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Impact of COVID-19 spread on visit intervals and clinical parameters for patients with periodontitis in supportive periodontal therapy: a retrospective study

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ABSTRACT

Purpose: This study investigated the relationship between the number of days that hospital visits were postponed and changes in clinical parameters due to the spread of coronavirus disease 2019 (COVID-19), after the Japanese government declared a state of emergency in April 2020.

Methods: Regarding the status of postponement of appointments, we analyzed the patients who had visited the Nihon University Hospital at Matsudo for more than 1 year for supportive periodontal therapy (SPT) and classified them into low-, moderate- and high-risk subgroups according to the periodontal risk assessment (PRA). Clinical parameters for periodontal disease such as probing depth (PD), full-mouth bleeding score (FMBS), full-mouth plaque score, periodontal inflamed surface area (PISA), and periodontal epithelial surface area (PESA) were analyzed in 2 periods, from October 2019 to March 2020 and after April 2020. Correlation coefficients between days of deferral and the degree of changes in clinical parameters were calculated.

Results: The mean age of the 749 patients was 67.56±10.85 years, and 63.82% were female. Out of 749 patients, 33.24% deferred their SPT appointments after April 2020. The average total of postponement days was 109.49±88.84. The number of postponement days was positively correlated with changes in average PD (rs=0.474) and PESA (rs=0.443) in the high-risk subgroup of FMBS, and average PD (rs=0.293) and PESA (rs=0.253) in the high-risk subgroup of tooth number (TN). Patients belonging to the high-risk subgroups for both FMBS and TN had a positive correlation between postponement days and PISA (rs=0.56).

Conclusions: The findings, the spread of COVID-19 appears to have extended the visit interval for some SPT patients. Moreover, longer visit intervals were correlated with the worsening of some clinical parameters for SPT patients with high PRA.

Keywords: COVID-19; Inflammation; Maintenance; Periodontitis; Risk assessment

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Conflict of Interest
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INTRODUCTION

Periodontitis is caused by host-mediated inflammation associated with pathogenic microorganisms, resulting in loss of periodontal attachment [1]. Dentists and dental hygienists who treat periodontitis aim to prevent further disease progression and consequent tooth loss. Active periodontal therapy (APT) is typically staged. The initial non-surgical treatment focuses on the reduction and elimination of pathogenic microorganisms through a combination of oral hygiene instruction and mechanical debridement to remove supra- and sub-gingival microbes [2]. Periodontal surgery could be applied for further reliable debridement and regeneration of lost periodontal tissue. Following APT, patients move to the phase of supportive periodontal therapy (SPT) and are managed to maintain treatment outcomes over the long term. The goals of SPT are 1) to prevent the recurrence and progression of periodontitis in patients who have completed treatment, 2) to prevent and reduce the incidence of tooth loss by monitoring dentition and prostheses, and 3) to improve the likelihood of quickly finding and treating other oral diseases and conditions [3]. As part of SPT, scaling and root planing reliably disrupt colonizing by microbial populations and minimize the inflammatory response that drives disease progression. In addition, appropriate SPT visits can help rapidly detect and prevent the recurrence or progression of periodontitis [4].

Coronavirus disease 2019 (COVID-19) has affected people in various ways around the world. After its initial outbreak, calls for community discipline including lockdown were enforced worldwide to prevent the spread of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), which causes COVID-19. In Japan, following the start of urban spread of COVID-19, the first state of emergency declared by the government in April and May 2020 asked citizens to stay home and maintain social distancing; thus, people refrained from all nonessential activities. Focusing on the field of dentistry, at the time there were no guidelines or clear criteria to support patients' decisions to visit dental offices [5]. Dental practitioners had to make their own decisions about providing dental care for the same reason. Chronic periodontitis differs from acute periodontal disease, which requires urgent treatment because it causes pain and discomfort [6]. Due to the spread of COVID-19, it is possible that the interval between hospital visits for patients with periodontitis who needed regular SPT increased, and that their symptoms of periodontal disease worsened. In this study, we analyzed the visit records of patients with periodontitis who had regular SPT visits before and after the COVID-19 pandemic began, and investigated the relationship between changes in visit intervals and clinical parameters of periodontitis.

MATERIALS AND METHODS

Patient population

The subjects were patients treated by the SPT program at the Department of Periodontology, Nihon University Hospital at Matsudo, Chiba, Japan before and after April 2020. Patients who completed APT and subsequently had at least 1 year of SPT visits (with at least 3 SPT visits per year) were included in the analysis. The following patients were excluded from the study: 1) patients who stopped SPT and restarted APT, 2) patients with less than 1 year in the SPT program, 3) patients who completed their treatment at the dentist's instructions, 4) patients not returning for SPT before March 2020 or after April 2020, 5) patients who visited irregularly, and 6) patients with missing clinical records (**Figure 1**). The Institutional Internal Review and Ethics Board at the Nihon University School of Dentistry at Matsudo approved the study (EC21-21-025-1).

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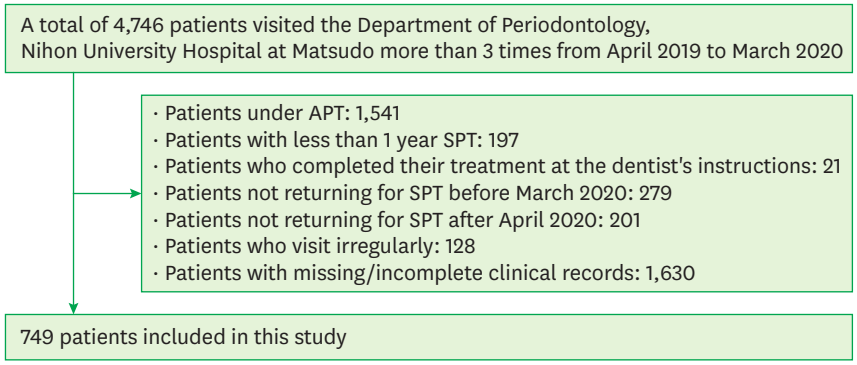

Figure 1. Number of patients included in this study, and reasons for exclusion.
APT: active periodontal therapy, SPT: supportive periodontal therapy.

Clinical records

April 2020 was considered a boundary line, since changes in the public awareness of COVID-19 became clear after the government declared the first state of emergency. The most recent periodontal examination performed from October 2019 to March 2020 was used as the baseline for comparison with the examination performed at the first visit after April 2020 (**Figure 2**). All examinations were performed by dentists belonging to the Department of Periodontology, Nihon University Hospital at Matsudo. Clinical parameters of periodontitis gathered from each examination included the average probing depth (PD), full-mouth bleeding score (FMBS), and full-mouth plaque score (FMPS). To calculate the periodontal epithelial surface area (PESA), the recession surface area (RSA) is subtracted from the attachment loss surface area (ALSA). Since ALSA=PESA+RSA, it can be deduced that ALSA-RSA=PESA. The periodontal inflamed surface area (PISA) is calculated using clinical attachment levels (CALs), recessions, and bleeding on probing (BOP). The PISA reflects the surface area of bleeding pocket epithelium in square millimeters. PISA, PESA, and PISA/PESA were calculated using PD, recessions, CAL, and BOP records following the method of Nesse et al. [7]. Further data were collected such as duration of SPT, visit interval over the prior year, presence or absence of postponement of the first appointment after April 2020, and the number of days the appointment was postponed. All data were collected by the 14 dentists engaged in periodontal treatment (MT, YS, SI, MO, TK, RK, SN, TN, NF, KH, MY, YY, YT, AY) using an electronic clinical record system.

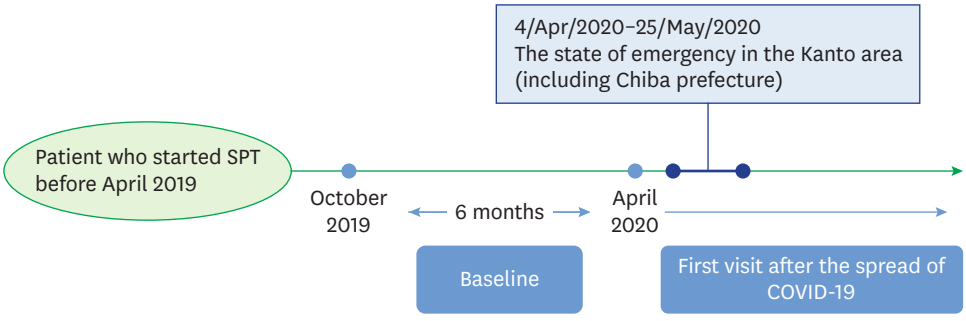

Figure 2. Patient visits in this study and the period of emergency declaration in the Kanto region, including Chiba Prefecture, due to COVID-19.
SPT: supportive periodontal therapy, COVID-19: coronavirus disease 2019.

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Classification of patients with the postponement of SPT appointment

The postponement of SPT appointments after COVID-19 had begun to spread was investigated, and the patients were divided into 2 groups (as scheduled and postponed) based on whether they had postponed appointments. Patients of the postponed group were classified into 3 subgroups focused on FMBS at baseline, according to the periodontal risk assessment (PRA) method in SPT patients by Lang and Tonetti [8]. The PRA can estimate the risk of susceptibility to the progression of periodontal disease. The entire spectrum of risk factors and risk indicators ought to be evaluated simultaneously. For this purpose, a functional diagram has been constructed including the following 6 aspects: 1) percentage of BOP, 2) prevalence of residual pockets greater than 4 mm, 3) loss of teeth from a total of 28 teeth, 4) loss of periodontal support in relation to the patient's age, 5) systemic and genetic condition, and 6) environmental factors, such as cigarette smoking. In addition, patients were categorized by tooth number (TN). Instead of the method described by Lang and Tonetti [8] of considering the number of missing teeth from a total of 28 teeth (excluding wisdom teeth), the current TN was used for convenience of classification. However, all of the data we collected, TN and clinical parameters, included wisdom teeth. Thus, the subgroup criteria in the present study were as follows:

FMBS subgroups

1) Low risk for FMBS: patients with FMBS <10%
2) Moderate risk for FMBS: patients with FMBS 10%–25%
3) High risk for FMBS: patients with FMBS >25%

TN subgroups

1) Low risk for TN: patients with ≥24 teeth
2) Moderate risk for TN: patients with 21–23 teeth
3) High risk for TN: patients with ≤20 teeth

The relationships between the number of postponement days and changes in clinical parameters were analyzed using Spearman's rank correlation coefficient. Similar analyses were performed for the patients assessed as high risk for both subgroup classifications.

Statistical analysis

The statistical analysis was performed using EZR [9], which is a graphical user interface for R (version 4.1.2; The R Foundation for Statistical Computing, Vienna, Austria). More precisely, it is a modified version of R Commander (version 2.7-1) designed to add statistical functions frequently used in biostatistics. Clinical parameters were presented as mean ± standard deviation (min-max), and mean differences in patient characteristics and clinical parameters were assessed using the Mann-Whitney *U* test. The Wilcoxon signed-rank test was utilized to compare the differences in clinical parameters between baseline and after the spread of COVID-19. Spearman's rank correlation coefficient was calculated to confirm the relationships between postponement days and clinical parameters.

RESULTS

Analysis of patient characteristics

A total of 749 patients were selected for the present study (**Figure 1**). The mean age of the patients at baseline was 67.56±10.85 years (range: 26–93 years), and 63.82% of patients (n=478) were female. Out of 749 patients, 66.76% (n=500) visited the hospital for SPT

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as scheduled after the spread of COVID-19, and 33.24% (n=249) postponed their SPT appointments. Clinical records before 2006, when the electronic medical record system was put into operation in the hospital, were unavailable for confirmation because the earlier records were not saved. Therefore, the mean duration of SPT was 4.37±3.20 years, calculated for 740 patients and excluding the 9 patients who started SPT before 2006. The mean interval of SPT visits was 3.33±0.54 months with a range of 1–5 months. The number of teeth of each patient was consistent between the 2 examinations immediately before and after the spread of COVID-19; the mean value per patient was 21.15±6.74 teeth. Mean values were calculated per group for age, sex, duration of SPT, SPT intervals, and TN, with no significant differences between the as-scheduled and postponed groups for any items. SPT appointment postponement days after April 2020 were analyzed for the postponed group. The average number of postponement days was 109.49±88.84, ranging from 1–628 days (**Table 1**).

Clinical parameters

Table 2 shows the periodontal clinical parameters recorded at baseline and after COVID-19 had begun to spread in April 2020. The average PD for all patients at baseline was 2.93±0.43 mm, and after COVID-19 had begun to spread, it was 2.94±0.43 mm. The mean values of

Table 1. Patients characteristics

Variables	All patients n=749 (100%)	As scheduled (A) n=500 (66.76%)	Postponed (B) n=249 (33.24%)	*P* values (between A & B)
Age at baseline (yr)	67.56±10.85 (26–93)	67.89±10.78 (26–89)	66.90±10.96 (28–93)	0.24
Gender (female)	478 (63.82)	317	161	0.75
Duration of SPT (yr)	4.37±3.20 (1–13) 740[a]	4.35±3.14 (1–13) 494[b]	4.39±3.32 (1–13) 246[c]	0.87
SPT interval (mo)	3.33±0.54 (1–5)	3.35±0.55 (1–5)	3.29±0.52 (2–5)	0.12
1	1 (0.13)	1	0	
2	17 (2.27)	11	6	
3	472 (63.02)	304	168	
4	253 (33.78)	180	73	
5	6 (0.80)	4	2	
No. of teeth	21.15±6.74 (3–32)	21.01±6.85 (3–32)	21.42±6.52 (3–32)	0.44
Postponement of appointment (d)	-	-	109.49±88.84 (1–628)	-

Values are presented as mean ± standard deviation (min–max) or number (%).
SPT: supportive periodontal therapy.
[a]Exclude 9 patients started SPT before 2006; [b]exclude 6 patients; [c]exclude 3 patients.

Table 2. Clinical parameters from the examination at baseline and after the spread of COVID-19

Variables	All patients n=749 (100%)	As-scheduled (A) n=500 (66.76%)	Postponed (B) n=249 (33.24%)	*P* values (between A & B)
Baseline				
Average PD (mm)	2.93±0.43 (2.07–5.54)	2.92±0.42 (2.07–4.91)	2.94±0.44 (2.07–5.54)	0.74
FMBS (%)	10.78±0.43 (0–61.11)	10.78±9.78 (0–61.11)	10.78±9.42 (0–53.57)	1.00
FMPS (%)	31.62±17.42 (0–91)	31.81±17.31 (0–91)	31.23±17.65 (0–89)	0.67
PISA (mm^2)	166.23±174.08 (0–1,124.41)	162.92±170.32 (0–1,077.68)	172.86±181.57 (0–1,124.41)	0.46
PESA (mm^2)	1,215.25±451.80 (169.31–3,148.56)	1,202.54±449.01 (169.31–3,148.56)	1,240.78±457.20 (187.75–2,486.92)	0.28
PISA/PESA	0.13±0.11 (0–0.60)	0.13±0.11 (0–0.60)	0.13±0.11 (0–0.56)	0.92
After the spread of COVID-19				
Average PD (mm)	2.94±0.43 (2.05–4.87)	2.94±0.42 (2.05–4.87)	2.96±0.43 (2.12–4.83)	0.64
FMBS (%)	11.00±10.06 (0–69.05)	10.77±9.72 (0–56.67)	11.46±10.72 (0–69.05)	0.38
FMPS (%)	31.99±18.41 (0–100)	32.06±18.70 (0–100)	31.85±17.84 (0–82)	0.88
PISA (mm^2)	172.57±186.25 (0–1,410.55)	165.70±178.34 (0–1,410.55)	186.37±200.87 (0–1,077.49)	0.15
PESA (mm^2)	1,222.22[a]±452.95 (169.31–3,279.87)	1,209.77±453.56 (169.31–3,279.87)	1,247.23±451.61 (181.27–2,548.52)	0.29
PISA/PESA	0.13±0.12 (0–0.70)	0.13±0.11 (0–0.64)	0.14±0.13 (0–0.70)	0.36

Values are presented as mean ± standard deviation (min–max) or number (%).
COVID-19: coronavirus disease 2019, PD: probing depth, FMBS: full-mouth bleeding score, FMPS: full-mouth plaque score, PISA: periodontal inflamed surface area, PESA: periodontal epithelial surface area.
[a]Statistically significant differences between baseline and after the spread of COVID-19 ($P<0.05$).

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PISA and PESA calculated using CAL, recessions, and BOP were 166.23±174.08 mm^2 and 1,215.25±451.80 mm^2 at baseline, and 172.57±186.25 mm^2 and 1,222.22±452.95 mm^2 after the spread of COVID-19. Mean PESA values increased significantly after the spread of COVID-19 compared to baseline. FMBS, FMPS, and PISA/PESA were not significantly different between baseline and after the spread of COVID-19. Furthermore, clinical parameters were analyzed by dividing the patients into the as-scheduled and postponed groups. Average PD, FMBS, FMPS, PISA, PESA, and PISA/PESA values for both groups were not significantly different between the 2 examinations that occurred immediately before and after the spread of COVID-19.

Correlation between SPT appointment postponement days and changes in clinical parameters

To investigate the influence of postponing SPT appointments on changes in clinical parameters, 249 patients in the postponed group were classified into 2 subgroups focused on FMBS and TN at baseline using the PRA method [9]. The correlation coefficients (rs) between the number of postponement days and the changes in clinical parameters were calculated (**Table 3**). In the FMBS subgroup, patients with FMBS <10% were classified as low risk (n=141), 10% to 24% as moderate risk (n=87), and ≥25% as high risk (n=21). Positive correlations were demonstrated between postponement days and the changes in average PD (rs=0.474) and PESA (rs=0.443) in the high-risk subgroup. In the TN subgroup, patients with ≥24 teeth were classified as low risk (n=127), patients with 21-23 teeth as moderate risk (n=31), and patients with ≤20 teeth as high risk (n=91). Weak positive correlations were demonstrated between postponement days and changes in FMPS (rs=0.355) in the moderate-risk group, and average PD (rs=0.293) and PESA (rs=0.253) in the high-risk group, respectively. Fourteen patients fell into the high-risk

Table 3. Correlation coefficient between the number of postponement days and changes in clinical parameters of patients in the subgroups of postponed group according to the periodontal risk assessment method

Subgroup	Average PD	FMBS	FMPS	PISA	PESA	PISA/PESA
All (n=249)						
rs	0.0906	0.0172	0.102	0.0224	0.0936	0.0261
P value	0.154	0.787	0.107	0.725	0.141	0.682
FMBS at baseline						
Low risk, <10% (n=141)						
rs	0.0298	−0.0165	0.0996	−0.026	0.0622	−0.0306
P value	0.725	0.846	0.24	0.76	0.463	0.719
Moderate risk, 10%–24% (n=87)						
rs	0.139	0.0178	0.0936	0.0307	0.107	0.055
P value	0.198	0.87	0.389	0.777	0.324	0.613
High risk, ≥25% (n = 21)						
rs	0.474[a]	0.369[b]	0.278[b]	0.409[a]	0.443[a]	0.37[b]
P value	0.0314[c]	0.101	0.222	0.0667	0.0458[c]	0.0993
TN at baseline						
Low risk, ≥24 (n=127)						
rs	−0.0879	−0.0566	0.0346	−0.0238	−0.0262	−0.0397
P value	0.326	0.527	0.7	0.791	0.77	0.658
Moderate risk, 23–21 (n=31)						
rs	0.0837	−0.222[b]	0.355[b]	−0.18	0.144	−0.199
P value	0.654	0.23	0.0499[c]	0.33	0.439	0.282
High risk, ≤20 (n=91)						
rs	0.293[b]	0.198	0.1	0.198	0.253[b]	0.196
P value	0.00489[c]	0.0602	0.343	0.0596	0.0155[c]	0.0625
FMBS ≥25% & TN ≤20 at baseline (n=14)						
rs	0.459[a]	0.49[a]	0.48[a]	0.56[a]	0.477[a]	0.464[a]
P value	0.101	0.0779	0.0826	0.0401[c]	0.0872	0.0972

PD: probing depth, FMBS: full-mouth bleeding score, FMPS: full-mouth plaque score, PISA: periodontal inflamed surface area, PESA: periodontal epithelial surface area, TN: tooth number.
[a]0.4< rs ≤0.7; [b]0.2< rs ≤0.4; [c]Significantly different from control: $^*p < 0.05$.

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subgroups in both classifications (FMBS and TN), and a positive correlation was found between postponement days and PISA (rs=0.56).

DISCUSSION

The present study was designed to estimate the effect of COVID-19's spread on patients with periodontitis treated by our SPT program. SPT has been reported to be essential for maintaining the successful results of periodontal treatment [10,11]. Continuous education and guidance for the patients provided with professional care during SPT are effective in ensuring the stability of periodontal tissue and preventing unfavorable events such as tooth loss [10,11]. The results show that 249 (33.24%) patients out of 749 included in this study postponed their SPT appointments after the initial spread of COVID-19 in Japan (**Table 1**). Additionally, 201 patients did not return for SPT after April 2020 (**Figure 1**). Patients who postponed or did not return to their SPT appointments had a variety of reasons, but the main reasons included patient willingness and reduced delivery of hospital care. The electronic medical record system's appointment change history was evaluated without detailed reasons for each patient.

SARS-CoV-2, which is responsible for COVID-19, is diffused primarily through coughing, sneezing, and saliva. The virus is transmitted through aerosol and typically enters through the mouth, nose, or eyes [12]. Dentistry is understood to be one of the medical fields with the highest risk of infection due to the frequent production of aerosol and the constant presence of saliva [13]. In the initial phase of the pandemic, people perceived dental attendance as a high-risk behavior for infection with COVID-19; hence, fear and anxiety kept patients away from dental clinics [14,15]. In an Iranian study during the COVID-19 pandemic, the main concern was prolongation of treatment, and the most common problem was irritation of oral soft tissues by orthodontic appliances [14]. In an Italian study, the risk of canceling or postponing the appointment at the dentist was 1.59 times greater in those who claimed to be strongly influenced by COVID-19 concerns [15]. Nearly half of US adults reported delaying dental care due to the COVID-19 pandemic. In a multivariable regression model, only living in an urban (vs. rural) area was associated with significantly higher odds of delayed dental care due to the pandemic [16].

In addition, significant decreases in dental attendance related to COVID-19's spread were reported in studies from Brazil and China [17,18]. Üstün et al. [19] reported that the COVID-19 pandemic had a significant influence on patients' attendance in emergency/non-emergency cases at the pediatric dental clinic of Istanbul Medipol University in Republic of Türkiye. Walter et al. [20] analyzed urgent dental care in the Department of Conservative Dentistry and Periodontology, University Hospital Munich during the initial spread of COVID-19 in Germany, and reported that public awareness of SARS-CoV-2 led to a quick decline in patient numbers. Thus, the COVID-19 pandemic had comprehensive effects on dental care and kept many patients away from dental clinics. A few reports have focused on periodontal health related to the COVID-19 pandemic. According to a recent cross-sectional study in Japan, interruption of regular dental visits during the COVID-19 pandemic was associated with a higher odds ratio for the presence of periodontitis [21]. In this study, we analyzed whether baseline data from periodontal examination performed in the 6 months immediately before the COVID-19 epidemic and subsequent changes in clinical parameters were associated with longer SPT visit intervals. Moreover, patients of the postponed group were classified into

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subgroups according to the PRA method [8]. Both high-risk subgroups for FMBS and TN showed significant positive correlations between total postponement days and average PD and PESA (**Table 3**). However, unexpectedly, there were no significant correlations between postponement days and FMBS or PISA. We considered several reasons. First, the smoking status of patients could not be taken into account because the electronic clinical record system could not be used to obtain an accurate smoking history for all patients. Several studies demonstrated that BOP in smokers was lower than that in non-smokers [22,23]. Park et al. [24] reported that PISA was positively correlated with the amount of current smoking. It was also reported that PISA reflects BOP well [25]. Thus, FMBS and PISA could be masked by smoking status. Second, TN in patients included in this study ranged widely from 3 to 32 teeth. Depending on the characteristics of the calculation method [7], both FMBS and PISA appear to be affected by TN. A significant positive correlation between postponement days and PISA was observed in the patients at high risk for both FMBS and TN (**Table 3**). Lang and Tonetti [8] described 6 parameters in PRA, including percentage of BOP and loss of teeth, and defined an individual who has at least 2 parameters in the high-risk category as a high PRA patient. The extended interval of SPT visits due to COVID-19 may have affected changes in PISA, especially in higher PRA patients.

PISA has developed as a novel measure of periodontitis and reflects the surface area of bleeding pocket epithelium in square millimeters. The strength of PISA is its ability to quantify the amount of inflamed periodontal tissue [7]. Recently, it has been shown that a positive correlation existed between PISA and HbA1c in type 2 diabetes mellitus patients [26]. It was also suggested that PISA correlates with homocysteine levels in plasma that are implicated in high blood pressure [27]. Moreover, there are several reports describing the association between increased PISA and systemic conditions surrounding periodontitis, such as dementia [28], chronic kidney disease [29], obesity [30], and atherosclerosis [31]. Though PISA has been developed as a measure for evaluating the relationship with systemic diseases, this study could not include the evaluation of patients' systemic conditions.

This study had several limitations. First, the clinical parameters used in this retrospective study were obtained from historical records and may contain operator-related measurement errors. Second, the patient population includes a variety of systemic diseases or smokers, which may affect PISA, the main objective of this study. In addition, the patient population may include more high PRA patients, since assessment of PRA inherently includes systemic aspects, genetic components, and smoking status. Therefore, the results of the present study should be interpreted with due consideration of these limitations.

Within the limitations of this study, our results indicated that PISA with high PRA patients, sorted by FMBS and TN, increased significantly with a larger number of days between SPT visits. The spread of COVID-19 may have influenced the periodontal stability of SPT patients by preventing their hospital visits. The management of SPT patients with high PRA requires scheduling appropriate visit intervals while considering various factors that may interfere with dental visits, such as the spread of infectious disease.

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