Influence of Compliance and Smoking Habits on the Outcomes of Supportive Periodontal Therapy (SPT) in a Private Practice

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Purpose: The purpose of this retrospective cohort study was to evaluate the effect of smoking habits and patient compliance on the outcomes of supportive periodontal therapy (SPT) (tooth loss and residual pockets defined by probing depth of ≥ 5 mm) in a private practice situation.

Materials and Methods: Eighty-seven patients, who completed active periodontal treatment and then followed an SPT program for at least 5 years, were recruited from the patient pool of a private dental practice. After active periodontal therapy and at the follow-up examination 5–11 years later, pocket probing depths (PPD) and tooth loss were assessed, and the patients were divided into 4 subgroups based on their smoking history: non-smokers (NS); occasional smokers (OS); moderate smokers (S); and heavy smokers (HS). The patient cohort was also divided into 4 subgroups based on patient compliance (mean delay from the scheduled recall sessions): fully compliant (< 1 week); compliant within 1–3 weeks; compliant within 3–6 weeks; and not compliant (> 6 weeks).

Results: The mean tooth loss per patient and year ranged from 0.11 – 0.18 in the various subgroups with no significant differences between them. After a mean observation period of 7.3 ± 1.5 years, the incidence of new sites with residual probing depth of ≥ 5 mm varied between 1.2% for the NS and 13.8% for the HS ($p < 0.05$,), and between 3.2% for the compliant and 5.8% for the non-compliant patients.

Conclusion: Smoking habits significantly influenced the treatment outcomes of SPT, while compliance was less influential regarding the incidence of new residual pockets during 7.3 years of SPT.

Key words: supportive periodontal therapy, SPT, compliance, smoking habits, tobacco, smoking, periodontal pockets, reinfection, maintenance, tooth loss

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Periodontal diseases represent opportunistic infections, and hence the therapy of the conditions must primarily be anti-infective in nature. Irrespective of the techniques chosen for debridement, there is strong evidence (Heitz-Mayfield et al, 2002) that such anti-infective therapy will lead to both resolution of gingival inflammation and reduction in clinical probing depth. Concomitantly with the latter, clinical attachment gains result from a tightening of the periodontal tissues, while shrinkage of these results in slight recession of the gingival margins. Such treatment outcomes may lead to long-term stability of the periodontal attachment apparatus provided that subgingival debridement of residual periodontal pockets combined with optimal individual supragingival prophylactic procedures prevail at

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regular intervals (Heasman et al, 2002). It has been demonstrated that treatment outcomes following periodontal therapy can be maintained stable for long periods of time by rendering regular SPT in compliant patients (Hirschfeld and Wasserman, 1978; Axelsson and Lindhe, 1981; Becker et al, 1984; Tonetti et al, 2000; König et al, 2002), while irregularly maintained patients may develop recurrent disease within 5–6 years (Axelsson and Lindhe, 1981; Kerr, 1981). Patient compliance in combination with a well-organized maintenance system therefore represents the key to the prevention of recurrent periodontal infection and the maintenance of periodontal stability (for review: see Lang et al, 2003).

In the last decade several studies have pointed to the central contributory role of heavy smoking in the pathogenesis of periodontal diseases (Bergström et al, 1991; Haber et al, 1993; Tonetti, 1998; Bergström et al, 2000). Clearly, smoking has been identified as a major risk factor for the development of periodontitis (Haber et al, 1993; Haber, 1994). However, the role of smoking in the maintenance of periodontal stability following active periodontal therapy has not been elucidated.

The purpose of this retrospective cohort study was to evaluate the effect of smoking habits and patient compliance on the outcomes of SPT (tooth loss and residual pockets defined by probing depth of ≥ 5 mm) in a private practice situation.

MATERIAL AND METHODS

Patients with a multitude of dental, periodontal and reconstructive problems originating from a patient pool of a private dental practice were treated during the years 1990 to 1996 by the same dental practitioner who had a strong background in periodontology. Eighty-seven patients, consecutively examined during a three-month maintenance period, participated in this retrospective study. The basis for enrollment into the study was the fact that active dental/periodontal treatment was completed at least 5 years before the follow-up examination. After completion of active dental and periodontal treatment, and the incorporation of reconstructions necessary to obtain individual optimal chewing function, the SPT system was offered to all participants. The maintenance visits were regularly scheduled and ranged from 3–9 months, which corresponded to the individual needs of the patient as judged by the clinician.

The patients were always re-evaluated at the recall visit, and pocket probing depths (PPD) and bleeding on probing (BOP) was determined. Bleeding sites as well as sites with residual PPD as defined by ≥ 5 mm were manually instrumented by a registered dental hygienist. The entire dentition was subsequently polished using a rubber cup and polishing paste, and topical fluorides were applied. Furthermore, the next recall visit was scheduled at an interval that corresponded to the patient's needs. This was scheduled to assure optimal compliance, but also took into account the private activities of the patient. At the follow-up examination – i.e. 5 to 11 years following completion of active therapy – the following clinical parameters were assessed:

1. PPD at 6 sites of each tooth (mesio-buccally, buccally, disto-buccally, disto-orally, orally and mesio-orally) in millimeters (Glavind and Löe, 1967) using a Michigan 0 periodontal probe with a point diameter of 0.4 mm and applying a light probing force (< 0.3N).
2. The number of teeth lost since completion of active therapy.
3. A smoking history stratifying the patients into 4 subgroups: **A)** Non-smokers (NS); **B)** Occasional smokers (OS), regularly smoking 1–9 cigs./day; **C)** Moderate smokers (S), regularly smoking 10–19 cigs./day; and **D)** Heavy smokers (HS), smoking at least 20 cigs./day. (Only 2 former smokers were incorporated into the NS cohort because they had quit smoking at least 5 years previously.)
4. The recall frequency per year and the compliance with which the patients followed the predetermined recall visits. Compliance could be evaluated by counting the number of weeks in excess of the predetermined recall-interval foreseen by the clinician. For patient compliance, subgroups were formed as follows: **A)** Patients who complied with the recommended recall interval within a week of the scheduled appointment; **B)** Patients who complied with the recommended recall interval within 1–3 weeks of the scheduled appointment; **C)** Patients, who complied with the recommended recall interval within 3–6 weeks of the scheduled appointment; and **D)** Non-compliant patients who delayed their acceptance of the invitation to a recall visit by more than 6 weeks.

The results of tooth loss and residual probing depth of ≥ 5 mm were analyzed for the 4 non-smok-

Table 1 Gender, mean age and mean observation periods for patients divided into four subgroups based on smoking habits and compliance

		Number of patients (n = 87)	Range	% of total number
Females n		52		59.8
Males n		35		40.2
Mean age (years)		44.6 ± 9.8	(27 – 69)	
Mean observation period (years)		7.3 ± 1.5	(5.0 – 11.6)	
Non-smokers (NS)		53		60.9
Occasional smokers (OS)	1 – 9 cigs./day	12		13.8
Moderate smokers (S)	10 – 19 cigs./day	11		12.6
Heavy smokers (HS)	> 19 cigs./day	11		12.6
Compliant	< 1 week	24		27.6
Compliant	1 – 3 weeks	24		27.6
Compliant	3 – 6 weeks	20		23
Non-compliant	> 6 weeks	19		21.8

ing/smoking groups and the four compliance groups. Inter-group comparison was performed using t-tests for independent samples. The level of significance was set at $\alpha = 0.05$.

RESULTS

The observation period between the termination of active treatment and the follow-up examination ranged from 5.0 – 11.6 years and averaged 7.3 ± 1.5 years. From the 87 patients treated for moderate to severe periodontitis, 52 (60%) were females and 35 (40%) were males, (aged 44.6 ± 9.8 years at the time of completion of active therapy, age range 27–69 years). Table 1 shows the stratification of the patients according to gender, smoking habit and compliance with the scheduled SPT visits. Sixty-one per cent of the patients were NS, while 13–14% belonged to each of the 3 smoking sub-cohorts. Regarding compliance with the SPT system, 28% belonged to compliance groups A and B, respectively, while 23% were in compliance group C, and 22% belonged to the non-compliant group D.

From the 87 patients, 48.3% showed no loss of teeth during the observation period; 26.4% lost only one tooth and 16.1% lost two teeth; 3.4% lost three teeth; and 5.7% lost four or more teeth.

The mean annual tooth loss per patient varied between 0.11 (SD ± 0.14) and 0.14 (SD ± 0.20) teeth for the three compliance groups A, B and C. However, the non-compliant group D demonstrated an elevated mean annual loss of teeth of 0.17 (SD ± 0.26) (Fig 1). However, this increase did not reach statistical significance. Fig 2 shows the percentage of residual pockets, defined as pockets with PPD ≥ 5 mm at the termination of active therapy and at the follow-up examination, respectively. At the time of the follow-up examination at least 5 years (mean 7.3 ± 1.5 years) after active therapy, it was evident that the three compliance groups A, B and C presented with additional residual pockets of 3.2% (SD ± 5.9), 2.6% (SD ± 4.1), and 3.4% (SD ± 9.0), respectively. The non-compliant group D, however, presented with 5.8% (SD ± 16.1) more residual pockets than after the termination of active therapy, resulting in a total of 11.2% residual pockets at the follow-up examination. This difference, however, did not reach statistical significance. After extrapolating the deterioration of the percentages in residual pockets to an average of 10 years, the percentages for groups A, B and C were 4.1%, 3.7% and 4.4%, respectively (Fig 3). For the non-compliant group, the corresponding percentage was 9.3% after an extrapolated mean of 10 years.

Non-smokers yielded a mean annual tooth loss of 0.12 (SD ± 0.20), while HS yielded a mean an-

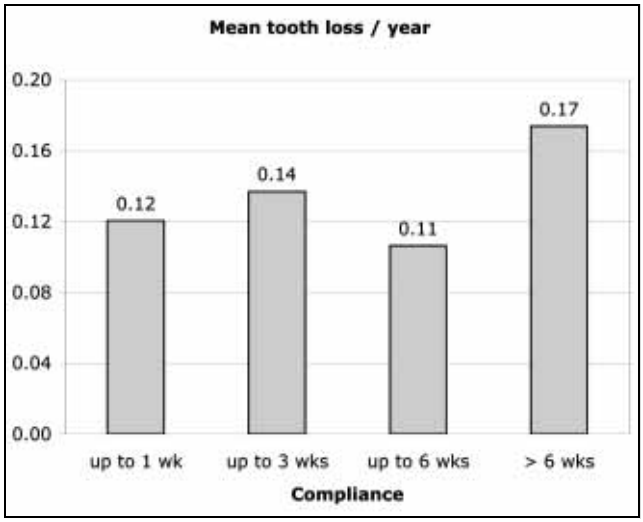

Fig 1 Mean annual tooth loss during the study period according to patient compliance with the recommended recall interval with attendance within: 1 week, 1–3 weeks, 3–6 weeks, and more than 6 weeks.

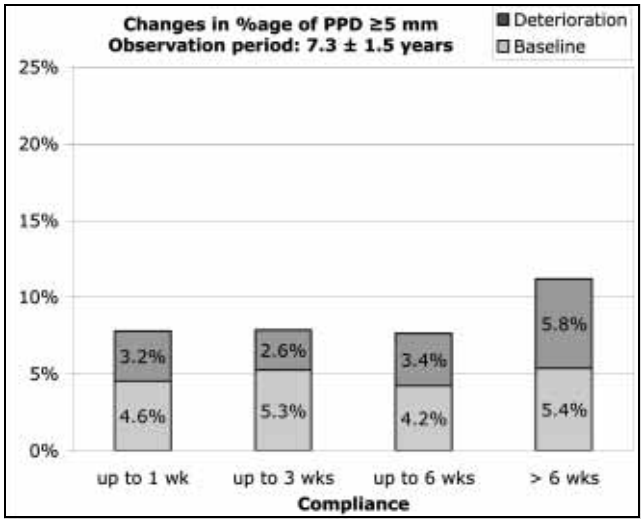

Fig 2 Percentage of residual pockets with probing depth ≥ 5 mm at the end of active therapy, and after a mean of 7.3 years of periodontal maintenance according to patient compliance with the scheduled maintenance appointments.

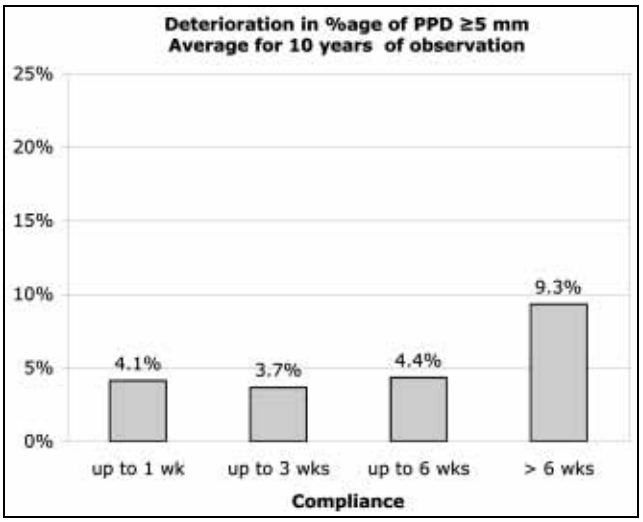

Fig 3 Increase in the percentage of residual pockets with probing depth ≥ 5 mm extrapolated over a presumptive period of 10 years of periodontal maintenance according to patient compliance with the scheduled maintenance appointments.

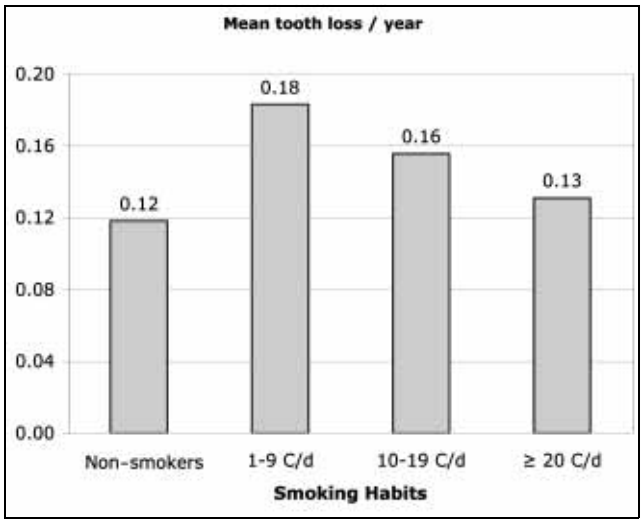

Fig 4 Mean annual tooth loss during the study period according to the smoking status of the patient: non-smokers (NS); occasional smokers (OS) with a cigarette consumption of 1–9 cigs./day; moderate smokers (S) with a cigarette consumption of 10–19 cigs./day; heavy smokers (HS) with cigarette consumption of at least a pack a day (≥ 20 cigs./day).

nual tooth loss of 0.13 (SD ± 0.19). OS and S presented with a mean annual tooth loss of 0.18 (SD ± 0.14) and 0.16 (SD ± 0.14), respectively (Fig 4). No differences between any of the 4 smoking subgroups reached the level of statistical significance. At the end of active therapy, the patients presented with residual pockets (PPD ≥ 5 mm) of 4.3% for the NS group, 6.1% for the OS group, 4.5% for the S group, and 6.4% for the HS group. When analyzing the percentages of additional residual pockets developing during the maintenance period of at least 5 years, the NS yielded only 1.2% (SD ± 4.2) additional residual pockets. The OS yielded 2.1% (SD ± 8.2), and the S, 7.2% (SD ±

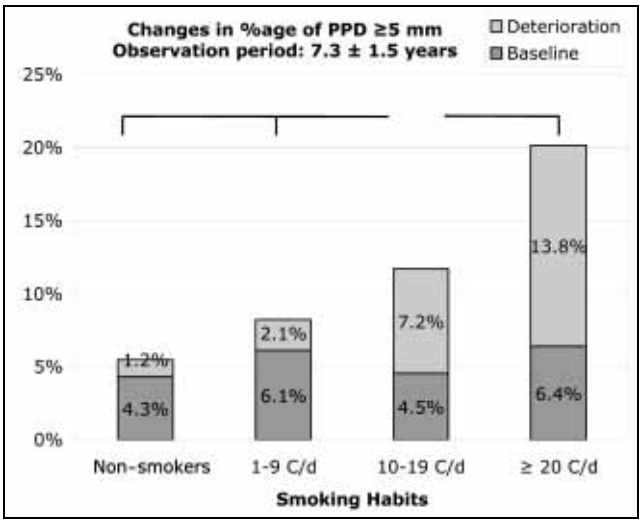

Fig 5 Percentage of residual pockets with probing depth ≥ 5 mm at the end of active therapy and after a mean of 7.3 years of periodontal maintenance according to the smoking status of the patient: non-smokers (NS); occasional smokers (OS) with a cigarette consumption of 1–9 cigs./day; moderate smokers (S) with a cigarette consumption of 10–19 cigs./day; heavy smokers (HS) with cigarette consumption of at least a pack a day (≥ 20 cigs./day).

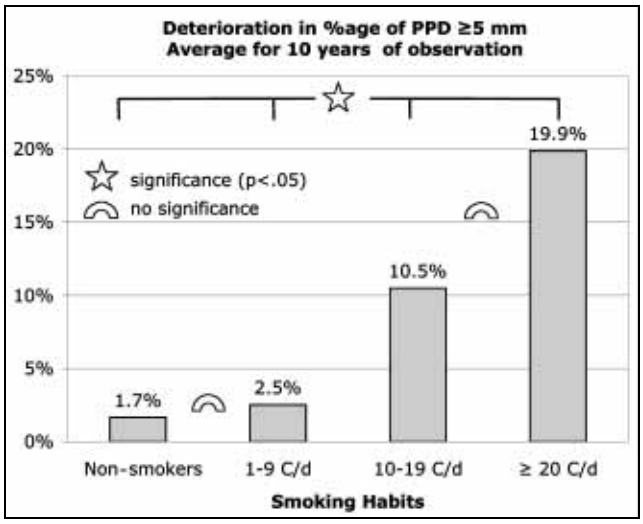

Fig 6 Increase in the percentage of residual pockets with probing depth ≥ 5 mm extrapolated over a presumptive period of 10 years of periodontal maintenance according to the smoking status of the patient: non-smokers (NS); occasional smokers (OS) with a cigarette consumption of 1–9 cigs./day; moderate smokers (S) with a cigarette consumption of 10–19 cigs./day; heavy smokers (HS) with cigarette consumption of at least a pack a day (≥ 20 cigs./day).

6.2) additional residual pockets, while the HS had developed 13.8% (SD ± 19.6) additional residual pockets resulting in 20.2% residual pockets after a mean of 7.3 years of maintenance in this group (Fig 5). The increase in additional residual pockets in the HS patients is statistically significant ($p < 0.05$). After extrapolating the results of the percentages of residual pockets individually for 10 years, thereby eliminating the influence of the observation time (Fig 6), the percentages of the different groups were 1.7% for the NS, 2.5% for the OS, 10.5% for the S and 19.9% for the HS. The differences between the NS/OS and S/HS were statistically significant ($p < 0.05$) The differences between the groups are indicated in Fig 6 and reveal a dose-dependent relationship between the consumption of cigarettes and the percentages of residual pockets after at least 5 years of maintenance.

DISCUSSION

The present study has demonstrated that smoking habits affected the treatment outcomes of moderate to advanced periodontitis patients following active periodontal therapy, while compliance habits did not influence either tooth loss or the incidence of new residual pockets in this patient cohort. The reason for this discrepancy can only be subject to speculation.

Although the three compliance subgroups were somewhat equal in size, the non-compliant group was slightly smaller consisting of only 21.8% of all patients. This, in turn, may indicate that the study was under-powered with respect to the compliance aspect. Nevertheless, a tendency of a higher mean individual tooth loss and higher incidences of new residual pockets were evident when comparing the non-compliant patient group to all the three other compliance subgroups. This would support the concept that compliance with scheduled recall intervals may only minimally affect the stability of treatment outcomes in periodontal patients (Brägger et al, 1992), while non-compliance may, indeed, result in deterioration of the periodontal treatment outcomes (Axelsson and Lindhe, 1981; Kerr, 1981).

One of the true outcome variables is tooth loss. However, the dentist's perception of both functional, periodontal, endodontic and caries aspects leading to the decision to extract or maintain a tooth may affect this. In the present study, tooth loss only affected 50% of the patients and, of these, half lost

one tooth only. However, the reasons for tooth loss in the present study were largely unknown. The study duration of the present retrospective analysis might not allow definite conclusions about tooth loss anyway, since only a mean annual loss of at worst 0.17 teeth/year was encountered in the non-compliant subgroup. On average, 4.5% of the teeth were lost during this mean maintenance period of 7.3 years. This is in agreement with results from a similar patient cohort (Tonetti et al, 2000) in which 4.2% of the teeth were lost during a mean maintenance period of 5.5 years.

In addition to tooth loss, a surrogate variable of the incidence of new residual pockets defined as pockets with PPD $\geq$ 5 mm was assessed in the present study. Clearly, an increasing incidence was observed in relation to tobacco consumption. If the results were extrapolated to an observation period of 10 years new residual pockets were identified in almost 20% of the sites as opposed to only 1.7% in NS. While the OS did not yield significantly more residual pockets than the NS, a significant and substantial increase in residual pockets to 10.5% was demonstrated for the S patients with a daily consumption of 10–19 cigarettes.

Previous studies on treatment outcomes following guided tissue regeneration of angular bony defects have clearly established that smoking is a high-risk factor for limited treatment success, jeopardizing the healing response as well as stability of the periodontal conditions during maintenance (Tonetti et al, 1995; Tonetti, 1998). In the present study, owing to the dose-response in the incidence of new residual pockets dependent on the amount of cigarettes smoked per day, it can be concluded that treatment outcomes and stability of achieved treatment results were also significantly affected whenever periodontitis patients smoked at least half a pack of cigarettes a day. It is, therefore, of utmost importance that smoking cessation programs be instituted for patients suffering from periodontitis. Treated patients have to be aware that long-term periodontal stability is questionable if they do not reduce their smoking habits below the level of 10 cigarettes a day.

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REFERENCES

1. Axelsson P, Lindhe J. Effect of controlled oral hygiene procedures on caries and periodontal disease in adults. Results after 6 years. J Clin Periodontol 1981;8:239-248.
2. Becker W, Berg L, Becker BE. The long term evaluation of periodontal treatment and maintenance in 95 patients. Int J Periodontics Restorative Dent 1984;4:54-71.
3. Bergström J, Eliasson S, Preber H. Cigarette smoking and periodontal bone loss. J Periodontol 1991;62:242-246.
4. Bergström J, Eliasson S, Dock J. A 10-year prospective study of tobacco smoking and periodontal health. J Periodontol 2000;71:1338-1347.
5. Brägger U, Hakanson D, Lang NP. Progression of periodontal disease in patients with mild to moderate adult periodontitis. J Clin Periodontol 1992;19:659-666.
6. Haber J. Smoking is a major risk factor for periodontitis. Curr Opin Periodontol 1994;12-18.
7. Haber J, Wattles J, Crowley M, Mandell R, Joshipura K, Kent RL. Evidence for cigarette smoking as a major risk factor for periodontitis. J Periodontol 1993;64:16-23.
8. Heasman PA, McCracken GI, Steen N. Supportive periodontal care: the effect of periodic subgingival debridement compared with supragingival prophylaxis with respect to clinical outcomes. J Clin Periodontol 2002;29:163-172.
9. Heitz-Mayfield LJA, Trombelli L, Heitz F, Needleman I, Moles D. A systematic review of the effect of surgical debridement vs. non-surgical debridement for the treatment of chronic periodontitis. J Clin Periodontol 2002;29:92-102.
10. Hirschfeld L, Wasserman B. A long-term survey of tooth loss in 600 treated periodontal patients. J Periodontol 1978;49: 225-237.
11. Kerr NW. Treatment of chronic periodontitis. 45% failure rate. Br Dent J 1981;150:222-224.
12. König J, Plagmann HC, Rühling A, Kocher T. Tooth loss and pocket probing depths in compliant periodontally treated patients: a retrospective analysis. J Clin Periodontol 2002; 29:1092-1100.
13. Lang NP, Brägger U, Salvi GE, Tonetti MS. Supportive periodontal therapy (SPT). In: Lindhe J, Karring T, Lang NP (eds). Clinical periodontology and implant dentistry 4th ed. Chapter 32. Oxford: Blackwell Munksgaard 2003;781-805.
14. Tonetti MS, Pini-Prato G, Cortellini P. Effect of cigarette smoking on periodontal healing following GTR in infrabony defects. A preliminary retrospective study. J Clin Periodontol 1995;22:229-234.
15. Tonetti MS. Cigarette smoking and periodontal diseases: etiology and management of disease. Ann Periodontol 1998; 3:88-101.
16. Tonetti MS, Steffen P, Müller-Campanile V, Suvan J, Lang NP. Initial extractions and tooth loss during supportive care in a periodontal population seeking comprehensive care. J Clin Periodontol 2000;27:824-831.