

Tooth Loss Assessment during Periodontal Maintenance in Erratic versus Complete Compliance in a Periodontal Private Practice in Shiraz, Iran: A 10-Year Retrospective Study

Amir Haji Mohammad Taghi Seirafi¹, Reyhaneh Ebrahimi²,
Ali Golkari³, Hengameh Khosropanah² and Ahmad Soolari⁴

¹Dental Student, School of Dental Medicine; ²Department of Community Dentistry; ³Department of Periodontology, School of Dental Medicine, Shiraz, Iran; ⁴Private Practice, Silver Spring, Maryland, United States

Abstract

Background: Several studies have demonstrated the efficacy of periodontal maintenance (PM), but there are conflicting data regarding tooth loss following patient compliance.

Method: Seventy-two periodontal patients (52 women, 20 men), 86% of whom had been diagnosed with chronic moderate to severe periodontitis, were included in this retrospective study. Clinical variables such as tooth loss, bleeding on probing (BOP), plaque index and probing depth were collected from patients after 10 years of PM. The periodontal status of regular compliers (RCs) and erratic compliers (ECs) were compared in a private practice.

Results: The statistical analysis showed that clinical variables were not significant between RCs and ECs except for BOP ($p = 0.038$). During PM, 24 teeth (a mean of 1.5 teeth per participant) were lost in the RC group, and 80 teeth (a mean of 1.43 teeth per participant) were lost in the EC group. Molars were the most frequently lost teeth and canines the least. In general, those patients with less BOP lost fewer teeth ($p = 0.002$) and attended more recall visits ($p = 0.001$).

Conclusions: In the present sample, RCs and ECs did not show significant differences in rates of tooth loss. However, a significant difference between RCs and ECs in regard to BOP was observed at the final examination ($p = 0.038$). There was also a strong relationship between BOP and recall visits: the patients with less BOP attended more recall visits ($p = 0.001$).

Key words: Maintenance, compliance, periodontitis, tooth loss

Introduction

Supportive periodontal treatment is the phase of periodontal therapy during which periodontal disease and conditions are monitored and etiological factors are reduced or eliminated. Periodontal maintenance (PM) is known to have a significant impact on periodontal prognosis and eventual tooth survival (American Academy of Periodontology, 2003).

The efficacy of PM and patient compliance has been evaluated by several retrospective and prospective cohort studies, and those studies demonstrated

that periodontal patients who comply with regular PM have less attachment loss and lose fewer teeth compared to patients who fail to receive PM following active periodontal therapy (Hirschfeld and Wasserman, 1978; McFall, 1982; Costa *et al.*, 2011, 2012).

In some studies, different reasons were given by noncompliant patients for abandoning PM. Stressful life events were reported to decrease compliance (Becker *et al.*, 1988). Mendoza *et al.* (1991) have shown that regular visits to general dentists, cost, and lack of a perceived need for periodontal treatment were the main stated reasons for noncompliance. Wilson *et al.* (1993) suggested several ways to improve compliance, such as setting early appointments, providing reminders, and informing patients about PM.

Correspondence to: Dr. Ahmad Soolari, 11616 Toulone Dr. Potomac, MD, USA 20854. Telephone: +1 301-384-5407. Fax: +1 240-845-1087. E-mail: asoolari@gmail.com

Many studies have reported low rates of regular compliance and adherence to PM (Hirschfeld and Wasserman, 1978; Nabers *et al.*, 1989; Wilson *et al.*, 1993; Soolari and Rokn, 2003), but some longitudinal studies have provided more encouraging information concerning compliance with maintenance appointments for periods ranging up to 34 years post-treatment (Becker *et al.*, 1984; Lindhe and Nyman, 1984; Goldman *et al.*, 1986). Wilson *et al.* (1984) reported on 961 treated patients who were provided the opportunity to receive maintenance care over an 8-year period in a private practice. Only 16% of the patients complied with the suggested maintenance intervals, 34% never returned for recall appointments, and the remainder were erratic in complying. The authors also pointed out that, in some clinical trials involving periodontal surgery, the proportion of non-compliers ranged from 11% to 45%. In another study, Soolari and Rokn (2003) evaluated the degree of compliance of 519 patients who had completed active periodontal treatment up to 7 years. They reported an overall rate of complete compliance of 3.3%. Female patients complied better than male patients, and patients who had received surgery complied better with PM than patients who had received only scaling and root planing. In a prospective study conducted by Lorentz *et al.* (2009) in Brazil, a total of 250 individuals diagnosed with chronic moderate to advanced periodontitis and who had finished active periodontal treatment were incorporated into a PM therapy program. During the 12-month monitoring period, which featured quarterly recalls, 150 patients were classified as regular compliers (RCs; 60%) and 62 were non-compliers (24.8%). Among the 150 RCs, only 20 subjects (13.3%) showed periodontal progression.

With regard to tooth loss, several studies support the benefit of PM in terms of tooth survival, prevention of periodontal disease recurrence, and prevention of periodontal disease progression in treated patients (Wilson *et al.*, 1987, 1993; Soolari, 2002; Costa *et al.*, 2012). In general, the majority of patients who are compliant with PM will keep their teeth over a longer period of time. In a study conducted by Wilson *et al.* (1987), tooth loss in erratic compliers (ECs) and in complete compliers over a 5-year period after active periodontal treatment was compared. Their results showed that the ECs lost an average of 0.06 teeth per patient per year and the complete compliers lost 0 teeth. Checchi *et al.* (2002) reported the efficacy of periodontal therapy and PM in preventing tooth loss in 92 patients over a period of 7 years. The results demonstrated that irregular compliers were at a 5.6 times greater risk of tooth loss than regularly compliant patients.

Chambrone *et al.* (2010) assessed the factors influencing tooth loss during long-term PM among 13 retrospective studies. They reported that age, smoking, and initial prognosis were found to be associated with tooth loss during PM. In a 3-year follow-up study in

Brazil (Costa *et al.*, 2012), it was shown that RCs presented a lower progression of periodontitis and tooth loss compared to patients who complied only irregularly. Moreover, important risk variables such as smoking and diabetes influenced periodontal status. However, studies conducted by other groups have suggested that tooth survival in noncompliant patients is not significantly different from that in patients with complete compliance after active treatment is performed (McGuire and Nunn, 1996; Konig *et al.*, 2001), although it should be remembered that the definitions of noncompliance and compliance used by various studies may differ.

Konig *et al.* (2001) conducted a 10-year retrospective study to determine whether compliant and noncompliant patients with moderate to severe periodontitis had comparable periodontal conditions during supportive periodontal therapy. The results indicated that both groups had similar periodontal conditions at the outset, but noncompliant patients responded less favorably to maintenance. McGuire and Nunn (1996) evaluated the survival rate of periodontally compromised dentitions and investigated the relationship between commonly measured clinical parameters and actual tooth survival. The results indicated that compliance did not significantly affect tooth survival. Therefore, it is still questionable whether a tooth in a completely compliant patient has an improved survival when compared to a tooth in an EC. Meanwhile, populations with varying periodontal status with PM have been reported in the literature, and there are conflicting data regarding tooth loss following patient compliance. Hence, the purpose of the present study was to determine and compare the periodontal status, especially tooth loss, between RCs and ECs under PM after a 10-year monitoring period in a periodontal private practice in an Iranian population.

Materials and methods

Study population

A list of 295 patients in a cohort study from patient records of a periodontal private practice who were surgically treated between March 2002 and March 2003 (Shiraz, Iran) was compiled. All the participants had provided written informed consent, and the study was approved by the research committee of Shiraz Dental School.

The study inclusion criteria were as follows: 1) diagnosis with moderate or moderate to severe chronic periodontitis (Armitage, 1999); 2) good general health; 3) presence of ≥ 14 teeth. Subjects were excluded from the study if they: 1) were pregnant; 2) showed debilitating disease; 3) presented with drug-induced gingival hyperplasia; 4) had uncontrolled diabetes; 5) presented with aggressive periodontitis; 6) had used systemic antibiotics within the previous 4 months; 7) received regenerative procedures during treatment.

Clinical examination

All patients remained in a PM program at 3- or 6-month intervals. All clinical measurements were evaluated at baseline and final examination in a new chart. All examinations were performed with a manual periodontal probe (Hu-Friedy, Chicago, IL). Pocket depths (PDs) were measured at four sites per tooth (three facial sites and one lingual site). All PDs that were ≥ 5 mm were recorded and considered as critical.

At the final maintenance visit, a periodontal examination was performed. Data regarding tooth loss, plaque index (PI; Silness and Loe, 1964), pocket depth (PD) and bleeding on probing (BOP) via the gingival bleeding index of Ainamo and Bay (1975) were recorded on a new chart so that the examiner (M. Seirafi) was blinded as to which group each patient fell into (RC or EC) to prevent bias in measurements. Tooth loss was determined from chartings done at the initial and final examinations. Because some of the patients (three patients) did not know the cause of tooth loss, such teeth were counted as lost due to periodontal causes (McFall, 1982).

Treatment

All patients were initially treated with full-mouth scaling and root planing by one periodontist (M. Seirafi) with an ultrasonic device (Cavitron) and hand instruments (curettes, Hu-Friedy); these procedures were repeated if necessary during the maintenance period (American Academy of Periodontology, 2000).

To achieve optimal plaque control, patients also received oral hygiene instructions. Tooth brushing (Bass method) was demonstrated in the patient's mouth while he or she observed with a hand mirror; then the demonstration was repeated with dental floss and other interdental cleaners according to patient need. All the patients had undergone mucoperiosteal flap surgery, with or without osseous procedures (osteoplasty, ostectomy) and occlusal adjustment as appropriate. All the patients after active periodontal treatment had continued in a maintenance program. All the participants were classified into one of two groups (Miyamoto *et al.*, 2006). Regular compliers attended at least 70% of the expected visits, and ECs failed to attend more than 30% of expected visits. In other words, ECs attended no more than 6 appointments during the 10-year recall period, and RCs attended at least 14 appointments; any patients who attended between 7 and 13 appointments were excluded from analyses.

Statistical analyses

Statistical analyses were conducted using a statistical software package (SPSS version 20, SPSS Inc, Chicago, IL). Differences between clinical parameters of RCs and ECs, such as number of teeth at initial and 10-year visit, BOP, PD ≥ 5 mm, and PI, were evaluated using

the Mann-Whitney *U* test and the Spearman correlation when appropriate. Initial evaluation of the categorical changes in these clinical parameters over time was conducted using the chi-square test of independence. Post-power calculations of our study were performed between clinical parameters. Power was calculated at $\geq 87\%$ (NCSS-PASS 2004). This value was considered acceptable. Results were considered significant if a *p* value $< 5\%$ was attained.

Outcome variables

The main purpose of the study was to compare tooth loss between RCs and ECs after 10 years; therefore, the primary outcome was changes in tooth loss between the two groups after PM. Secondary outcomes included differences between groups for changes in PD, PI, and BOP, as well as the frequency of recall visits.

Results

Seventy-two patients (52 women, 20 men) were identified who met all the criteria for participation. The patients' ages ranged from 30 to 78 years (mean age 51.30 ± 10.24 years). The characteristics of the sample by patient age and frequency at the final examination are presented in *Table 1*. During the 10-year maintenance program, 21 patients (29.16%) were classified as RCs and 51 patients (70.84%) were characterized as ECs (*Table 2*).

Table 1. Distribution of patients by age at final exam

Patient age (y)	No. of patients	% of patients
30 – 35	5	6.94
36 – 41	7	9.72
42 – 47	11	15.27
48 – 53	21	29.16
54 – 59	12	16.66
60 – 65	10	13.88
66 – 71	5	6.94
≥ 72	1	1.38

Table 2. Comparison of numbers of patients and teeth lost between regular compliers (RCs) and erratic compliers (ECs) and by sex

Group	Sex	No. of patients (%)	Teeth lost (%)
RC	Female	17 (23.61)	18 (17.30)
RC	Male	4 (5.55)	6 (5.77)
EC	Female	35 (48.61)	49 (47.12)
EC	Male	16 (22.22)	31 (29.81)

With regard to tooth loss, 24 teeth (23.07%) were lost by RCs, compared to 80 teeth (76.93%) lost by ECs. No significant difference in tooth loss was observed between the two groups. *Table 3* shows the distribution of tooth loss with respect to tooth type in both arches. Sixty-four teeth in the maxilla and 40 teeth in the mandible were lost over the 10-year period. Molars were lost most often and canines the least often. None of the lost teeth was extracted before PM, but during PM three patients lost five teeth to unknown causes. Two of them were in the EC group (2 teeth lost by each patient) and one patient belonged to the RC group (lost one tooth).

The periodontal variables of the patients are presented in *Table 4*. The mean recall visit interval for the RC group was 6.31 months and for the EC group it

was 3.16 years. The mean number of recall appointments attended was 3.70 ± 1.55 (range 2 - 6) for the EC group and 18 ± 3.52 (range, 14 - 26) for the RC group. Summary statistics were calculated for clinical parameters in both groups, such as number of teeth at initial and reevaluation visits, recall frequency, BOP, PI, and percentage of sites with $PD \geq 5$ mm. There were no statistically significant differences between RCs and ECs with respect to gender, number of teeth at initial and final examinations, PI, or number of sites with $PD \geq 5$ mm. However, a significant difference between RCs and ECs in regard to BOP was observed at the final examination ($p = 0.038$). There was also a strong relationship between BOP and recall visits: the patients with less BOP attended more recall visits ($p = 0.001$).

Table 3. Number and types of teeth lost in both arches

Maxilla	7	5	5	1	3	4	4	2	1	0	4	10	10	8
Tooth no.	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Tooth no.	31	30	29	28	27	26	25	24	23	22	21	20	19	18
Mandible	7	5	4	0	0	2	2	2	3	1	0	6	4	4

Table 4. Periodontal clinical variables of regularly compliant (RC) and erratically compliant (EC) patients at the final examination

Variable	Regular compliers		Erratic compliers		p value
	Mean \pm SD	Range	Mean \pm SD	Range	
Age	53.69 \pm 11.80	44 - 78	50.63 \pm 9.77	30 - 79	NS
PD \geq 5 mm (%)	2.31 \pm 4.90	0 - 19	2.09 \pm 3.55	0 - 16	NS
No. of teeth at initial exam	25.63 \pm 3.46	15 - 28	26.27 \pm 2.14	19 - 28	NS
No. of teeth at final exam	24.13 \pm 4.59	10 - 28	24.84 \pm 3.93	8 - 28	NS
PI	1.11 \pm 0.48	0.37 - 2.17	1.23 \pm 0.35	0.45 - 2.62	NS
BOP (%)	24.14 \pm 21.63	0 - 90	28.64 \pm 13.94	4 - 87.50	0.038*
Tooth loss	1.50 \pm 1.71	0 - 5	1.43 \pm 2.34	0 - 14	NS
No. of recalls	18.69 \pm 3.52	14 - 26	3.70 \pm 1.55	2 - 6	< 0.001*

NS, not significant; *significant; BOP, bleeding on probing; PD, pocket depth; PI, plaque index; SD, standard deviation

Table 5. Spearman correlation (Spearman's rho) between bleeding on probing (BOP%) and tooth loss, and BOP% and number of recall visits

		Correlations			
			Recall visits	BOP%	Tooth loss
Spearman's rho	Recall visits	Correlation coefficient	1.000	-0.377	-0.067
		p value (2-tailed)	-	0.001	0.574
	BOP%	Correlation coefficient	-0.377	1.000	0.358
		p value (2-tailed)	0.001	-	0.002
	Tooth loss	Correlation coefficient	-0.067	0.358	1.000
		p value (2-tailed)	0.574	0.002	-

N = 72

Moreover, a greater likelihood for older patients to comply with suggested maintenance was also seen, although this difference was not statistically significant (*Table 4*). Spearman analysis (Spearman rho) showed significant correlations between BOP and tooth loss and between BOP and number of recall visits (*Table 5*).

Discussion

The present retrospective study was done with two objectives in mind: (1) to assess tooth loss between RCs and ECs over a 10-year period; and (2) to determine the periodontal status of the patients after PM.

In this study, none of the periodontal clinical variables, especially tooth loss, were statistically significantly different between RCs and ECs except for BOP. This result is not in agreement with most studies regarding PM (Mendoza *et al.*, 1991; Wilson *et al.*, 1993; Lorentz *et al.*, 2009; Costa *et al.*, 2011, 2012), although, as mentioned earlier, the definitions of noncompliance with PM may have differed among studies. With regard to tooth loss, some other studies have shown an indirect ratio between compliance and the number of teeth lost (Chace and Low, 1993). However, data from our study and some other studies suggest that no clear association exists between erratic compliance with PM and a decreased incidence of tooth loss when completely noncompliant patients are excluded from analyses (Miyamoto *et al.*, 2006; Carnavale *et al.*, 2007; Chambrone and Chambrone, 2006). McGuire and Nunn (1996) reported that compliance did not significantly affect tooth survival. Chambrone and Chambrone (2006) confirmed that the duration of PM and frequency of recall visits was not associated with periodontal tooth loss. Miyamoto *et al.* (2006) evaluated the relationship between patient compliance and tooth loss. The results showed that completely compliant patients were more likely to experience tooth loss than patients with erratic compliance. However, they also suggested that dentists' decisions to extract teeth at PM visits may have resulted in greater tooth loss in the compliant patients.

In another study, Miyamoto *et al.* (2010) stated that tooth loss is occasionally referred to as the "true endpoint characteristic" in dental studies and as the landmark of tangible patient benefit. However, when the accumulating evidence of dental implant treatment or periodontal disease systemic health interactions influences the recommendation to extract a tooth, the validity of those endpoint characteristics becomes questionable.

Data from the present study showed that the mean tooth loss rates (MTLR) in RCs and ECs were 0.15 and 0.14, respectively. Meanwhile, several other studies reported different rates of tooth loss in periodontal patients during PM: 0.01 (Axelsson *et al.*, 1991), 0.13 (McGuire, 1991), 0.16 (Goldman *et al.*, 1986), 0.24 (Becker *et al.*, 1984), and 0.28 (Checchi *et al.*, 2002).

Matulienė *et al.* (2010) reported loss rates of 0.13 and 0.30 for RCs and ECs, respectively. One reason for the variations in these numbers may be the distribution of disease severity within each study population. The MTLR in this study is similar to that seen in other studies (Goldman *et al.*, 1986; McGuire, 1991; Matulienė *et al.*, 2010). No similar studies of Iranian patients have been conducted, so no data are available for comparison in the Iranian population.

The relationship between compliance and common clinical variables such as BOP, PI and PD was another point of discussion in this study. There is a general consensus that complete compliance results in better oral hygiene, as measured by these parameters. Lang *et al.* (1990) showed that the absence of BOP in PM is considered a good predictor of periodontal stability. Joss *et al.* (1994) revealed that a frequency of 25% of sites with BOP may be considered a limit among patients with progression of periodontitis. In this study, BOP was significantly different between the RC and EC groups. In other words, the patients with more recall visits had less BOP. This finding is in agreement with those of previous studies (Lang *et al.*, 1990; Joss *et al.*, 1994; Miyamoto *et al.*, 2006; Lorentz *et al.*, 2009; Costa *et al.*, 2011, 2012).

In this study, a mean PI of 1.11 was seen in RCs, while in ECs the mean PI was 1.23, but this difference was not statistically significant. It is important to state that efforts in oral hygiene motivation during PM have proven to be relatively ineffective (Mendoza *et al.*, 1991; Faggion *et al.*, 2007).

Another parameter evaluated in this study was PD. At the final clinical examination in 72 patients, the number of critical sites (i.e., PD \geq 5 mm) in RCs and ECs was not significantly different. However, if we had chosen to define the progression of periodontitis based on this parameter, we believe that changes in PD that occurred between the intervals of recall visits might not necessarily represent the actual loss of periodontal insertion, especially because PD is more susceptible to measurement error or because it simply reflects changes in periodontal marginal inflammatory tissues (Costa *et al.*, 2007). Therefore, it has been suggested that clinical attachment level (CAL) should be used as the gold standard for periodontal diagnosis in future studies, although many studies of larger groups have not used this measurement for the sake of preserving simplicity and to limit expenses (McGuire and Nunn, 1996; Konig *et al.*, 2001; Chambrone and Chambrone, 2006). Another subject of this study is different degrees of compliance with PM. Among the 295 patients originally treated, 78 (26%) never returned, about half were ECs, and only 23% were RCs. These data are in agreement with those of Wilson *et al.* (1984, 1993) and other researchers (Mendoza *et al.*, 1991; Lorentz *et al.*, 2009).

Most studies that have analyzed historic data have limitations inherent to their retrospective nature, because the treatment procedures provided were based on clinical judgment, the patient's desires, prosthetic expediency and financial considerations, rather than being allocated randomly, as would be done in a randomized controlled clinical trial (Miyamoto *et al.*, 2010). In addition, the lack of a parallel control group and standardization may have affected the statistical analyses and results (Chambrone and Chambrone, 2006; Lorentz *et al.*, 2009). Hence, it should be emphasized that, although the majority of the studies on PM feature a retrospective design, long-term prospective studies, although expensive and logistically difficult, tend to produce more reliable results.

One limitation of the present study is the inclusion of several clinical variables in a small patient sample. Thus, the statistical power of this study is reduced. In this sense, additional studies in large patient populations are needed to validate these findings.

Conclusions

A long-term retrospective study of the relationship between patient compliance and clinical parameters such as tooth loss, BOP, PI, and PD was performed. Based on the results, regular compliance and erratic compliance with PM did not produce significantly different effects with respect to tooth loss. However, a significant difference between RCs and ECs in regard to BOP was observed at the final examination ($p = 0.038$). There was also a strong relationship between BOP and recall visits: the patients with less BOP attended more recall visits ($p = 0.001$).

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