A multicenter prospective cohort study on the effect of smoking cessation on periodontal therapies in Japan

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Abstract: Few prospective studies have reported the effects of periodontal therapy on patients who attempted to quit smoking. This study aimed to assess how smoking cessation affects periodontal therapy. Twenty-five smokers with periodontitis were investigated by dividing them into two groups, a smoking cessation support group and a continued smoking group. Those in the support group received counseling and nicotine replacement therapy, followed by periodontal treatment conducted by dentists who had completed an e-learning course on smoking cessation. Clinical parameters were measured at baseline, 3, and 6 months. Most clinical parameters improved for those in the smoking cessation support group as compared with those in the continued smoking group. Pathogenic bacteria confounded by environmental factors such as smoking [1]. In 2017, the World Health Organization reported that the risk ratio of smoking for periodontal disease was (2.14; 95% confidence interval [CI], 1.44 to 3.17) [World Health Organization 2017. ISBN 978-92-4-151267-1]. Smoking >10 cigarettes/day is a significant risk factor for periodontal disease.

Several reports have shown the effects of smoking cessation on periodontitis with or without periodontal intervention. One prospective study demonstrated significantly less bone loss in patients who quit smoking than in current smokers. The effects of smoking cessation on gingival tissues are observed in the short term via the recovery of gingival microcirculation [2]. Among smokers, fewer improvements were noted in periodontal parameters on completion of periodontal therapy than nonsmokers [3]. Recently, prospective intervention studies that included smoking cessation during nonsurgical periodontal therapy showed significant improvements in periodontal health. They showed a greater reduction of probing pocket depth (PPD) in quitters compared with nonsmokers, despite high dropout rates at 3 and 6 months after scaling and root planing (SRP) [4,5].

In this study, the impact of smoking cessation on periodontal therapy was assessed by comparing data from patients who stopped smoking, or had a smoking relapse, or had no smoking cessation support.

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Materials and Methods

This study was part of a prospective multicenter project to assess the effects of tobacco cessation in patients who had various oral health-related disorders; oral potentially malignant disorders (OPMD), patients receiving dental implants and those diagnosed with periodontitis in dental settings. The clinical effects of periodontal therapy in patients who received smoking cessation support were assessed. The study was approved by the Institutional Review Board of the Japanese Society of Oral and Maxillofacial Surgeons (No. 2015-004) and received ethical approval from each study center’s ethics committee. This study was registered at ClinicalTri-
als.gov identifier:NCT02737176 and UMIN-CTR:000021429, and the results are presented here.

This study sequentially recruited regular smokers with chronic periodontitis. All subjects received periodontal therapy as prescribed by periodontal specialists. All patients in this study were enrolled through 5 private dental clinics and 8 dental teaching hospitals between May 2016 and October 2018. The inclusion criteria were the presence of ≥30% teeth with a PPD of ≥4 mm and ≥3 sites with PPD ≥6 mm. The exclusion criteria are shown in Fig. 1. The status of nicotine dependence was evaluated using the Fagerstrom Test for Nicotine Dependence (FTND). A score of >3 indicated moderate or high tobacco dependence.

The tobacco cessation support program included an e-learning program for dentists, tobacco cessation counseling, and nicotine replacement therapy (NRT) - and nicotine transdermal (skin) patches supplied free of charge (Fig. 1). Self-reporting was used to confirm the patients’ smoking cessation status during reevaluation at 3 and 6 months. Occurrences of patient oscillation and dropout were considered as smoking relapse. Participants who did not intend to abstain from smoking were considered as subjects in the continued smoking group.

The study flowchart is shown in Fig. 1. Periodontal examinations were performed by trained periodontists and four clinical parameters, PPD, clinical attachment levels (CAL), bleeding on probing (BOP), and plaque index were measured. The periodontal inflamed surface area (PISA) and periodontal epithelial surface (PESA) were calculated [6]. All participants received a periodontal examination at the first visit and during initial treatment preparation. At baseline (BLsrp), two periodontal sites for SRP were selected, being the worst and second worse sites except for teeth indicated for extraction [7]. All sites with ≥4 mm of PPD were treated with SRP and reevaluated (RE post-SRP). REs were repeated at 3 and 6 months. Smoking status was confirmed at each RE. Periodontal surgery sites were excluded from reevaluation for SRP, as shown in Fig. 1.

Statistical normality and equal variance tests were confirmed to compare the differences in parameters between groups, to choose between parametric or nonparametric analyses. Mann-Whitney U-test was used, as appropriate.

### Table 1 Baseline characteristics of the study population

| Variable | Smoking cessation support group | Continued smoking group | P value |
|----------|--------------------------------|-------------------------|--------|
| Sex      | Male  8 (42.1) 5 (30.0)       | Female 11 (57.9) 3 (50.0) |       |
| Age      | 50 (33-61) 52 (46-67)         | 42.5 (30-60) 15 (10-30)   | 0.134  |
| Number of cigarettes (day) | 20 (10-30) | 15 (10-30) | 0.159  |
| Years of smoking | 28 (10-35) | 35 (20-47) | 0.060  |
| Pack-years | 455.0 (300-600) | 630.0 (250-705) | 0.484  |
| FTND     | 5 (4-6) | 2.7 (1-8) | 0.796  |
| Drinking habit | Regular 4 (21.0) | 6 (10.0) |        |
| Systemic diseases | Yes 3 (15.8) | 2 (10.5) | 0.484  |
| Medication | Yes 3 (15.8) | 2 (10.5) | 0.484  |
| Use of NRTs at cessation support | 13/19 (68.4) | 0/6 (0.0) |        |

* Mann-Whitney U-test was used to compare differences between groups. FTND, Fagerstrom Test for Nicotine Dependence. NRTs, nicotine replacement therapies. Data shown as median (1st row), interquartile range (IQR, 2nd row), minimum and maximum in parentheses (3rd row).
Table 2 Improvements in clinical parameters of full-mouth and at SRP sites between the smoking cessation support and continued smoking groups at BLsrp and 3 or 6 months after SRP

| Variable | Smoking cessation support group (<i>n</i> = 15) | Smoking relapse group (<i>n</i> = 4) | Continued smoking group (<i>n</i> = 4) |
|----------|---------------------------------|---------------------------------|---------------------------------|
|          | Smoking cessation (SC')<sup>1</sup> | Continued smoking (CS)          | Continued smoking (CS)          |
|          | (<i>n</i> = 11)                    |                                 |                                 |
| Number of teeth | Baseline (BLsrp) | Reevaluation (6 months after SRP) | P value | Baseline (BLsrp) | Reevaluation (6 months after SRP) | P value | Baseline (BLsrp) | Reevaluation (6 months after SRP) | P value |
|          | (28)                            | (28)                            | † 0.797 | (28)              | (28)                            | † 0.767 | (28)              | (28)                            | † 0.767 |
| PPD (mm) | 2.5                            | 2.5                             | † 0.01  | 2.5               | 2.5                             | † 0.01  | 2.5               | 2.5                             | † 0.01  |
| Rate of PPD (≥4 mm) | 32.2                          | 32.2                            | † 0.01  | 32.2   | 32.2                            | † 0.01  | 32.2              | 32.2                            | † 0.01  |
| Rate of PPD (≥6 mm) | 23.4                          | 23.4                            | † 0.01  | 23.4   | 23.4                            | † 0.01  | 23.4              | 23.4                            | † 0.01  |
| BOP (%)  | 36.2                           | 36.2                            | † 0.01  | 36.2   | 36.2                            | † 0.01  | 36.2              | 36.2                            | † 0.01  |
| o-PCR (%) | 36.7                          | 36.7                            | † 0.05  | 36.7   | 36.7                            | † 0.05  | 36.7              | 36.7                            | † 0.05  |
| PISA (mm²) | 1,941.9×10<sup>6</sup>  | 1,941.9×10<sup>6</sup>  | † 0.01  | 1,941.9×10<sup>6</sup>  | 1,941.9×10<sup>6</sup>  | † 0.01  | 1,941.9×10<sup>6</sup>  | 1,941.9×10<sup>6</sup>  | † 0.01  |
| PESA (mm²) | 2,419.7                      | 2,419.7                         | † 0.05  | 2,419.7| 2,419.7                         | † 0.05  | 2,419.7           | 2,419.7                         | † 0.05  |

**Note:** Values in bold indicate statistically significant differences. No statistical analyses to compare parameters between BL and RE in the groups where sample size is less than 4 with non-normality and non-equal variance.
Table 3  Comparison of changes in clinical parameters of SRP sites between the smoking cessation support and continued smoking groups at 3 and 6 months after SRP

| Variable | Smoking cessation support group | Continued smoking group | Difference between the three groups* | P value |
|----------|---------------------------------|-------------------------|-------------------------------------|---------|
|          | Smoking cessation (SC)          | Smoking relapse (SR)    | SC VS. SR†                          | SC VS. CS‡ |
|          | 3 month after SRP               |                         | SC VS. CS‡                          |         |
| Number of sites | 17      | 6           | 8         | 0.584 | 0.278 | 0.816 | 0.561 |
| Improvement rate of PPD (%) | 26.9 ± 17.2† | 42.1         | 18.3-48.6 | 0.00-6.67 | 12.5-45.8 | 0.00-50.0 |         |
| Improvement rate of CAL (%) | 25.0 | 16.7-33.3 | 26.2 | 6.25-29.3 | 20.8 ± 23.2† |         | 0.729 | 1.00 | 0.398 | 0.699† |
| ABOP | 0.00 | 0.00-1.00 | 0.50 | 0.00-1.00 | 0.13 ± 0.60† |         | 0.602 | 0.753 | 0.432 | 0.333† |
| 6 month after SRP | | 5 | 10 | 1 | 0.159† |
| Number of sites | | 4 | | | | | |
| Improvement rate of PPD (%) | 42.9 | 33.5-50.0 | 41.7-43.3 | 48.6-51.1 | (−40.0-55.6) | (44.4-54.6) |         |
| Improvement rate of CAL (%) | 37.5 | 33.5-37.5 | 22.0 | 13.0-50.0 | 20.6 ± 20.9† |         | 0.076† |
| ABOP | 1.00 | 1.00-1.00 | 0.75 | 0.00-1.00 | 0.75 ± 0.40† | <0.05† |

SRP: scaling and root planning; PPD: probing pocket depth; CAL: clinical attachment level; BOP: bleeding on probing. Normality: equal variance. *By patient self-report. †Kruskal-Wallis test was used to compare differences among the three groups. ‡Dunn-Bonferroni test was used to compare differences between two groups. Data shown as median (1st row), interquartile range (IQR, 2nd row), minimum and maximum in parentheses (3rd row). Values in bold indicate statistically significant difference. No statistical analyses to compare parameters between BL and RE in the groups where sample size is less than 4 with non-normality and non-equal variance.

Results

Of the enrolled 74 patients in total, 49 were subjected to therapy for OPMD or implants, and 25 were eligible for periodontal therapy (Table 1), and 19 completed the study.

Clinical improvements following SRP were assessed at the third and sixth months (Table 2) from BLsrp. The mean values of PPD and the rate of PPD ≥4 mm at BLsrp were significantly reduced in the smoking cessation (SC) subgroup, and similar tendencies were found in the smoking relapse (SR) and continued smoking (CS) subgroups 3 months after SRP with no statistical analyses performed due to small sample size. Rates of PPD ≥6 mm and BOP at 3 months after SRP were significantly decreased in the SC subgroup. Similar tendencies were found in the SR subgroup but not in the CS subgroup with no statistical analyses performed due to small sample size.

A total of 31 SRP sites from 17 patients were evaluated at 3 and 6 months after SRP. Reduction of PPD and CAL gain was demonstrated in the three groups; however, improvements in BOP at the third month were found only in the smoking cessation subgroup. At 6 months after SRP, clinical improvement was similar to that at 3 months (Table 2).

Differences in the improvement rates of PPD, CAL, and BOP were compared in the three subgroups (Table 3). At 6 months, the SC subgroup showed significantly more improvement in BOP (ABOP) compared with the SR subgroup.

Discussion

Japanese dental professionals have shown interest in being involved in supporting and providing smoking cessation [8]. To address this, the current prospective, multicenter study was designed.

In evaluating full-mouth parameters, PPD of 6 mm and BOP did not improve in the CS subgroup. Clinical parameters at the third month in comparison with baseline significantly improved in quitters as well as in the SR subgroup. These results suggest that continuing to smoke negatively affected PPD at severe periodontal sites, and that recovery of gingival microcirculation was virtually identical among quitters and those who had temporarily stopped smoking. PISA contains the component of BOP attributed to inflamed areas; however, PISA did not significantly improve, even among quitters. These results imply that in ex-smokers, a much longer period is required to regain normal gingival texture after recovery of microcirculation.

At SRP sites, significant improvements in BOP in quitters and the SR subgroup were demonstrated, but not in smokers. This result suggests that successful or temporary smoking cessation activates the periodontal healing response. A few studies have reported differences in the microbiome in subgingival plaque between smokers and nonsmokers [9]. Generally, SRP leads to intensive qualitative changes in bacterial flora, which explains the benefits of SRP in the three groups in this study, even among nonquitters.

This study had one major limitation. The use of patient self-reporting of smoking status could lead to miscalculation of real quitters [10]. Although the required sample size was estimated from an intervention study [4], the used sample size (n = 19) in this study was insufficient, and the dropout rate was high. This study was based on short-term evaluations. Patients who had a smoking relapse tended to delay visiting the dentist, even when they needed periodontal therapy. This made it difficult to estimate clinical parameters at correct intervals.

This is the first report on tobacco cessation support in Japan, with the dentist giving advice on quitting while treating periodontitis. Successful or temporary smoking cessation was beneficial to periodontal therapy. A further randomized controlled trial on a larger scale is warranted to elucidate the effects of tobacco cessation support for periodontal therapy.

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Conflict of interest

None declared.

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