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A comprehensive periodontal treatment project: The periodontal status, compliance rates, and risk factors

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Abstract   *Background/purpose:* The comprehensive periodontal treatment project (CPTP) is being implemented in Taiwan since 2010. This retrospective study compared the periodontal status, compliance rates, and influence of risk factors for periodontal recurrence and tooth loss among groups of patients who accepted CPTP and conventional periodontal treatment (CPT).
Materials and methods: A total of 161 patients who received periodontal therapy were investigated and divided into compliant ($n = 94$) and noncompliant ($n = 67$) groups. Patients in the compliant group were further assigned to two subgroups: CPT with a postcard recall (PR) system (CPT + PR, $n = 48$) and CPTP with a PR system (CPTP + PR, $n = 46$). Demographic characteristics and periodontal parameters, including the probing pocket depth (PPD), bleeding on probing (BOP), and plaque control record (PCR), were collected for comparison between the subgroups. The risk factors for periodontal recurrence and tooth loss were statistically analyzed.
Results: The 161 patients were followed-up for a mean of 3.8 years. The patients in the CPTP + PR subgroup exhibited shallower PPD, less BOP, improved PCR, and fewer tooth loss. Age, smoking, PPD $\geq$7 mm, and PCR $\geq$30% were associated with periodontal recurrence, whereas age, diabetes, BOP $\geq$30%, and duration of the follow-up period were correlated with tooth loss. PR apparently increased the compliance rate of patients (27.3% vs. 77.7%).
Conclusion: CPTP with PR led to an optimal and stable periodontal status in patients. Compliant patients maintained a significantly improved periodontal status as compared with noncompliant patients.

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Introduction

The long-term stability of periodontal status depends upon active periodontal therapy combined with supportive periodontal therapy (SPT) or periodic recall maintenance care.[1–3] Patients who receive periodontal treatment without regularly complying with SPT are susceptible to recurrent periodontal disease and considerable tooth loss.[4–6] Although SPT provides clinical benefits, few treated patients comply with regular recall.[7]

Understanding the influence of risk factors on maintaining a better periodontal status can facilitate identifying periodontal progression and tooth extraction with an unpredictable prognosis. The results of an 11-year maintenance program indicated that heavy smoking, initial diagnosis, and a probing pocket depth (PPD) $\geq$ 6 mm were risk factors for periodontal progression, whereas a PPD $\geq$ 6 mm and bleeding on probing (BOP) $\geq$ 30% were risk factors for tooth loss.[8] However, because of the heterogeneity among these studies, the effects of compliance on the risk factors for periodontitis have not been definitively compared.

Japan advocated the "8020 Movement" program, a nationwide promotion aimed at retaining more than 20 teeth in people over 80 years of age. The "8020 Promotion Foundation" executed the program for more than 15 years.[9,10] In 1995, a similar conventional periodontal treatment (CPT) program was started in Taiwan under the surveillance of the National Health Care Program. However, the efficiency of CPT was unsatisfactory and inconsistent because patients lacked motivation for, or vigilance in their treatment. The patients had to pay approximately 20% of the treatment fees and there was no meticulous recall system to remind them about professional aftercare. In Taiwan, a comprehensive periodontal treatment project (CPTP) was proposed in 2000 and implemented in 2010. The CPTP is supported by a special government budget for fully supporting the additional 20% expense of treatment fees when most patients have moderate to severe periodontitis and require comprehensive treatment. At present, only two countries, Taiwan and Japan, have actively developed a health policy for treating periodontal disease and preventing tooth loss. Currently, we have established a postcard recall (PR) system in the Periodontal Clinics of Taipei Medical University Hospital to maintain a high level of motivation in patients during their maintenance care and to diminish the high prevalence of periodontal disease (94.8%) in Taiwan.[11,12] Based on our research, no study has comprehensively scrutinized the periodontal status of patients who received treatment through CPTP and compared the results of CPTP with those of CPT.

The objectives of this longitudinal study were to evaluate and compare the periodontal status, compliance rates, and influence of risk factors on periodontal recurrence and tooth loss in individuals between the compliant and noncompliant groups.

Materials and methods

Patients

Patients diagnosed with chronic or aggressive periodontitis (ChP or AgP), according to the classification of the American Academy of Periodontology,[13] between 2006 and 2013 were randomly selected for this retrospective study. Patients with gingivitis or mild periodontitis were assigned to interns and those with moderate-to-severe periodontitis were assigned to postgraduate students. All studied patients were assigned according to the clinical standard operational procedure and a clinical superintendent oversaw all procedures. Demographic characteristics of patients, such as age and sex, were recorded (Table 1). The Joint Institutional Review Board of Taipei Medical University (TMU), Taiwan, approved this study (TMU-JIRB-201406024).

Sample grouping and comparisons

The studied patients were divided into compliant ($n = 94$) and noncompliant ($n = 67$) groups depending on regular recall from 2006−2013.[14] The compliant-group patients were further assigned to CPT + PR ($n = 48$) and CPTP + PR ($n = 46$) subgroups. Patients who attended CPT from 2006−2010 and CPTP or CPT after 2010 and missed more than one recall after receiving active periodontal therapy were considered noncompliant. The grouping data are shown in Figure 1.

In order to independently evaluate the effect of PR on the compliance rate, 110 additional CPT cases before 2010, when the PR system was not developed, were randomly chosen using a computer. The compliance rates were compared on the basis of whether the patients underwent PR surveillance before or after 2010 (Table 2).

CPT and CPTP

Patients who required periodontal treatment at TMU Hospital were administered CPT + PR and CPTP + PR before and after 2010, respectively. Eligibility criteria for receiving CPTP were: (1) no history of periodontal treatment elsewhere; (2) effective medical control of systemic disease, or no disease; (3) diagnosed as moderate to severe ChP or AgP in at least six teeth with a PPD $\geq$ 5 mm; and (4) at least 16 teeth remaining in the oral cavity after nonsurgical therapy. Patients who were ineligible for CPTP + PR underwent CPT + PR and paid approximately 20% of the treatment fees.

Both CPT and CPTP include meticulous periodontal therapy, oral hygiene instructions, flap surgery, and long-term surveillance. The patients who received CPT before 2010 were mostly only verbally instructed to return for regular maintenance, whereas after 2010, the CPT and CPTP patients were followed-up by PR surveillance.

Postcard recall

PR was initiated in 2010 and designed as a standard procedure in our department for a 6-month period. Receiving CPT or CPTP after 2010, the patients wrote their address on a postcard after each subsequent 6-month recall appointment.

Clinical periodontal status

Periodontal parameters were determined at three time points: the initial appointment (T1, initial examination),

Table 1 Demographic characteristics between noncompliant and compliant groups and CPT + PR and CPTP + PR subgroups.

	Noncompliant	Compliant	CPT + PR	CPTP + PR
No.	67	94	48	46
Age (y)	50.54 ± 10.45	52.99 ± 11.24	52.52 ± 10.49	53.48 ± 12.08
Gender				
Female	31 (46.3)	43 (45.7)	21 (43.8)	22 (47.8)
Male	36 (53.7)	51 (54.3)	27 (56.3)	24 (52.2)
Diabetes	16 (23.9)	12 (12.8)	3 (6.5)	9 (18.8)
Smoking habits				
Current smoker	17 (25.4)	5 (5.3)*	2 (4.3)	3 (6.3)
Non-/Former-smoker	50 (74.6)	89 (94.7)	44 (95.7)	45 (93.8)
Diagnosis AAP				
ChP	58 (86.6)	81 (86.2)	41 (89.1)	40 (83.3)
AgP	9 (13.4)	13 (13.8)	5 (10.9)	8 (16.7)
Tn (mean ± SD)	25.37 ± 2.24	25.51 ± 2.69	25.44 ± 2.84	25.59 ± 2.54
Shallow pocket (mean ± SD)	25.02 ± 21.33	26.09 ± 20.42	24.75 ± 20.24	30.46 ± 19.85
Moderate pocket (mean ± SD)	52.93 ± 20.88	54.63 ± 19.74	53.64 ± 22.87	54.45 ± 19.32
Deep pocket (mean ± SD)	22.05 ± 19.52	19.27 ± 17.53	21.62 ± 21.31	15.08 ± 12.67
BOP (mean ± SD)	48.13 ± 18.80	50.72 ± 20.33	47.13 ± 19.60	54.39 ± 20.62
PCR (mean ± SD)	70.20 ± 18.13	60.56 ± 17.15	66.10 ± 21.36	59.77 ± 16.62

Data are presented as n (%) or mean ± SD; Mean ± SD: independent t test; Number of patients (%): Chi-square test.
*$P < 0.05$.
AAP = American Academy of Periodontology; AgP = aggressive periodontitis; BOP = bleeding on probing; ChP = chronic periodontitis; CPT = conventional periodontal treatment; CPTP = comprehensive periodontal treatment project; PR = postcard recall system; PCR = plaque control record; SD = standard deviation; Tn = tooth number initially.
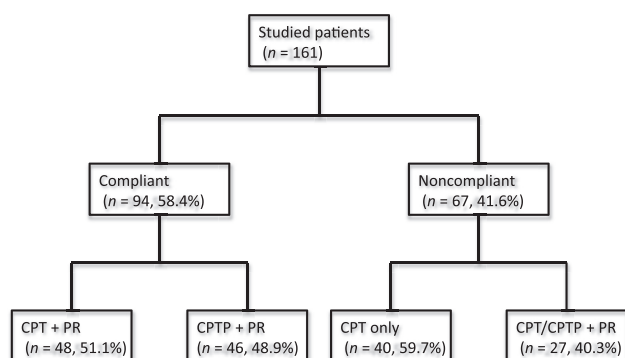

Figure 1 Flow chart of the grouping and number of patients. CPT = conventional periodontal treatment; CPTP = comprehensive periodontal treatment project; PR = postcard recall system.

Table 2 Number of patients and the compliance rates dichotomized by the year 2010.

	CPT without PR before 2010	CPTP/CPT with PR after 2010
No. of samples	110	121
No. of compliers	30	94
The compliance rates	27.3%	77.7%

CPT = conventional periodontal treatment; CPTP = comprehensive periodontal treatment project; PR = postcard recall system.

first recall (T2, 6 weeks after nonsurgical therapy), and end-point recall (T3, latest available recall data). Full-mouth periodontal charting included the PPD, BOP,[15] plaque control record (PCR),[16] and tooth loss. The reasons for tooth loss were severe periodontal destruction (68%), endodontic problems (14%), caries (10%), and root fracture (8%) during the observation period. The clinical attachment level was not included in this study because the locations of cemento-enamel junction in a large proportion of teeth (29%) were replaced by Class II/V composite restorations or crowns.

Periodontal recurrence

Periodontal recurrence was determined as any periodontal site with an increased PPD ≥3 mm from the baseline during the observation period.[17] Recurrent sites were treated during the recall appointments if the PPD exceeded 5 mm and BOP and/or suppuration occurred.

Statistical analyses

The PPD for each tooth was classified as shallow (1–3 mm), moderate (4–6 mm), or deep (≥7 mm).[2,18] Data were statistically analyzed using Chi-square and independent t tests for categorical (e.g., sex) and continuous (e.g., age) variables. Demographic characteristics and initial periodontal conditions were compared between the noncompliant and compliant groups and between the CPT + PR and CPTP + PR subgroups. Additionally, the mean values of the clinical parameters at the three time points were compared and $P < 0.05$ was considered significant.

The hazard ratio (HR) of tooth loss among all groups was analyzed using Cox regression. Logistic regression analysis was performed to identify the independent variables (e.g., PPD) that influenced the dependent variables (e.g., tooth loss). Data were organized using Microsoft Excel (Microsoft Corp., Redmond, WA, USA), and Cox regression and logistic regression analysis were performed using SPSS 21.0 (IBM Corp., Armonk, NY, USA).

Results

Noncompliant group versus compliant group

The 161 studied patients were followed-up with for a mean of 3.8 years. The patient characteristics and initial periodontal conditions were summarized in Table 1, and there were no significant differences (P > 0.05) at the baseline. Table 3 showed significant differences (P < 0.001) in the PPD distribution, BOP, and PCR at T3 between the noncompliant and compliant groups.

CPT + PR subgroup versus CPTP + PR subgroup

The CPTP + PR and CPT + PR subgroups showed no significant differences (P > 0.05) at the baseline (Table 1). The PPD, BOP, and PCR values at the three time points were summarized in Table 3. Both subgroups exhibited significant differences (P < 0.05) in the PPD, BOP, and PCR at T3.

Compliance rates of patients before and after 2010

Before 2010, the compliance rate of patients receiving CPT alone was 27.3%. After 2010, the compliance rate of patients participating in PR surveillance increased to 77.7% (94/94 + 27) (Table 2).

Periodontal recurrence and tooth loss during the observation period

The noncompliant group exhibited the highest incidence of periodontal recurrence (1.7 per tooth per patient), whereas the CPTP + PR subgroup exhibited the lowest incidence of periodontal recurrence (1.2 per tooth per patient). The HR of tooth loss in the noncompliant group as compared with that observed in the compliant group was 2.18, whereas the HR of tooth loss in the CPT + PR subgroup as compared with that observed in the CPTP + PR subgroup was 4.48 (Table 4). These HR values differed significantly (P < 0.05).

Logistic regression analysis of risk factors

In the noncompliant group, the variables significantly related to periodontal recurrence were age per year (odds ratio (OR) = 1.1, confidence interval (CI): 1.03−1.30), smoking (OR = 12.0, CI: 1.10−129.92), and PPD $\geq$ 7 mm (OR = 49.3, CI: 6.08−400.05). Furthermore, the significant risk factors associated with tooth loss were age per year (OR = 1.1, CI: 1.01−1.18), diabetes (OR = 1.2, CI:

Table 3 The comparison of variables (mean $\pm$ SD), including frequency distribution of PPD, BOP%, and PCR%, between noncompliant and compliant groups and CPT + PR and CPTP + PR subgroups.

	Noncompliant, n = 67	Compliant, n = 94	CPT + PR, n = 48	CPTP + PR, n = 46
Shallow pocket				
T1	25.02 ± 21.33	26.09 ± 20.42	24.75 ± 20.24	30.46 ± 19.85
T2	58.46 ± 25.38	60.45 ± 24.26	56.80 ± 22.45	64.54 ± 21.01
T3	57.44 ± 22.05	75.13 ± 18.16**	70.84 ± 18.87	79.62 ± 16.42*
Moderate pocket				
T1	52.93 ± 20.88	54.63 ± 19.74	53.64 ± 22.87	54.45 ± 19.32
T2	34.37 ± 21.31	33.89 ± 20.96	34.24 ± 21.29	30.88 ± 18.65
T3	37.88 ± 19.84	23.25 ± 16.58**	26.72 ± 16.76	19.61 ± 15.75*
Deep pocket				
T1	22.05 ± 19.52	19.27 ± 17.53	21.62 ± 21.31	15.08 ± 12.67
T2	7.21 ± 7.85	5.69 ± 6.25	6.84 ± 13.06	4.58 ± 4.78
T3	4.68 ± 6.86	1.68 ± 3.35**	2.50 ± 4.14	0.83 ± 1.96*
BOP				
T1	48.13 ± 18.80	50.72 ± 20.33	47.13 ± 19.60	54.39 ± 20.62
T2	23.49 ± 14.58	25.30 ± 17.89	23.03 ± 19.74	27.42 ± 15.88
T3	32.72 ± 13.13	24.27 ± 11.64**	27.19 ± 13.25	21.23 ± 8.83*
PCR				
T1	70.20 ± 18.13	60.56 ± 17.15	66.10 ± 21.36	59.77 ± 16.62
T2	30.74 ± 20.03	28.58 ± 17.35	38.31 ± 31.16	26.91 ± 13.73
T3	33.01 ± 10.30	27.06 ± 8.58**	29.53 ± 7.63	24.43 ± 8.84**

Data are presented as mean (%) ± SD; mean ± SD: independent t test.
*P < 0.05.
**P < 0.001.
BOP = bleeding on probing; CPT = conventional periodontal treatment; CPTP = comprehensive periodontal treatment project; PCR = plaque control record; PPD = probing pocket depth; PR = postcard recall system; SD = standard deviation; T1 = initial examination; T2 = 6 weeks after nonsurgical follow-up; T3 = latest available recall data.

Table 4 Hazard ratio of tooth loss between groups by Cox regression.

Tooth loss	Hazards Ratio	95% CI	P
Noncompliant vs. compliant	2.183	1.085–4.392	0.029*
CPT + PR vs. CPTP + PR	4.478	1.054–19.03	0.042*

*P < 0.05.
CI = confidence interval; CPT = conventional periodontal treatment; CPTP = comprehensive periodontal treatment project; PR = postcard recall system.

0.03–1.96), BOP ≥ 30% (OR = 6.5, CI: 1.27–33.01), and the observation period (OR = 1.0, CI: 1.00–1.08). In the compliant group, the variables related to periodontal recurrence were age per year (OR = 1.1, CI: 1.00–1.15), smoking (OR = 10.1, CI: 1.21–83.95), PPD ≥ 7 mm (OR = 11.0, CI: 1.93–62.39), and PCR ≥ 30% (OR = 11.3, CI: 1.85–69.42). Furthermore, the significant risk factors associated with tooth loss were age per year (OR = 1.1, CI: 1.00–1.19) and the observation period [OR = 1.0, CI: 1.01–1.08, (Table 5, models 1 and 2)].

Discussion

The importance of regular recall in SPT has been emphasized,[1,19] however, regular recall might be challenging for most patients because of time and cost constraints.[20] The compliance rate in studies ranged between 16% and 36%.[7,14,21] Only a Norwegian study, conducted in a private clinic with a 10-year follow-up, achieved a high compliance rate of 87%.[22] In other studies, the compliance rate of patients decreased with time, and most patients were lost to follow-up after the first year of periodontal treatment.[7,14] We compared the compliance rates of patients undergoing periodontal treatment before (27.3%) and after (77.7%) 2010 and discovered that the patients after 2010 were highly motivated. Previously, most patients had been only randomly and verbally instructed by dentists to return for regular maintenance, although many patients ignored these instructions. Recall through postcards written in the patient's own handwriting and sending them regularly may be more effective in promoting patient's participation than through e-mail or verbal instructions. Additionally, complete financial support for the CPTP in combination with the PR may have contributed to high patient compliance.

During SPT, the PPD, BOP, and PCR exhibited an improving trend from deep to shallow pockets in the compliant group. Cox regression analysis showed that the numbers of tooth loss per patient per year (0.12 vs. 0.07) and periodontal recurrence per patient (1.7 vs. 1.4) were higher in the noncompliant group than in the compliant group, indicating that participation in regular maintenance was essential and that the positive attitudes of compliant patients improved their periodontal status. The CPTP + PR subgroup exhibited an improved PPD, BOP, PCR, and fewer tooth loss at T3, whereas these factors changed only slightly in the CPT + PR subgroup. CPTP was designed to

Table 5 Logistic regression models of risk factors for periodontal recurrence and tooth loss.

Independent Variable	Noncompliant				Compliant			
	OR	95% CI		Significance	OR	95% CI		Significance
		Lower	Upper			Lower	Upper	
Model 1, periodontal recurrence								
Age (per y)	1.1	1.03	1.30	0.012*	1.1	1.00	1.15	0.039*
Gender (male vs. female)	1.8	0.34	9.99	0.485	2.1	0.42	10.13	0.374
Diabetes	0.1	0.00	1.53	0.093	5.1	0.53	48.05	0.158
Smoking	12.0	1.10	129.92	0.042*	10.1	1.21	83.95	0.033*
Diagnosis (AgP vs. ChP)	2.0	0.10	40.04	0.644	0.7	0.09	5.11	0.716
PPD ≥7 mm	49.3	6.08	400.05	<0.001*	11.0	1.93	62.39	0.007*
BOP ≥30%	0.8	0.12	5.66	0.839	2.8	0.57	13.92	0.201
PCR ≥30%	1.4	0.18	11.56	0.743	11.3	1.85	69.42	0.009*
Duration (per mo)	1.0	0.99	1.09	0.119	1.0	0.98	1.04	0.398
Model 2, tooth loss								
Age (per y)	1.1	1.01	1.18	0.037*	1.1	1.00	1.19	0.041*
Gender (male vs. female)	3.1	0.63	15.67	0.161	2.3	0.37	14.57	0.366
Diabetes	1.2	0.03	1.96	0.045*	1.0	0.14	1.19	0.967
Smoking	2.8	0.49	16.03	0.244	0.0	0.00	10.70	0.999
Diagnosis (AgP vs. ChP)	0.9	0.13	6.72	0.937	0.3	0.02	4.51	0.358
PPD ≥7 mm	0.9	0.21	4.24	0.934	1.6	0.28	9.27	0.59
BOP ≥30%	6.5	1.27	33.01	0.025*	0.4	0.06	2.40	0.305
PCR ≥30%	0.4	0.09	1.89	0.257	1.6	0.39	6.36	0.529
Duration (per mo)	1.0	1.00	1.08	0.045*	1.0	1.01	1.08	0.011*

Duration = the length of time from initial appointment to end-point check-up.
*P < 0.05.
AgP = aggressive periodontitis; BOP = bleeding on probing; ChP = chronic periodontitis; CI = confidence interval; OR = odds ratio; PCR = plaque control record; PPD = probing pocket depth.

treat the majority of the population with moderate-to-severe periodontitis in Taiwan. Most patients receiving CPT + PR were excluded from the CPTP + PR subgroup because they had advanced periodontitis and were unable to retain ≥16 teeth after nonsurgical treatment. However, tooth loss per patient per year and periodontal recurrence per patient of the CPT + PR subgroup (0.08 and 1.5, respectively) were similar to those of the compliant group (0.07 and 1.4, respectively), but higher than those of the CPTP + PR subgroup (0.04 and 1.2, respectively). With effective regular recall, periodontal disease could be treated and maintained even in patients with severe periodontal destruction.[23] The present study showed that both CPT + PR and CPTP + PR enrollees could maintain a stable periodontal status during the observation period. This result is in agreement with those of numerous studies that have reported that high compliance and patient motivation may improve clinical results and cause fewer tooth loss.[2,3,24,25]

Smoking is a risk factor associated with periodontal disease and quitting smoking may improve overall periodontal health.[26,27] However, smoking is only partly responsible for tooth loss in this multivariate model of periodontal recurrence. According to epidemiological surveys, more attachment loss occurs in males than in females because of hygiene behaviors.[28] However, in our study, the influence of gender on periodontal condition was neutralized by SPT and PR surveillance.

In some studies, age was a risk factor for alveolar bone loss and attachment loss,[29,30] whereas age was considered a surrogate for the duration of exposure to general or local risk factors for tissue destruction.[31] In our study, age was associated with periodontal recurrence and tooth loss, indicating that regular SPT is necessary as age increases.[8] Moreover, there was no strong correlation between the initial diagnosis of AgP and periodontal recurrence or tooth loss. This result was in agreement with those of earlier studies.[25,32]

Patients with diabetes and poor metabolic control are at high risk of periodontal disease.[33,34] A previous study reported a bidirectional relationship between diabetes and periodontal disease.[35] In our study, diabetes considerably influenced tooth loss in the noncompliant group, but not in the compliant group. Diabetes was not a significant risk factor for periodontal recurrence in either group. A study revealed that patients with poorly controlled Type II diabetes receiving nonsurgical therapy in CPTP achieved considerable improvement in periodontal status and moderate improvement in glycated hemoglobin (HbAlc) control,[36] which was affirmed in our study. Patients with diabetes who received CPTP + PR exhibited consistent improvement in their periodontal status. High patient compliance can break the vicious, bidirectional cycle of periodontal disease and diabetes, as well as reduce the possibility of tooth loss.[37,38]

Our study showed that patients with a PPD ≥7 mm had a high OR for periodontal recurrence in the compliant (OR = 11.0) and noncompliant (OR = 49.3) groups. This difference in OR showed that regular 6-month recall diminished the influence of the PPD on periodontal recurrence. Moreover, in the noncompliant group, BOP ≥30% significantly correlated with tooth loss (OR = 6.5), and is

considered a risk factor during maintenance.[8] The PCR is a weak predictor of periodontal progression.[39,40] Proper plaque control might prevent the progression of caries and periodontitis.[18,24] In the present study compliant group, PCR ≥ 30% did not significantly influence the rate of tooth loss, but influenced the rate of periodontal recurrence. Enhancing oral hygiene can reduce the PCR and positively influence soft-tissue response, thereby affecting the possibility of periodontal pocket recurrence instead of hard-tissue changes, such as bone or tooth loss.

In general, the compliant patients maintained a significantly improved periodontal status when compared with the noncompliant patients. PR evidently increased the compliance rate of patients with regular recall. CPTP with PR leads to an optimal and stable periodontal status.

Conflicts of interest

The authors have no conflicts of interest relevant to this article.

Acknowledgments

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