tooth/implant-supported fixed prosthesis.
2. Patients with different oral hygiene levels had different periodontal disease progression scores. Thus, patients with higher periodontal risk should be encouraged to recall more frequently.

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CONFLICTS OF INTERESTS

The authors have no relevant financial or non-financial interests to disclose.

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