Original Article

Tooth Loss in Problem-oriented, Irregular, and Regular Attenders at Dental Offices

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Abstract

The aim of this retrospective study was to compare number of teeth lost among regular attenders (RAs), irregular attenders (IRAs), and problem-oriented attenders (POAs) at dental offices over a 10-yr observation period. Information on tooth loss was obtained from general practitioners. Patients were divided into 3 groups based on appointment adherence. A total of 1,886 teeth were lost in 1,400 patients. The mean number of teeth lost in men was 2.2 ± 2.6 per patient over 10 yr in POAs, 1.2 ± 1.7 in IRAs, and 1.5 ± 1.5 in RAs. This number was significantly lower in IRAs (p = 0.011) or RAs (p = 0.012) than in POAs. When the dependent variable was defined as “a patient with at least 2 or more extracted teeth”, the independent variables showed the following correlations with tooth loss: IRAs (OR: 0.54; 95%CI: 0.35–0.84), RAs (OR: 0.65; 95%CI: 0.47–0.89), man (OR: 1.43; 95%CI: 1.11–1.83), hypertension (OR: 1.38; 95%CI: 1.04–1.85), 20–25 present teeth (OR: 2.41; 95%CI: 1.81–3.22), and 1–19 present teeth (OR: 3.75; 95%CI: 2.73–5.16). The risk of tooth loss showed a 0.65-fold increase in RAs undergoing maintenance compared with POAs. Motivating patients to visit the dentist more regularly and undergo maintenance is important. The present results may be of use to dental professionals in providing patients with detailed information on potential tooth loss and associated risk factors with the aim of achieving such a change in behavior.

Key words: Maintenance — Regular attenders — Irregular attenders — Problem-oriented attenders — Tooth loss

Introduction

Long-term plaque control programs have been shown to exert a preventive effect on the development of dental caries and periodontal disease, thereby ultimately reducing tooth loss². This indicates the importance of regular visits to the dental clinic. The reality, however, is that such behavior is not as common as might be desired. In one study on patterns of such attendance, patients were classified as “regular attenders” (RAs)
or “problem-oriented attenders” (POAs)\(^7\). Another study noted that it was sometimes difficult for patients to continue with regular visits to their dentist\(^23\). Although attenders are often categorized as RAs or “irregular attenders” (IRAs)\(^10\), the criteria on which this distinction is based remain to be established\(^22\).

Many studies comparing tooth loss between RAs and IRAs or POAs have relied on questionnaires\(^1,9,16,17\). Astrom et al.\(^1\) reported that long-term RAs were 0.6 times less likely than non-RAs to have major tooth loss. Cunha-Cruz et al.\(^9\) also reported that the odds ratio (OR) of excessive tooth loss was 2.2 for POAs compared with RAs. However, these studies provided no detailed data on the mean number of teeth lost.

In another study relying on data from both dental examinations and self-reported questionnaires, Thomson et al.\(^29\) showed that RAs aged up to 32 yr had fewer teeth missing due to caries than non-RAs (OR: 0.56). In a cohort study of young adult New Zealanders, Thomson et al.\(^28\) reported that the incidence of tooth loss was 3.9% in RAs and 16.1% in non-RAs. They also found that POAs were 3 times more likely to experience caries-associated tooth loss over an 8-yr period than RAs. The participants in these studies were young adults.

Some studies using data obtained from dental offices to investigate attendance patterns among patients found no clear advantage for RAs over IRAs or POAs in number of present teeth (PT)\(^3,24,25\). Bullock et al.\(^5\) found no significant difference between RAs and POAs in mean number of PT. Richards and Ameen\(^24\) reported that RAs had fewer teeth than IRAs (p<0.05).

There is a great need to demonstrate the effectiveness of maintenance to patients. However, to the best of our knowledge, no studies to date have investigated long-term tooth loss among RAs, IRAs, and POAs at dental offices. The aim of the present study was to compare the number of teeth lost by RAs, IRAs, and POAs at dental offices over a 10-yr period.

Materials and Methods

1. Study design

This was a retrospective cohort study.

2. Participating dentists

Questionnaires were sent to 32 dentists who were members of a clinical research organization and all of whom were general practitioners. These dentists had all opened their offices before 2004 and had engaged in patient recall for maintenance. Two of the dental offices were located in the Tohoku region, 29 in the Kanto region, and 1 in the Tokai region of Japan. The mean period of time the dentists had been practicing since graduation from dental school was 26.2 yr (ranging from 13 to 48 yr) as of April 2014.

3. Participants

Participants in the study were first seen at the above clinics between January 2000 and December 2003, and then again between January and June 2014. All the patients visited the same dental clinic over a period of 10 yr, and treatment had been completed before December 2003. The status of periodontitis was not clearly recorded at the end of treatment. All the data collected pertained to dentate patients aged between 50 and 79 yr as of 1 January 2004, as the goal was to investigate tooth loss, which generally begins increasing at around the age of 50 yr\(^27\).

4. Data collected

The dentists were requested to provide information on the general condition and oral status of each patient together with their record of appointment adherence over the stipulated 10-yr observation period spanning 2004 to 2014. The observation period for tooth loss was from 1 January 2004 to 31 December 2013. Dentists were requested to provide the tooth type and reason for any teeth lost during this period. A total of 32 dentists provided data on a total of 1,400 patients. The mean number of patients per clinic was 43.8 (±39.7).
5. Definition of RAs, IRAs, and POAs

Maintenance was performed in all RAs and IRAs during the 10-yr period. All patients agreeing to visit dental offices to undergo maintenance at intervals of 6 months or shorter were classified as RAs, as long as they kept at least 70% of their appointments over the 10-yr period, in accordance with the method of Miyamoto et al. All patients with an appointment adherence rate of below 70% were classified as IRAs. All patients who did not agree to visit a clinic for maintenance regularly, instead going to a dentist only when they had a problem for which they independently realized treatment was required, were classified as POAs, according to the definition of Gilbert et al. with modification. This group was classified as such by the attending dentist, who had received an explanation about the definition being used in this investigation.

6. Method of counting lost teeth

Only permanent tooth loss was counted in this study. Donor teeth extracted for autotransplantation were excluded, as were third molars and extractions for orthodontic purposes. Cases of root resection were counted as one lost tooth. However, if additional roots of the same tooth were resected later during the 10-yr observation period, these were not counted as additional lost teeth. An example of this would be if the mesial root of the lower first molar had been extracted in 2006 and then the distal root of the same tooth was extracted in 2008.

7. Recall intervals

Maintenance intervals of 3 to 4 months are common in published studies. The intervals in this study were decided by the dentist in each patient based on the risk factors involved in each case and individual wishes. The distribution of recall intervals for the RAs in this study was as follows: 1–2 months, 24.4%; 3–4 months, 48.4%; and 6 months, 27.2%. The distribution of recall intervals for the IRAs was as follows: 1–2 months, 13.7%; 3–4 months, 36.0%; and 6 months, 50.3%.

8. Age groups

The patients in this study were divided into 3 age groups: 50–59 yr, 60–69 yr, and 70–79 yr.

9. Present teeth

Completely or partially erupted permanent teeth not extracted before 1 January 2004 were defined as PT. Treated teeth such as crowns, inlays and abutment teeth of bridge work were included in the PT count. However, implant-supported superstructures were not counted as PT.

10. Present teeth groups

The patients were divided into the following 3 PT groups: 1–19, 20–25, and 26–28. The justification for these cut-off points was as follows: third molars were excluded from this study; therefore, 28 was the maximum number of PT. The 8020 campaign, which has been in place in Japan since 1991, encourages the elderly to retain at least 20 teeth until the age of 80 yr. The WHO stated in 1992 that throughout life, the retention of a functional, aesthetic, natural dentition of 20 teeth, without prosthesis, should be the treatment goal for oral health. The mean number of occlusal pairs among molars changes from 2 or more pairs to less than 2 pairs at the cut-off point between 26 and 25 PT.

11. Maintenance procedure

Recall intervals were from 1 to 6 months, and each appointment lasted for 30 to 60 min, depending on the risk of periodontal disease or caries in each case, as well as the patient’s wishes. The maintenance protocol was not standardized among the participating dentists. The following basic procedures were performed, however: 1) examination for periodontal disease, caries, and prosthodontics; 2) subgingival and supragingival plaque and calculus removal using hand instruments and an ultrasonic scaler; and 3) mechanical tooth cleaning. If necessary, the following procedures were also performed: 4) X-ray examination; 5) tooth brushing instruction;
6) fluoride varnish; 7) examination of occlusion; and 8) adjustment of partial dentures.

12. General health condition and behavior
Baseline data regarding the general health condition and behavior of each patient, such as diabetes, hypertension, and smoking, were collected by questionnaire or inquiry.

13. Reasons for tooth extraction
The main reasons for extraction were categorized as follows: periodontal disease (where pain, loss of function, or pocketing due to periodontal disease required tooth extraction), caries (crown or root displayed advanced destruction), apical periodontitis (including failed root treatment), root fracture (complete or incomplete), and other (any reason not covered by the above, such as loss due to trauma).

14. Statistical analysis
The Steel-Dwass test was used to compare the mean number of teeth lost by POAs, RAs, and IRAs. The level of significance was set at 0.05. The chi-squared test was used to compare the percentage of patients in each group (or Fisher’s exact test in cases with fewer than 5 cells in the contingency table). These analyses were performed using Excel Statistics 2012, version 1.11 (the add-in).

The ORs and 95% confidence intervals (CIs) were determined using multiple logistic regression analyses (forced entry method).

The dependent variable was set at 2 or more teeth extracted during the observation period versus fewer than 2 teeth lost, as the mean number of teeth lost per patient was 1.3. Appointment adherence, sex, age group at baseline, diabetes at baseline, hypertension at baseline, smoking status at baseline, and number of PT at baseline were used as the independent variables. Spearman’s correlation coefficient was used to compare the relationships among independent variables. These analyses were performed using the computerized statistical package SPSS, version 23.0 (SPSS Japan, Inc.).

This study was approved by the Ethics Committee of Tokyo Dental College (Approval Number 504).

Results
Over the 10-yr period investigated, a total of 1,886 teeth were extracted in 1,400 patients. The distribution of the number of extracted teeth in POAs, RAs, and IRAs is shown in Table 1. The percentage of patients with at least one extracted tooth during the observation period was 67.2% in POAs, 54.9% in IRAs, and 60.3% in RAs in men (p = 0.176), and 53.2% in POAs, 48.1% in IRAs, and 54.1% in RAs in women (p = 0.534). The percentage of patients with at least 2 extracted teeth was 48.4% in POAs, 28.6% in IRAs, and 34.5% in RAs in men (p = 0.005), and 31.9% in POAs,

<table>
<thead>
<tr>
<th>Number of lost teeth</th>
<th>Men</th>
<th>Women</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>POAs</td>
<td>IRAs</td>
</tr>
<tr>
<td>0</td>
<td>40</td>
<td>41</td>
</tr>
<tr>
<td>1</td>
<td>23</td>
<td>24</td>
</tr>
<tr>
<td>2</td>
<td>15</td>
<td>10</td>
</tr>
<tr>
<td>3</td>
<td>17</td>
<td>6</td>
</tr>
<tr>
<td>4 to 12</td>
<td>27</td>
<td>10</td>
</tr>
<tr>
<td>Total</td>
<td>122</td>
<td>91</td>
</tr>
</tbody>
</table>

Table 1 Distribution of number of extracted teeth during 10-yr period by POAs, IRAs, and RAs
21.7% in IRAs, and 27.8% in RAs in women (p = 0.254).

The mean number of extracted teeth during the 10-yr period by sex is shown in Table 2. The mean number of teeth lost in men was 2.2 ± 2.6 per patient over 10 yr in POAs, 1.2 (± 1.7) in IRAs, and 1.5 (± 1.5) in RAs. This number was significantly lower in IRAs (p = 0.011) or RAs (p = 0.012) than in POAs. In women, the mean number of teeth lost was 1.1 (± 1.5) in POAs, 1.0 (± 1.6) in IRAs, and 1.2 (± 1.6) in RAs. No significant difference was observed between POAs, IRAs, and RAs.

Table 3 shows the reasons for tooth extraction. In men, POAs had more teeth extracted due to caries (13.4%) than IRAs (6.3%, p = 0.045) or RAs (7.7%, p = 0.006).
Meanwhile, IRAs had more extractions due to periodontitis (69.6%) than POAs (58.0%, \( p = 0.033 \)) or RAs (54.2%, \( p = 0.002 \)). More extractions were observed in RAs due to root fracture (24.9%) than POAs (16.7%, \( p = 0.006 \)) or IRAs (12.5%, \( p = 0.004 \)). In women, POAs had more extractions due to caries (15.1%) than IRAs (3.8%, \( p = 0.008 \)) or RAs (7.1%, \( p = 0.006 \). Meanwhile, IRAs had more extractions due to periodontitis (46.7%) than POAs (29.2%, \( p = 0.009 \)) or RAs (35.4%, \( p = 0.028 \)). More extractions were observed in RAs due to root fracture (46.5%) than any other reason.

Table 4 shows the logistic regression analysis for tooth loss. There were no strong relationships (\(|r|>0.3\)) among the independent variables by Spearman's correlation coefficient. The following independent variables were found to be correlated with tooth extraction: appointment adherence in IRAs (OR: 0.54; 95%CI: 0.35–0.84), appointment adherence in RAs (OR: 0.65; 95%CI: 0.47–0.89), man (OR: 1.43; 95%CI: 1.11–1.83), hypertension (OR: 1.38; 95%CI: 1.04–1.85), 20–25 PT (OR: 2.41; 95%CI: 1.81–3.22), and 1–19 PT (OR: 3.75; 95%CI: 2.73–5.16).

<table>
<thead>
<tr>
<th>Independent variable</th>
<th>n (%)</th>
<th>OR (95%CI)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appointment adherence</td>
<td>n</td>
<td>n (%)</td>
<td></td>
</tr>
<tr>
<td>POAs</td>
<td>216</td>
<td>89 (41.2)</td>
<td>1</td>
</tr>
<tr>
<td>IRAs</td>
<td>197</td>
<td>49 (24.9)</td>
<td>0.54 (0.35–0.84)</td>
</tr>
<tr>
<td>RAs</td>
<td>987</td>
<td>306 (31.0)</td>
<td>0.65 (0.47–0.89)</td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Woman</td>
<td>714</td>
<td>196 (27.5)</td>
<td>1</td>
</tr>
<tr>
<td>Man</td>
<td>686</td>
<td>248 (36.2)</td>
<td>1.43 (1.11–1.83)</td>
</tr>
<tr>
<td>Age at baseline</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>50–59</td>
<td>655</td>
<td>180 (27.5)</td>
<td>1</td>
</tr>
<tr>
<td>60–69</td>
<td>553</td>
<td>189 (34.2)</td>
<td>1.18 (0.91–1.53)</td>
</tr>
<tr>
<td>70–79</td>
<td>192</td>
<td>75 (39.1)</td>
<td>1.19 (0.82–1.72)</td>
</tr>
<tr>
<td>Diabetes at baseline</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No or unknown</td>
<td>1,323</td>
<td>412 (31.1)</td>
<td>1</td>
</tr>
<tr>
<td>Yes</td>
<td>77</td>
<td>32 (41.6)</td>
<td>1.13 (0.68–1.85)</td>
</tr>
<tr>
<td>Hypertension at baseline</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>No or unknown</td>
<td>1,112</td>
<td>323 (29.0)</td>
<td>1</td>
</tr>
<tr>
<td>Yes</td>
<td>288</td>
<td>121 (42.0)</td>
<td>1.38 (1.04–1.85)</td>
</tr>
<tr>
<td>Smoking status at baseline</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>No or unknown</td>
<td>1,194</td>
<td>360 (30.2)</td>
<td>1</td>
</tr>
<tr>
<td>Yes</td>
<td>206</td>
<td>84 (40.8)</td>
<td>1.20 (0.85–1.68)</td>
</tr>
<tr>
<td>Number of PT at baseline</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>26–28</td>
<td>551</td>
<td>100 (18.1)</td>
<td>1</td>
</tr>
<tr>
<td>20–25</td>
<td>512</td>
<td>182 (35.5)</td>
<td>2.41 (1.81–3.22)</td>
</tr>
<tr>
<td>1–19</td>
<td>337</td>
<td>162 (48.1)</td>
<td>3.75 (2.73–5.16)</td>
</tr>
</tbody>
</table>
Discussion

To our knowledge, this is the first study to show that, after adjusting for confounding factors, and in contradiction to previous reports, tooth loss was lower in RAs than in POAs at dental offices, even though the definition of POAs, IRAs, and RAs adopted here differed somewhat to that used earlier. This anomaly may be due to the longer period of time or higher patient age range and lower number of PT involved than in previous reports.

The IRAs in this study had more teeth at baseline than the RAs among men. This is in line with the results of a previous study which showed RAs had fewer teeth than IRAs (p<0.05). Here, IRAs had fewer teeth extracted than RAs during the observation period, although the difference was not significant. This may, however, be due to IRAs believing that they are at a low risk for tooth loss and subsequently not bothering to visit a dental clinic regularly.

It has been reported that it is difficult to collect data on POAs at dental offices, and this was true in our study as well as evident from the fact that the number of POAs was lower than that of RAs. Indeed, the observed difference in number of teeth lost between the two groups was small.

Universal health insurance in Japan covers most illnesses, and people can receive care at any hospital in the country. Therefore, Japanese people can access treatment more easily than people in many other countries, and at a lower cost. This may make comparisons with previous studies difficult, especially concerning the definition of POAs. Therefore, even patients classified as POAs here may have in fact attended dental offices more often than POAs in previous studies. The oral health status of the POAs in the present study, therefore, may have been better than that of POAs in previous studies.

Previous studies have suggested that low socioeconomic status is a barrier to dental attendance, and that such barriers appear to have a negative effect on oral health.

Although universal healthcare insurance covers dental prostheses in Japan, individual financial status is associated with use of such. Socioeconomic status was not addressed in the present study, and its potential influence on patient behavior cannot be ruled out.

The present results revealed a strong relationship between number of PT and tooth extraction. It is well known that the risk of tooth loss increases as the number of PT decreases. We believe greater awareness of this fact among the general public would encourage a change in behavior with regard to regularly visiting their dentist, which should help prevent further tooth loss.

No significant difference was observed in mean number of teeth lost among POAs, RAs, and IRAs in women. Male sex is a risk factor for tooth loss. Women have been reported to be more likely to adhere to appointments than men, and have also been demonstrated to visit dental offices more frequently. Demetriou et al. showed that a greater percentage of women demonstrated complete adherence to supportive periodontal therapy than men. This suggests that women at high risk for tooth loss visit dental offices more regularly than high-risk men. Additionally, the POA group in the present study may have included patients at low risk for tooth loss. These factors may have contributed to the lack of a significant difference in tooth loss between RAs and POAs seen here in women.

Longitudinal epidemiological studies have established a relationship between habitual smoking and tooth loss. Costa et al. showed that smoking and diabetes were risk factors for tooth loss in patients undergoing supported periodontal therapy after periodontal treatment. Neither smoking nor diabetes were associated with tooth loss in the present study, however, although the reason for this disparity remains unclear. It may, however, have had something to do with the fact that the present patients had been visiting the same dental clinic over a period of 10yr, which would seem to indicate a lower risk of periodontitis and differences in health.
behavior compared with participants in previous studies.

The percentage of tooth loss due to root fracture was higher in RAs than in POAs or IRAs in men \( (p<0.05) \), and it was also higher than other reasons in women. Several researchers\(^5,6\) have reported that root fracturing is a major problem during the maintenance phase of periodontal treatment. Axelsson \textit{et al.}\(^2\) reported that root fracture was the main reason for tooth loss during a 30-yr plaque control program to prevent dental caries and periodontal disease. During the 30-yr period, 173 teeth were lost in total, of which 108 (62.4\%) were lost due to root fracture. The results of Chambrone and Chambrone\(^6\) as well as those of Carnevale \textit{et al.}\(^5\) also support this claim. These reports indicate that the incidence of root fracture is higher in patients who are under long-term maintenance.

\textbf{Conclusion}

The number of PT at baseline correlates strongly with tooth extraction, indicating that maintenance is particularly important in patients at high risk for tooth loss. The risk of tooth loss showed a 0.65-fold increase in patients regularly attending dental offices for maintenance compared with POAs. Patients need to be informed of the importance of attending dental clinics and undergoing maintenance more regularly if tooth loss is to be avoided. We believe that the present results offer a useful informational tool for the dental professional in explaining this issue to patients.

\textbf{Acknowledgements}

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\textbf{Conflict of Interest}

The authors declare no potential conflict of interest related to this article.

\textbf{References}

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