

# Tooth Loss in Patients under Periodontal Maintenance in a Private Practice: A Retrospective Study

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The aim of the present study was to evaluate the incidence and causes of tooth loss in periodontal subjects from a private practice in Brazil. Two trained examiners extracted data from the records of subjects who sought periodontal treatment from 1980 to 2013. Only records of patients who completed the non-surgical periodontal treatment and had at least one visit for maintenance were included. Data were analyzed by chi-square test, Student's t-test, Kaplan-Meier survival curve and Cox regression. A total of 3,319 records were reviewed and 737 records included (58.6% women, mean age of 46.6±13.0 years at the beginning of the treatment). Maintenance period ranged from 1 to 33 years (7.4±6 years). During this period, 202 individuals (27.4%) lost 360 teeth, 47.5% of losses within the first five years (n=171). Non-compliers lost more teeth than compliers (p<0.001), respectively 211 and 149 teeth. Regarding reasons of tooth loss, 84 individuals lost 38% of the teeth from periodontal disease progression (n=137). Survival analysis showed that most patients lost only one tooth from periodontal disease, and differences in the survival rates between compliers and non-compliers were observed following the second tooth loss. Approximately one-third of tooth losses was related to periodontal disease progression, and there was stability in time of the proportion of losses from disease progression and other reasons. Therefore, it is possible to conclude that compliant patients in a private practice lose fewer teeth than do non-compliers. Among compliers, periodontal disease progression was not the main cause of tooth loss.

Key Words: periodontal  
diseases, tooth loss, dental  
scaling, long-term care.

## Introduction

Infectious and inflammatory periodontal diseases are subdivided as gingivitis when limited to protective tissues and as periodontitis when the supporting tissues of the tooth are affected. Although both inflammatory processes are reversible, periodontitis clearly expresses an imbalance between bacterial aggression and host response, leaving the patient at constant risk (1). This is a direct consequence of the chronic nature of these diseases. In this sense, it is possible to observe the importance of a longitudinal follow-up of the treated patients so that any imbalances in the pathophysiological axis can immediately be diagnosed, seeking to maintain the results after active therapy (2).

Periodic Preventive Maintenance (PPM) is a procedure based on regular established visits following the active periodontal treatment, well known as an essential strategy to preserve periodontal health for treated and rehabilitated patients and as a preventive strategy for healthy patients (2). Since the 30-year study by Axelsson et al. (3), it is well established that the incidence of caries and periodontal disease, as well as tooth mortality, is very small in patients under PPM. Chambrone Et Chambrone (4) observed low rates of tooth loss during the maintenance

phase of periodontal therapy, and an incidence of 0.92 teeth extracted per year and per patient. Also, studies have demonstrated that the compliant patients regularly attending maintenance consultations have a lower rate of tooth loss than do non-compliant patients (5).

A systematic review reported that data regarding factors of influence on tooth loss during PPM is still heterogeneous, not allowing definitive conclusions. Some factors such as age, smoking and initial tooth prognosis were found to be associated with tooth loss (2). Despite this heterogeneity, overall, patients must always be instructed to attend periodic periodontal maintenance appointments. Most of those studies are, however, performed in an academic environment and few studies with large sample sizes are available.

Therefore, the aim of this retrospective study was to evaluate the incidence and causes of tooth loss in patients treated by non-surgical periodontal therapy and maintained in a program of periodontal maintenance in a Brazilian private practice clinic. The hypothesis was that patients under PPM lose fewer teeth and that periodontal disease progression is not responsible for the majority of tooth losses.

## Material and Methods

An analysis was performed by a census conducted on file records of a private clinic in Porto Alegre, southern Brazil, composed of 3 periodontists (RVO, CKR, SCG). The file records were initially coded with numbers by the legal responsible (CKR) not involved with the present study. Two trained examiners extracted data from the records for all patients treated between the years of 1980 and 2013 (AFS and MM). The Ethics Committee of the Federal University of Rio Grande do Sul approved the study protocol (n. 21648).

All records from private practice in which a non-surgical therapy is the main treatment performed, i.e. when the surgical therapy is not the first choice for periodontal disease treatment, were eligible. From those, the ones from patients with diagnosis of gingivitis and chronic or aggressive periodontitis (6) that completed the non-surgical periodontal treatment and made at least one visit for PPM were included. Three experienced periodontists (RVO, CKR and SCG) treated all patients with hand instruments (curettes and files) and without use of any adjunctive medication, except for the use of pain control when necessary. After treatment, subjects were included in the PPM, which consisted in full-mouth clinical examination, supragingival scaling and polishing and subgingival debridement (using Gracey curettes and periodontal files, rubber cups and abrasive paste). Oral hygiene instructions and additional interventions (restorations, prosthetic rehabilitation, extractions etc.) were provided according to individual needs.

Data regarding age, gender, systemic condition, smoking status, regularity in time interval between appointments (compliers and non-compliers), periodontal diagnosis, years and number of maintenance visits, tooth loss during treatment and reasons for underlying tooth loss during maintenance were collected. Reasons of tooth loss were categorized as (1) immediate prognosis (tooth was considered lost during treatment, but it was kept in mouth while rehabilitation procedures were being provided, or by patient's option); (2) periodontal disease progression (increase in clinical attachment loss up to the moment it was not possible to maintain tooth in function); (3) non-treatable endodontic pathological processes; (4) fracture; (5) endo-periodontal lesions; (6) prosthetic/rehabilitation needs or (7) others.

Systemic condition was assessed for diabetes, cardio-diseases (e.g., hypertension, myocardial infarction, stroke) and other conditions (e.g., arthritis, hyper- or hypothyroidism, obesity). Patients' self-reported smoking status was categorized as smokers, non-smokers and former smokers. The definition of compliers and non-compliers was according to Costa et al., 2012, compliers being considered those showing 100% cooperation with the recall visits

interval suggested by the periodontist. Non-compliers were considered those that lost any regular visit but continued, irregularly, with their PMP appointments (7).

Statistical data analysis included a description of the sample assessed by chi-square test and Student's t-test when appropriate. Differences between patients with or without tooth loss during the PPM phase and between those who lost 1, 2 or more teeth were calculated with a chi-square analysis for the entire sample (n=737 subjects). Among lost teeth, reasons for extractions were calculated with a chi-square analysis (n=202 teeth).

A Kaplan-Meier survival analysis was performed at patient level (n=737) and at tooth level (i.e., for those patients for whom data regarding number of present teeth at baseline was available; n=328) to show the survival curves of tooth loss over time, related to factors that might have affected it. For this analysis, tooth loss was considered the outcome variable. Time of follow-up was the explanatory variable, and compliers/non-compliers subjects, molar/non-molar teeth, tooth loss for periodontal disease progression/other reasons were the comparison groups. The survival distribution was then compared with the test statistics for equality of survival distribution with the log-rank test.

To determine the predictors of tooth loss during PPM, the Cox regression model was used. Gender (male/female), age (continuous variable), compliance (yes/no), smoking status (smoker/non-smoker/former smoker), systemic condition (healthy/diseased), tooth loss during treatment (yes/no) and appointments per year (1/2/more) were the variables included in the univariate analysis. Variables with  $p < 0.25$  values were included in the multivariate analysis. SPSS 20.0 (IBM SPSS Statistics for Mac, IBM Corp., Armonk, NY) was used for all analyses. Significance level was set as 5%.

## Results

Thirty-three hundred nineteen records were reviewed. Those belonging to individuals that did not complete the periodontal treatment or did not return to at least one PPM appointment (n=849), received just implants or esthetic surgeries (n=203), were submitted only to an initial exam (n=1,422) or received non-periodontal treatments (n=108) were not included (n=2,582). Seven hundred thirty seven records were included in the study. The sample consisted in records of 432 women (58.6%) and had a mean age of  $46.6 \pm 13.0$  at the beginning of the treatment. All included subjects had only non-surgical periodontal treatment. During the periodontal treatment, 183 individuals (24.9%) lost 278 teeth, loss rate being 1.52 teeth per subject.

PPM ranged from 1 to 33 years, averaging  $7.4 \pm 6.0$  years of maintenance. Half of the sample (375 patients, 50.9%) attended a periodontal maintenance routine for more than

five years. Thirty-eight of these patients (5%) had more than 20 years of maintenance. During the PPM period, 202 individuals (27.4%) had tooth loss. Three hundred sixty teeth were lost (1.78 teeth per subject), 171 of these teeth (47.5%) lost within the first five years. Among individuals who lost teeth during the PPM phase, 111 patients (55%) had a time interval between maintenance visits greater than the one set by the dentist and were responsible for 59% of the total teeth loss (211 teeth).

During PPM, there was no significant difference between tooth-loss and no-tooth-loss groups in relation to gender ( $p=0.676$ ) or systemic condition ( $p=0.454$ ). Patients who had a regular appointment for PPM (compliers) lost fewer teeth compared to non-compliers ( $p<0.001$ ). Also, there was a significant difference between smoking status ( $p=0.024$ ), age group ( $p=0.003$ ), years of PPM ( $p<0.001$ ) and number of PPM visits per year ( $p=0.006$ ; Table 1).

In relation to the reasons underlying tooth loss, 84 individuals (11.4%) lost 137 teeth (38%) because of periodontal disease progression and 64 out of the 137 teeth (46.7%) were lost within the first 5 years of PPM. There was stability in the proportion of tooth loss due to periodontal disease and to other reasons over time. Tooth lost by periodontal disease varied from 28.6% to 44.7% when 5-year increments were considered. Table 2 shows the characteristics of teeth and population in relation to reasons for tooth loss (periodontal disease or others) during PPM. Other reasons underlying tooth loss were immediate prognosis ( $n=13$ , 4%), non-treatable endodontic pathological process ( $n=11$ , 3%), fracture ( $n=69$ , 19%), non-treatable endo-periodontal lesions ( $n=29$ , 8%), prosthetic/rehabilitation needs ( $n=61$ , 17%) and other reasons ( $n=40$ , 11%). When the number of tooth losses was categorized as 1 and 2 or more lost teeth, most individuals lost one tooth, with no significant difference according to gender, smoking status, systemic condition, age group or PPM visits per year. However, the difference was significant between compliers and non-compliers ( $p=0.022$ ).

Survival analysis at patient level (Fig. 1A) showed that most patients lost only one tooth from periodontal disease. The survival rate increased from the first tooth loss (long-term survival rates of 91.1% among compliers and 85.4% among non-compliers) to the second (survival rates of 97.8% and 94.1% respectively) and third tooth lost (survival rates of 99.3% and 96.9% respectively) associated with the progression of periodontitis. Additionally, there was a difference in log-rank test results between

compliers and non-compliers for the second ( $p=0.026$ ) and third ( $p=0.021$ ) loss due to periodontal disease, but not for the first tooth loss ( $p=0.133$ ).

For the survival analysis at tooth level (Figs. 1B and 1C), only data from 328 subjects ( $n=8,624$  teeth) were available. Concerning type of tooth, it was observed that non-molars had a higher survival rate compared to molar teeth (98.8% and 94.7% respectively,  $p<0.001$ ). Similarly, tooth in complying subjects had a higher survival rate compared to non-compliers (98.2% and 96.7% respectively,  $p<0.001$ ), when log-rank test was used. Considering reasons

Table 1. Characteristics of the sample - differences between patients with or without tooth loss during PPM<sup>b</sup>

| Subject - n(%)                  | No tooth loss | Tooth loss | Total     | p-value <sup>a</sup> |
|---------------------------------|---------------|------------|-----------|----------------------|
| Total                           | 535 (72.6)    | 202 (27.4) | 737 (100) |                      |
| Gender                          |               |            |           |                      |
| Male                            | 224 (73)      | 81 (27)    | 305 (100) | 0.663                |
| Female                          | 311 (72)      | 121 (28)   | 432 (100) |                      |
| Smoking Status                  |               |            |           |                      |
| Smoker                          | 54 (61.4)     | 34 (39)    | 88 (100)  | 0.024                |
| Non-smoker                      | 455 (74.6)    | 155 (25.4) | 610 (100) |                      |
| Former smoker                   | 26 (67)       | 13 (33)    | 39 (100)  |                      |
| Systemic Condition              |               |            |           |                      |
| Healthy                         | 441 (73.1)    | 162 (26.9) | 603 (100) | 0.454                |
| Diabetes                        | 17 (65.4)     | 9 (34.6)   | 26 (100)  |                      |
| Cardio-diseases                 | 38 (77.6)     | 11 (22.4)  | 49 (100)  |                      |
| Other                           | 66 (76.7)     | 20 (23.3)  | 59 (100)  |                      |
| Compliance                      |               |            |           |                      |
| Compliant                       | 323 (78)      | 91 (22)    | 414 (100) | <0.001               |
| Non-compliant                   | 212 (65.6)    | 111 (34.4) | 323 (100) |                      |
| Age (years)                     |               |            |           |                      |
| ≤ 47 years                      | 218 (79.6)    | 56 (20.4)  | 274 (100) | 0.003                |
| ≥ 48 years                      | 178 (66.7)    | 89 (33.3)  | 267 (100) |                      |
| Unknown                         | 139 (70.9)    | 57 (29.1)  | 196 (100) |                      |
| PPM <sup>b</sup> period (years) |               |            |           |                      |
| ≤5                              | 319 (88.1)    | 43 (11.9)  | 362(100)  | <0.001               |
| 5-10                            | 126 (67.4)    | 61 (32.6)  | 187(100)  |                      |
| >10                             | 90 (47.9)     | 98 (52.1)  | 188 (100) |                      |
| PPM <sup>b</sup> visits/year    |               |            |           |                      |
| ≤ 1                             | 335           | 105        | 440       | 0.006                |
| ≥ 2                             | 200           | 97         | 297       |                      |

<sup>a</sup>Chi-square test, <sup>b</sup>PPM: Periodic Preventive Maintenance.

for tooth loss (n=207 lost teeth; 2.4%), no significant differences were found comparing periodontal disease progression with other reasons (p=0.072).

The Cox regression model for multivariate analysis showed that smoking status (smoker/non-smoker/former smoker), compliance (yes/no) and number of appointments per year of maintenance (1 or 2 or more) were predictors for tooth loss during PPM (Table 3). Gender (male/female), age (continuous variable) and tooth loss during treatment (yes/no) were not statistically significant.

## Discussion

The objectives of the present study were to assess the incidence and causes of tooth loss in patients under a program of Periodic Preventive Maintenance (PPM) from a private practice clinic in Brazil. Periodontal disease was the cause of 38% of the tooth losses, and patients under regular PMT lost fewer teeth. This study extends previous knowledge since showing the existence of stability in the proportion of teeth lost to periodontal disease and for other reasons over time in patients followed for up to 33 years.

The results herein showed that the overall rates of

tooth loss were 0.5 per subject, 0.2 of which being due to periodontal causes. When considering only subjects who lost teeth during PPM (n=202), the rate was 1.8 and 0.7 respectively. Other studies have assessed tooth loss in private practice, showing rates of tooth loss from 0.1 to 3.3 per subject and from 0.4 to 1.8 when loss due to periodontal reasons was considered (4,8-11).

In the present study, some teeth were extracted during the active periodontal treatment phase. This is in accordance with other studies (12). After treatment, tooth loss due to periodontal disease progression accounted for 38% of the losses. This result differs from previous observations. A recent publication (13) found that 80% of tooth loss resulted from periodontal disease progression. In a long-term study, considering participants treated by a periodontist, but with regular maintenance appointments with hygienists or general practitioners, 73% of the tooth losses were due to periodontal disease (12). The lower rate observed herein is probably because all appointments were performed by periodontists, and patients were kept under a strict periodontal maintenance protocol (3).

The present findings suggest that patients who complied regularly with maintenance appointments

Table 2. Characteristics of teeth and population in relation to the reasons underlying tooth loss during periodic maintenance therapy

| Teeth - n(%)       | Periodontal disease | Other      | Total     | p-value <sup>a</sup> |
|--------------------|---------------------|------------|-----------|----------------------|
| Total              | 137 (38.1)          | 223 (61.9) | 360 (100) |                      |
| Type of teeth      |                     |            |           |                      |
| Single-rooted      | 29 (24.4)           | 90 (75.6)  | 119 (100) | <0.001               |
| Two-rooted         | 38 (33.9)           | 74 (66.1)  | 112 (100) |                      |
| Three-rooted       | 70 (54.3)           | 59 (45.7)  | 129 (100) |                      |
| Gender             |                     |            |           |                      |
| Female             | 93 (41.7)           | 130 (58.3) | 223 (100) | 0.069                |
| Male               | 44 (32.1)           | 93 (67.9)  | 137 (100) |                      |
| Smoking Status     |                     |            |           |                      |
| Smoker             | 32 (47.1)           | 36 (52.9)  | 68 (100)  | <0.001               |
| Non-smoker         | 88 (32.7)           | 181 (67.3) | 269 (100) |                      |
| Former-smoker      | 17 (73.9)           | 6 (26.1)   | 23 (100)  |                      |
| Systemic Condition |                     |            |           |                      |
| Healthy            | 101 (34.6)          | 191 (65.4) | 292 (100) | 0.010                |
| Diabetes           | 6 (46.2)            | 7 (53.8)   | 13 (100)  |                      |
| Cardio-diseases    | 14 (70)             | 6 (30)     | 20 (100)  |                      |
| Others             | 16 (45.7)           | 19 (54.3)  | 35 (100)  |                      |

<sup>a</sup> Chi-square test.

Table 3. Multivariable Cox regression analysis for predictors of tooth loss for periodontal disease during periodic maintenance therapy

| Parameter                   | $\beta$ coefficient | SE <sup>a</sup> | p-value | 95% CI <sup>b</sup> |
|-----------------------------|---------------------|-----------------|---------|---------------------|
| Gender                      |                     |                 |         |                     |
| Male (ref)                  |                     |                 |         |                     |
| Female                      | -0.25               | 0.27            | 0.364   | 0.46-1.33           |
| Age                         | 0.02                | 0.01            | 0.139   | 0.99-1.04           |
| Compliance                  |                     |                 |         |                     |
| Non-compliers (ref)         |                     |                 |         |                     |
| Compliers                   | -0.89               | 0.29            | 0.002   | 0.23-0.72           |
| Smoking                     |                     |                 |         |                     |
| Smoker (ref)                |                     |                 |         |                     |
| Non-smoker                  | -0.79               | 0.32            | 0.014   | 0.24-0.85           |
| Former smoker               | 0.24                | 0.44            | 0.582   | 0.54-3.03           |
| Tooth loss during treatment |                     |                 |         |                     |
| No (ref)                    |                     |                 |         |                     |
| Yes                         | -0.12               | 0.27            | 0.671   | 0.52-1.52           |
| Appointments per year       |                     |                 |         |                     |
| $\geq 2$ (ref)              |                     |                 |         |                     |
| $\leq 1$                    | 1.06                | 0.28            | <0.001  | 1.65-5.04           |

<sup>a</sup>SE: standard error; <sup>b</sup>CI: confidence interval.

lost significantly fewer teeth than did non-compliers. Interestingly, the survival analysis at patient level showed that there were significant differences between compliers and non-compliers in relation to the second and third tooth loss for periodontal disease, but not for the first loss, indicating that long-term PPM benefits participants. Fifty-six percent of all patients fully complied with the recommended appointments, a smaller percentage than the 76% to 80% rate reported by Muller et al. (14), and a higher one than those in reports from other authors: 30.2% (15) and 33% (16). In the present sample, 55% of the patients who lost teeth were non-compliant. Interestingly, a recent retrospective study with 10 years of follow up, but with only 72 patients, did not observe significant differences in rates of tooth loss between compliers and non-compliers (17). On the other hand, the results herein are in accordance with previous studies with larger samples. A recent study with 134 Korean adults showed that poor compliers were more likely to lose teeth (18). Similar results were presented by a recent 5-year prospective study with 212 Brazilian participants that demonstrated significantly lower tooth loss among compliant patients (13). Also in accordance with previous studies, it was observed that a small number of individuals accounted for most of the tooth loss (3-5).

The present results show similarities with previous studies regarding the type of teeth lost most frequently

(13,15). Thirty-three point two percent of the teeth lost in the present study were three-rooted, followed in frequency by single-rooted teeth (30.7%) and double-rooted teeth (28.9%). Recent literature has shown that loss of molar teeth is related to smoking status, lack of compliance and furcation involvement or baseline bone loss in patients treated for periodontitis and under supportive periodontal therapy (19,20).

A recent systematic review showed that the reported logistic regression models for studies assessing risk factors for tooth loss in patients who have received periodontal treatment are not optimal (21). The authors also suggest that survival analysis should be considered in future research. In the present study, both Kaplan-Meier survival curve and Cox regression analyses were performed. The survival analysis at patient level (Fig. 1A) shows the proportion of subjects who did not experience tooth loss at a given point in time. The survival rates remained above 84% when considering tooth loss resulting from periodontal disease progression. When the survival curve is performed at tooth level (Figs. 1B and 1C), the survival rates remained above 94%, independent of the type of the tooth (molars and non-molars) and the compliance of the patient. This result corroborates the findings from Moghaddam et al. (22). They showed that, even for compromised teeth that underwent combined endodontic, periodontal and prosthodontic

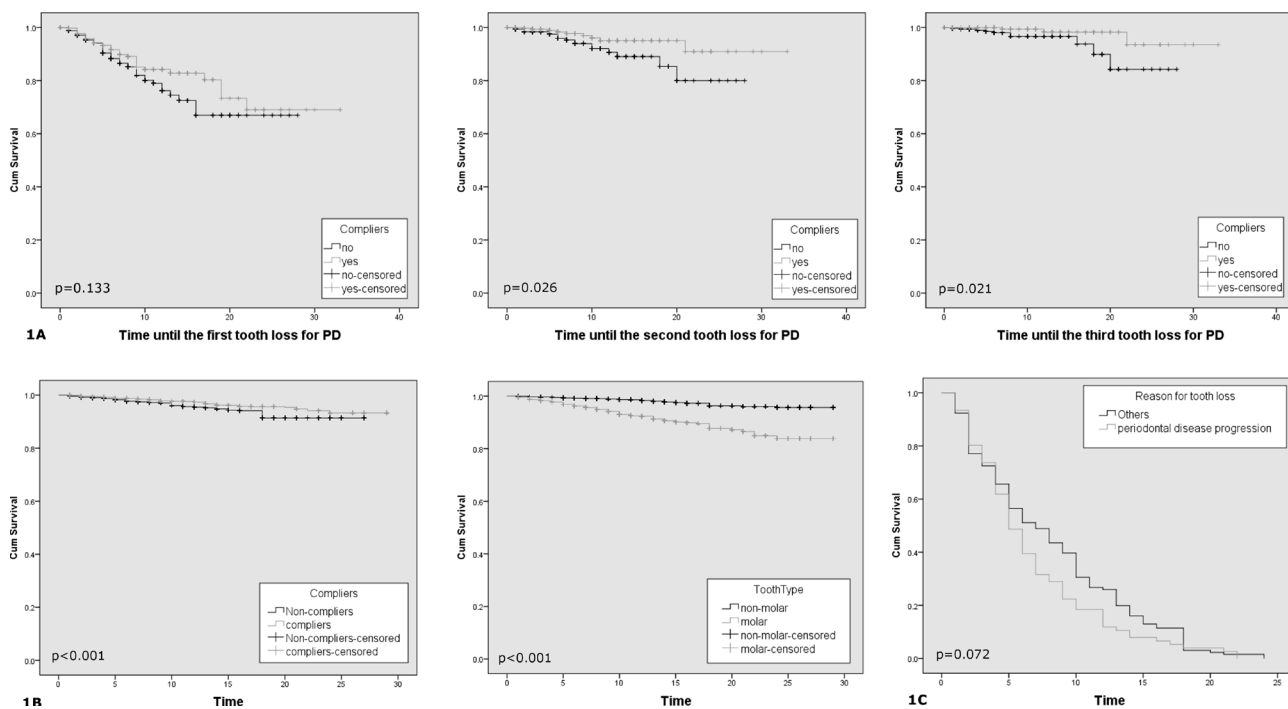


Figure 1. Cumulative survival analysis (in years) at patient level (n=737 subjects) for first, second and third tooth lost from periodontal disease (Fig. 1A) and at tooth level (n=328 subjects, n=8,624 teeth), comparing compliance and tooth type (Fig. 1B), and comparing reasons for tooth loss among lost teeth (n=207 teeth, Fig. 1C).

therapy, the survival rate was between 83% and 98%. The Cox regression analysis showed that non-complying subjects and subjects that attended 0-1 appointments per year during the maintenance phase were more likely to lose teeth. This result is in agreement with a classical review of literature combined with clinical observations (23) that showed that maintenance care for treated periodontitis patients should be performed every 3 months. Another important finding from the regression model is that non-smokers lost fewer teeth than smokers, and no significant differences were observed between smokers and former smokers. These results are in accordance with previous findings (2,13).

Among the strong points of this study are the large sample involved, the sampling method, the extent of the observation period and the survival analysis. However, this study also has limitations. There were some difficulties in retrieving full sets of data from clinical records. Not all patients had clear data regarding age, so the unknown data were recorded as a missing value. Additionally, almost half of the file records did not give precise information about the number of teeth each patient had before starting the treatment, allowing the survival analysis at tooth level possible for only 50% of the sample.

In conclusion, within the limitations of this study, data show that among patients who lost teeth, only approximately one-third of the tooth losses were related to periodontal disease progression. In addition, there is stability in the proportion of tooth loss from periodontal disease progression and for other reasons over time. Moreover, patients who followed regular PPM appointments in a private practice clinic in Brazil were significantly less likely to lose teeth. The clinical implications of the findings are to reinforce the need of professionals, both dentists and dental hygienists, to encourage patients to perform a routine protocol of maintenance visits, avoiding periodontal disease progression and consequent tooth loss.

## Resumo

O objetivo do presente estudo foi avaliar a incidência e causas de perda dentária em pacientes em manutenção periódica preventiva (MPP) de uma clínica privada. Dois examinadores extraíram os dados de registros de pacientes que procuraram tratamento periodontal entre 1980 a 2013. Os registros de pacientes que completaram o tratamento periodontal não cirúrgico e tiveram ao menos uma visita de MPP foram incluídos. Os dados foram avaliados utilizando os testes chi-quadrado, T de Student, curva de sobrevida de Kaplan-Meier e regressão de Cox. Dos 3.319 prontuários, 737 foram incluídos (58,6% mulheres, 46,6±13,0 anos). O período de MPP variou de 1 a 33 anos (7,4±6 anos). Durante este período, 202 indivíduos (27,4%) perderam 360 dentes, 47,5% das perdas durante os primeiros 5 anos de manutenção (n=171). Indivíduos irregulares nas consultas de MPP perderam mais dentes (p<0.001) do que indivíduos com regularidade, 211 e 149 dentes respectivamente. Oitenta e quatro indivíduos perderam 38% de dentes por progressão de doença periodontal (n=137). A maioria dos indivíduos perdeu 1 dente por doença periodontal, e foram observadas diferenças na sobrevida a partir da segunda perda dentária quando

comparados indivíduos regulares e irregulares na MPP. Aproximadamente um terço dos dentes perdidos estava relacionado à progressão de doença periodontal. Foi observada uma estabilidade na proporção de perdas por progressão de doença e outras razões ao longo do tempo. Desta forma, conclui-se que indivíduos com uma frequência regular de MPP perdem menos dentes e a progressão de doença nesses indivíduos não é a principal razão para perda dentária.

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