Tooth loss and pocket probing depths in compliant periodontally treated patients: a retrospective analysis


Abstract

Background/aims: This retrospective study determined the treatment outcomes of 142 compliant periodontal patients observed for at least 10 years at the University of Kiel. All patients had been treated for moderate to advanced periodontitis and regularly received supportive periodontal therapy (SPT).

Methods: Patient- and tooth-related variables [tooth loss and pocket probing depth (PPD)] were analysed.

Results: Of a total of 3353 teeth, 167 were extracted during active treatment and 99 during SPT, mainly for periodontal reasons. Forty-five per cent of the patients did not lose any teeth during 11.7 years of observation. Thirty-seven per cent underwent extractions during active treatment or SPT, 18% both during active periodontal therapy and SPT. Mean tooth loss per patient was 0.07 teeth/year during SPT, 18% both during active periodontal therapy and SPT. Mobility, furcation involvement, smoking, and prescription antibiotics had a negative impact on prognosis. Intraindividual differences in PPD were significant between single- and multirooted teeth with initial PPD ≥ 4 mm at baseline, following active treatment and at the end of SPT, and between firm and mobile teeth at baseline. Interindividual differences in mean PPD were only significant between smokers and non-smokers at the end of the observation period.

Conclusions: Long-term maintenance of our patients was effective. Periodontal disease represented the major cause of tooth loss in a minority of the population.

Periodontal therapy is a successful means of arresting disease progression and maintaining the teeth of most patients. This has been well documented in both prospective and retrospective studies. Prospective studies, such as those by Knowles et al. (1979), Lindhe & Nyman (1984) and Kaldahl et al. (1996), are carried out in a well-controlled research setting. Retrospective studies, for example those by Hirschfeld & Wasserman (1978), McFall (1982), Goldman et al. (1986), McGuire & Nunn (1996) and Rosling et al. (2001), are based on well-documented charts and patients who reliably attend appointments during the pre-selected examination period. The tooth longevity recorded in such unsupervised studies is lower.

Various parameters can be applied to evaluate the success of periodontal treatment. Surrogate outcomes, which usually measure disease progression and are based on anatomy (change in probing depth, attachment level and radiography), pathology and immunology (inflammation indices and crevicular fluid components), and microbiology (identification of pathological flora), are distinguished from the true end-point, i.e. tooth loss (Hujoel & DeRouen 1995). Surrogates are used to obtain quick answers at an economical cost where various treatment modalities lead one to expect only slight differences and/or where the observation period is too short to reach the true end-point. However, one problem with
the surrogate outcomes mentioned above is that they must accurately reflect the true end-point of tooth loss and not lead to either false positive or false negative conclusions. The rate of tooth loss in periodontal studies depends greatly on the treatment philosophy. In Hirschfeld & Wasserman’s (1978) landmark study and those it inspired, only the teeth that were extracted during maintenance were included; no information is available on teeth extracted during the active phase of periodontal treatment. This does not take into consideration the fact that the greater the number of teeth extracted with an unpredictable prognosis during active periodontal therapy, the lower is the risk of tooth loss during supportive periodontal therapy (McGuire 1991).

The aim of our longitudinal retrospective study was to evaluate treatment outcome of compliant patients treated for moderate to advanced periodontitis both in terms of pocket probing depth (PPD) changes and tooth loss during active treatment and supportive periodontal therapy.

**Material and Methods**

**Subjects**

This investigation was conducted as a longitudinal retrospective study based on tooth status and PPD of compliant patients. Data were obtained from charts of 142 (76 female and 66 male) Caucasian patients who were treated for moderate to advanced periodontitis at the Department of Periodontology, University of Kiel, Kiel, Germany. They had received active treatment and regular supportive periodontal therapy (SPT) and were followed over a period of at least 10 years (see König et al. 2001).

Active treatment consisted of periodontal surgery (hygienic phase). Periodontal surgery was performed either as subgingival scaling and root planing or access flap surgery. Pocket elimination surgery, osseous resection, regenerative procedures, and occlusal adjustments were not carried out. During supportive periodontal therapy, professional tooth cleaning and/or subgingival debridement was performed as the operator deemed necessary, and periodontal conditions were documented annually with PPD charts and plaque index values (for a detailed description of treatment, see Kocher et al. 2000, König et al. 2001).

**Data**

The pertinent information was obtained from each patient’s file, and comprised gender, age, number of teeth, PPD, mobility, furcation involvement, time of tooth loss, and plaque index. Data on third molars were excluded. Each tooth extracted was classified according to pathology or reason for extraction: periodontal disease, caries, endodontic problems, prosthetic reasons, and others.

Except for baseline data in Table 1, mean data on PPD, mobility, and furcation involvement were taken from surviving teeth only. Data from teeth extracted during active treatment or SPT were not included.

Although PPDs were routinely measured on six sites of each tooth in whole millimetres with the PCP 11 manual probe (Hu-Friedy®, Chicago, Illinois, USA), we only selected the deepest PPD value per tooth for our analyses.

Mobility was classified by degrees 0–3 ad modum Lindhe & Nyman (1977). For statistical analyses, mobility was dichotomized into firm teeth presenting mobility degree 0 or 1 and mobile teeth.

Baseline furcation invasion was

**Table 1.** Patient data for the 142 compliant patients

<table>
<thead>
<tr>
<th>Patient data</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean age ± SD (years) initially</td>
<td>46 ± 9</td>
</tr>
<tr>
<td>Mean number ± SD of initially present teeth</td>
<td>24 ± 4</td>
</tr>
<tr>
<td>Mean number ± SD of initially present molars</td>
<td>6 ± 2</td>
</tr>
<tr>
<td>Mean PPD ± SD (mm) initially</td>
<td>5.4 ± 1.3</td>
</tr>
<tr>
<td>Mean frequency ± SD (%) of teeth with max. PPD 1–3mm initially</td>
<td>17 ± 18</td>
</tr>
<tr>
<td>Mean frequency ± SD (%) of teeth with max. PPD 4–6mm initially</td>
<td>60 ± 23</td>
</tr>
<tr>
<td>Mean frequency ± SD (%) of teeth with max. PPD &gt; 6mm initially</td>
<td>23 ± 26</td>
</tr>
<tr>
<td>Mean frequency ± SD (%) of firm teeth initially</td>
<td>89 ± 20</td>
</tr>
<tr>
<td>Mean frequency ± SD (%) of mobile teeth initially</td>
<td>11 ± 20</td>
</tr>
<tr>
<td>Mean frequency ± SD (%) of molars with no/initial furcation invasion</td>
<td>77 ± 28</td>
</tr>
<tr>
<td>Mean frequency ± SD (%) of molars with advanced furcation invasion</td>
<td>23 ± 28</td>
</tr>
<tr>
<td>Total observation period ± SD (years)</td>
<td>11.7 ± 1.4</td>
</tr>
<tr>
<td>Period of supportive periodontal therapy SPT ± SD (years)</td>
<td>10.5 ± 1.6</td>
</tr>
<tr>
<td>Mean number ± SD of teeth after surgery</td>
<td>22 ± 5</td>
</tr>
<tr>
<td>Mean PPD ± SD (mm) after surgery</td>
<td>2.9 ± 0.5</td>
</tr>
<tr>
<td>Mean PPD ± SD (mm) after 8 years of SPT</td>
<td>3.6 ± 1.0</td>
</tr>
<tr>
<td>Relative number of patients with mean plaque index = 30% during SPT</td>
<td>93/142</td>
</tr>
</tbody>
</table>

**Fig. 1.** Surviving and extracted teeth of the 142 compliant patients during the observation period (active phase of periodontal treatment and supportive periodontal therapy [SPT]) in relation to tooth type.

**Fig. 2.** Extraction rate per year of supportive periodontal therapy (SPT). Columns beyond the dotted line show a decreasing number of patients.
dichotomized into initial (horizontal probing values between 0 and 3mm) and advanced (horizontal probing values exceeding 3mm). To assess oral hygiene, plaque was stained with 4% erythrosine dye. The presence or absence of plaque was recorded for three surfaces per tooth (Plagmann 1988).

Data analyses
Teeth were categorized for analysis into three groups according their initial PPD (1–3, 4–6 and >6mm), and patient mean data calculated. Descriptive cumulative survival rates (Kaplan-Meier functions) were calculated with the event tooth loss as the ultimate failure.
Comparison of mean PPDs was performed with the unpaired t-test (interindividual comparison) and the paired t-test (intraindividual comparison).

To determine the influence of patient-based variables on tooth loss or PPD change during SPT, a multiple regression analysis was applied in which the independent variables were smoking, age, gender, number of teeth, and PPD at initial examination, number of maintenance visits per year, oral hygiene, number of treating dentists, reoperation, and antibiotic therapy. All statistical calculations were performed with StatView 4.5 (Abacus, Berkeley, California, USA).

Results
Patients
Baseline
The average patient age was 46 years, ranging between 23 and 72 years. They presented with a mean number of 24 teeth, or six molars. Eleven per cent of the teeth were mobile and 23% of the molars had advanced furcation involvement with horizontal probing values exceeding 3mm. On average, 60% of teeth had PPDs in the range of 4–6mm, and 23% of the teeth had PPDs >6mm. Mean PPD was 5.4mm.

Supportive periodontal therapy (SPT)
The mean period of supportive periodontal therapy was 10.5 years (8–13 years). The patients entered the maintenance phase with a mean number of 22 teeth. Mean PPD started at 2.9mm after active treatment and was 3.6mm by year 8 of SPT. Two-thirds of the patients had good oral hygiene with a
Tooth loss and pocket probing depths

Tooth loss

Tooth-related data

At baseline, the 142 compliant patients possessed a total of 3353 teeth (third molars excluded). All teeth were symmetrically distributed between left and right quadrants. The patients had fewer teeth in the maxilla than in the mandible. Previous dental treatment alia loco was responsible for the extraction of 19.2% of the maxillary and 12.1% of the mandibular teeth. First molars were most frequently missing (33.1%), while canines were rarely lost (3.5%) (Fig.1).

During active treatment, the surgical procedure on the surviving teeth consisted of flap surgery (41% of the teeth), scaling and root planing (44%), or simply supragingival debridement (15%).

Overall, 266 teeth were extracted during the observation period (167 during active treatment and 99 during SPT). More teeth had to be removed in the maxilla than in the mandible (10.3 vs. 6.6%), mainly due to the higher extraction rates of maxillary first premolars (13.1%) and first and second molars (19.3%). In the mandible, higher extraction rates were only obvious for the first and second molars (12.8%). The mandibular first molars were the only teeth with a higher extraction rate during SPT (6.3%) than during active treatment (2.1%) (Fig.1). There was a linear increase in annual extraction rate from year 4 to year 7 during SPT (Fig.2).

Extraction reasons varied. During active treatment, periodontal disease accounted for 82% (137/167) and prostho-
dontic reasons for 12% (21/167) of the tooth loss. During SPT, 48% of the teeth (48/99) were extracted as a result of periodontal disease, 30% (30/99) for endodontic reasons and 14% (14/99) as a consequence of further prosthodontic treatment planning.

Irrespective of the reasons for extraction, we constructed Kaplan-Meyer survival tables for censored data. Only descriptive survival curves are shown (Figs3a, b and c).

Tooth type: Single-rooted teeth had a better survival prognosis than molars (Fig.1). Molars without furcation involvement had survival rates similar to those of non-molar teeth (Figs3a and b).

Furcation involvement: Of a total of 827 multirooted teeth (third molars excluded), 71 were extracted during active treatment and 51 during SPT. A detailed survey showed that increased furcation involvement reduced survival time. With increasing furcation invasion, molar loss was more likely. Multirooted teeth with advanced furcation involvement seemed to behave like root-resected teeth, with a survival rate of 83% (19/23 teeth) (Fig.3b).

Mobility: Another tooth-related factor influencing treatment outcome was mobility. Increasing mobility worsened the prognosis of the tooth (Fig.3c).

Patient-related data

The histograms (Fig.4) illustrate the patient-related distribution of teeth present at baseline, and lost during active treatment and SPT for the cohort of patients with and without tooth loss during the observation period. Forty-five per cent (64/142) of the patients lost no teeth during the observation period (Fig.4a). Thirty-seven per cent received extraction therapy during either active treatment (27/142) or SPT (26/142), and 18% (25/142) received extraction therapy during both active periodontal therapy and SPT. During SPT, mean tooth loss per patient was 0.07 teeth/year. Patients who received extraction during SPT lost an average of 1.9 teeth per subject. Patients who only lost teeth during maintenance lost a maximum of three teeth. Five so-called downhill [Hirschfeld & Wassermann’s (1978) terminology] or extreme downhill patients with four or more teeth lost during SPT had already lost teeth during active treatment, but not more than during maintenance (Fig.4b).

Multiple regression analysis with 10
independent variables (smoking, age, gender, number of teeth and mean PPD at initial examination, number of maintenance visits per year, oral hygiene, number of treating dentists, reoperation and antibiotic therapy) explained 12% of the tooth loss during maintenance ($r^2 = 0.12$). Only smoking and antibiotic therapy were statistically significantly associated with tooth loss.

**Pocket probing depth (PPD)**

**Patient-related data**

The bar charts in Fig. 5a illustrate the annual frequency distribution of the PPDs for the categories PPD < 4, 4–6 and > 6 mm during the observation period. After periodontal surgery, the average proportion of all surviving teeth with PPD > 6 mm dropped from 21.8 to 0.1%, and even after 8 years of maintenance, remained below 2.7%. Parallel to this, the proportion of teeth with shallow pockets (PPD < 4 mm) increased from 17.0% to 83.7% and reached 64.4% after 8 years of SPT. This decrease during maintenance was associated with a relative increase in teeth with PPD of 4–6 mm, from 16.2 to 33.0%.

Figure 5b graphically portrays the development of the PPD categorized by initial PPD of < 4, 4–6 and > 6 mm. The deeper the initial PPD, the more pronounced the decrease after active treatment. In the category of surviving teeth with an initial PPD of > 6 mm, the average PPD changed from 7.7 to 3.4 mm after surgical treatment, and to 4.4 mm after 8 years of maintenance. Teeth with initial PPDs of 4–6 mm started with an average of 5.1 mm, were 2.9 mm at the beginning of the maintenance period, and were 3.5 mm after 8 years of maintenance. Teeth with initially shallow pockets (< 3 mm) showed minimal changes in mean PPD: 2.9 mm at baseline became 2.4 mm following active treatment, but returned to 2.9 mm after 8 years of SPT.

Detailed observation makes it possible to compare the development of mean PPDs between surviving molar and non-molar teeth (Fig. 6). Multi-rooted teeth in the categories initial PPD > 6 mm and 4–6 mm started with a mean PPD of 7.9 and 5.3 mm, respectively, compared to the significantly lower ($p < 0.0001$ and $p = 0.0032$) mean values of single-rooted teeth with 7.7 and 5.0 mm at baseline. After active treatment, molars in the categories > 6 and 4–6 mm had mean values of 3.7 and 3.3 mm compared to the highly significantly lower mean values of non-molar teeth of 3.1 and 2.8 mm. The reduction in mean PPD during active treatment was not significantly different. During 8 years of SPT, mean PPD values increased for all categories. A significantly higher increase was obvious for multi-rooted teeth of the categories initial PPD > 6 mm ($p = 0.039$) and 4–6 mm ($p \leq 0.0001$) compared with single-rooted teeth. This resulted in highly significant differences of the mean values at year 8 of SPT between molar (mean PPD = 5.0 and 4.1 mm) and non-molar teeth (mean PPD = 3.9 and 3.2 mm) for both categories.

The intra- and interindividual comparisons of mean PPD at different time points depending on initial mobility, plaque index during SPT, and smoking status are shown in Table 2. Very significant differences in PPD were only obvious for mean PPD at baseline between loose and firm teeth ($p = 0.0097$) and for mean PPD at the end of the supportive periodontal therapy between smokers and non-smokers ($p = 0.0042$) (Table 2).

Multiple regression analysis with 10 independent variables (smoking, age, gender, number of teeth and mean PPD at initial examination, number of maintenance visits per year, oral hygiene, number of treating dentists, reoperation and antibiotic therapy) explained 9% of the PPD changes in the period of supportive periodontal therapy ($r^2 = 0.09$). Only the number of maintenance visits/year (positively correlated) and number of teeth at initial examination (negatively correlated) were statistically significant.

**Discussion**

Patients in our retrospective analysis (mean age 46 years) suffered predominantly from generalized chronic periodontitis. They were treated for moder-
Tooth loss and pocket probing depths

Fig. 6. Mean PPDs of surviving molars (upper diagram) and non-molar teeth (lower diagram) during supportive periodontal therapy (SPT) starting at baseline (bl) and categorized by PPD at baseline examination. Mean values beyond the dotted line are not representative because of a decreasing number of patients.

Table 2. Intra- and interindividual comparison of mean PPDs at baseline examination (baseline), following active treatment (1 year) and after 8 years of supportive periodontal therapy (8 years) depending on initial mobility, plaque index during SPT and smoking status

<table>
<thead>
<tr>
<th>Variable</th>
<th>Comparison</th>
<th>Baseline</th>
<th>1 year</th>
<th>8 years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mobility</td>
<td>Firm teeth</td>
<td>Intra-individual</td>
<td>5.3**</td>
<td>2.9</td>
</tr>
<tr>
<td></td>
<td>Loose teeth</td>
<td>Inter-individual</td>
<td>6.3**</td>
<td>3.0</td>
</tr>
<tr>
<td>Plaque index</td>
<td>= 30% during SPT</td>
<td>Intra-individual</td>
<td>5.4</td>
<td>2.9</td>
</tr>
<tr>
<td></td>
<td>&gt; 30% during SPT</td>
<td>Inter-individual</td>
<td>5.3</td>
<td>3.0</td>
</tr>
<tr>
<td>Smoking</td>
<td>Non-smoker</td>
<td>Inter-individual</td>
<td>5.3</td>
<td>2.9</td>
</tr>
<tr>
<td></td>
<td>Smoker</td>
<td>Inter-individual</td>
<td>5.4</td>
<td>3.1</td>
</tr>
</tbody>
</table>

** Very significant difference.

Tooth loss is the true end-point of therapy, indicating an unsuccessful treatment outcome. Hujoel et al. (1999) recommended that periodontal treatments should be evaluated based on overall tooth mortality. The reason for using overall tooth mortality instead of periodontal tooth mortality as the endpoint is the uncertainty about whether treatment influences mortality as a result of other causes (Hujoel et al. 1999). For this reason and because proper plaque control prevents caries development and thus eliminates the need to treat its consequences, for example using endodontic procedures, we did not differentiate between extraction causes in our survival plots.

In a retrospective longitudinal survey of tooth loss, Tonetti et al. (2000) compared the extraction rate during active periodontal therapy with that during supportive care. Data were analysed from 273 periodontal patients with 6503 teeth (according to a mean number of initially present teeth of 24, third molars included) who remained in a maintenance programme for 5.6 years. These patients lost 8.8% (= 574 teeth) of their teeth (third molars and retained primary teeth included) during the observation period. Fifty-four per cent of these teeth were extracted during active treatment. In our study, patients presented with 24 teeth (third molars excluded) at baseline and lost 7.9% of their teeth (third molars and retained primary teeth excluded). We extracted more teeth during active treatment (63%), thus resulting in a lower extraction rate during SPT despite a maintenance period that was almost twice as long (10.5 years). In our patient population, extraction was performed in 37% of the patients during active periodontal therapy and in 36% of the patients during SPT. Tonetti et al. (2000) extracted teeth in 46% of the patients during the active phase and in 41% during maintenance. Specifically, we extracted 82% of the teeth during active treatment as a result of periodontal problems, and 48% for the same reason during SPT. This is in line with the data from Tonetti et al. (2000) and Chace & Low (1993). During SPT, we observed tooth loss caused by endodontic problems, i.e. parodontitis apicalis or tooth fracture, in 30% of the cases. Superficially, this value seems much higher than that found by Tonetti et al. (2000); however, adding the extraction rate resulting from technical problems (27%) which, according to Tonetti, also includes root fracture – to that resulting from endodontic pathology (13%), the values are comparable (Table 3). As in other studies (Hirschfeld & Wasserman 1978, McFall 1982, McGuire 1991, Chace & Low 1993, McLeod et al. 1998), we noted approximately bilateral symmetry of tooth loss during maintenance. For the whole observation period, the majority of teeth lost were the maxillary second molars followed by
the maxillary first molars. During SPT, we predominantly extracted maxillary first molars, despite the fact that this tooth type was initially the rarest.

We chose survival plots for the event tooth loss to describe the effect of furcation involvement and mobility on the prognosis of the tooth. No statistical analysis was performed, because tooth-related data do not represent a realistic situation when patients with different numbers of teeth and events are entered into the statistical analysis. As in the study by McGuire & Nunn (1996), our survival plots also show that teeth with advanced furcation involvement and increased mobility have markedly worse survival rates, albeit to a lesser extent than reported by the aforementioned authors. Tooth mobility might reflect increased attachment loss (Ismail et al. 1990, Wang et al. 1994, Wheeler et al. 1994), and easily explains why increased mobility leads to more extraction. These and other studies (Hirschfeld & Wassermann 1978, Goldman et al. 1986, Chace & Low 1993, Wang et al. 1994, McLeod et al. 1998) confirm that molars with furcation involvement have a questionable prognosis with a higher tendency to be extracted compared to molars without furcation involvement. In any case, according to the classification of Hirschfeld & Wassermann (1978), over 95% of our patient population was well maintained (0–3 teeth lost) during 10.5 years of supportive periodontal therapy.

An additional treatment option for molars with furcation involvement is root resection. The failure rates after 5–10 years fluctuate between 0% (Hamp et al. 1975) and 38% (Langer et al. 1981). This large difference can be explained as follows.

1 Teeth were specifically selected, because many ‘uncertain’ molars had already been extracted. Hamp et al. (1975) extracted 135/310 teeth = 44%. This leads to a positive bias.

2 Patients were specifically selected. Because the risk of tooth loss depends not only on tooth-specific but also internal (e.g. genetic) and external (e.g. smoking and oral hygiene) patient-specific factors, a positive bias would be expected as a result of root resection of molars in patients with optimal internal and external preconditions. Optimal conditions in terms of maintenance and oral hygiene were achieved in the study by Carnevale et al. (1991).

3 Root resection therapy had been performed on only a few teeth because of periodontal problems, for instance, only 9% of the teeth in the study of Carnevale et al. (1991).

In our study, only 9% (71/827) of the multirotted teeth were extracted during active treatment and 7% (51/756) during 10.5 years of SPT. Seventeen percent (4/23) of the root-resected teeth had to be extracted, yielding a survival prognosis similar to that for molars with advanced furcation involvement. Taking into account the fact that root resection usually requires subsequent prosthetic treatment, the usefulness of this treatment must be questioned, particularly when – thanks to the amputation – the periodontal problems are exchanged for endodontic ones (Blomlof et al. 1997) and root fracture (for review see Carnevale et al. 1995). Knowing that root resection is a technique-sensitive treatment form, a strict indication (= selection) and interdisciplinary cooperation with endodontic and prosthetic specialists are justified. Only in this manner is it possible to attain survival rates higher than those for molars with advanced furcation involvement after periodontal treatment.

A further treatment option for molars with furcation involvement is regenerative periodontal therapy. However, our data show that molars with initial furcation involvement have only a slightly worse survival prognosis than molars without furcation involvement. This type of therapy would thus only be profitable on multirooted teeth with advanced furcation involvement, but it is well known that the regenerative periodontal treatment of molars with degree III furcations is unpredictable as a result of a great variability of clinical outcome (for reviews see Karring et al. 1997 and Sanz & Giovanolli 2000).

Pocket probing depth is a surrogate variable that does not inevitably represent treatment outcome because of possible false positive or false negative results. Nevertheless, clinical probing depth measurement is a fundamental part of periodontal examination (Kerry 1995), and possesses great importance because of the fact that worsening periodontitis is accompanied by more inflammation and deeper pockets. Sites with PPD ≥ 6 mm are at a significantly higher risk of developing additional attachment loss (for reviews see Armitage 1996 and Lang et al. 1997). Calculating with patient means can be misleading, in that many healthy sites mask changes in sites with disease progression (Knowles et al. 1979, Papapanou 1994). In order to reduce the effect of masking, PPDs can be grouped according to different thresholds, as the risk of progression increases with pocket depth. Another kind of masking

Table 3. Comparison of the clinical data between our and Tonetti et al.‘s (2000) study

<table>
<thead>
<tr>
<th>Variable</th>
<th>Our study</th>
<th>Tonetti et al.¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of patients</td>
<td>142</td>
<td>273</td>
</tr>
<tr>
<td>Mean no. of initially present teeth</td>
<td>24</td>
<td>24</td>
</tr>
<tr>
<td>Period of maintenance (years)</td>
<td>10.5</td>
<td>5.6</td>
</tr>
<tr>
<td>% of teeth lost during observation period</td>
<td>7.9</td>
<td>8.8</td>
</tr>
<tr>
<td>% of teeth extracted during active therapy</td>
<td>63</td>
<td>54</td>
</tr>
<tr>
<td>% of teeth lost during active therapy</td>
<td>37</td>
<td>46</td>
</tr>
<tr>
<td>% of teeth lost during maintenance</td>
<td>36</td>
<td>41</td>
</tr>
<tr>
<td>No. of lost teeth per patient within extraction subgroup</td>
<td>3.4</td>
<td>2.5</td>
</tr>
<tr>
<td>% of teeth lost during recall per patient within extraction subgroup</td>
<td>1.9</td>
<td>2.4</td>
</tr>
<tr>
<td>% of extractions for periodontal reasons during active therapy</td>
<td>82</td>
<td>77</td>
</tr>
<tr>
<td>% of extractions for periodontal reasons during maintenance</td>
<td>48</td>
<td>64</td>
</tr>
<tr>
<td>% of extractions for endodontic reasons during maintenance</td>
<td>30</td>
<td>40²</td>
</tr>
</tbody>
</table>

¹In contrast to our data, Tonetti et al. included third molar teeth and retained primary teeth.
²Endodontic reasons including technical problems such as root fracture.
is obvious, if the probing values of extracted teeth up to the time of extraction are taken into consideration. It is highly likely that such teeth have worse PPD and/or attachment values. The mean value improves solely as a result of extracting these teeth. Therefore, we made our calculations using only the deepest value per surviving tooth (for detailed discussion see König et al. 2001). PPD changed dramatically following active treatment, and the deeper the initial PPD, the greater was the reduction. This is in line with other studies (Knowles et al. 1979, Lindhe et al. 1982, Pihlström et al. 1983, Ramfjord et al. 1987, Kaldahl et al. 1996). During SPT, we observed an increase in PPD, especially for teeth with initially high PPD. Pihlström et al. (1984) also pointed out that an increase in PPD compared to single-rooted teeth, molar teeth had significantly higher initial PPD than incisors and premolars. These results agree with those of Pihlström et al. (1984). However, Ramfjord et al. (1980), Lindhe et al. (1982) and Pihlström et al. (1984) all pointed out that an increase in PPD is not necessarily equivalent to attachment loss.

Multiple regression analysis with 10 different variables failed to explain tooth loss and PPD changes during supportive periodontal treatment sufficiently, indicating that these variables had only a minor impact on treatment outcome. Missing data on host and microbial factors, psychosocial status and genetic susceptibility might explain the low $r^2$ values. The impact of these and other risk factors on the development of destructive periodontal disease (for reviews see Kinane 2001 and Garcia et al. 2001) is still a matter for research.

**Conclusion**

The results of our retrospective study support our treatment philosophy that periodontal surgery without resective osseous recontouring in combination with regular supportive periodontal therapy can achieve stable results during an observation period of 11.7 years, irrespective of a minor increase in mean PPD during maintenance. Further, these data reinforce the concept that a minority of patients possess the greatest proportion of teeth with furcation involvement and mobile teeth, and are responsible for the majority of tooth extractions during both active treatment and SPT.

**Zusammenfassung**

Zahnverlust und Sondierungstiefe bei parodontal behandelt Patienten mit guter Compliance – eine retrospektive Analyse

**Grundlagen/Ziele:** In dieser retrospektiven Studie wurde bei 142 an der Universität von Kiels parodontal behandelten Patienten mit guter Compliance, welche für 10 Jahre unter Beobachtung standen, das Behandlungsergebnis bestimmt. Alle Patienten wurden wegen moderater bis fortgeschrittener Parodontitis behandelt und wurden regelmässig im Rahmen der Erhaltungstherapie (SPT) betreut.


**Schlussfolgerungen:** Die Langzeitbeobachtung unserer Patienten war effektiv. Bei einer Mindeart der Population stellte sich die parodontale Krankheit den Hauptgrund für den Zahnverlust dar.

**Résumé**

Pertes dentaires et profondeurs de poche au sondage chez des patients coopératifs traités pour une parodontite. Une analyse rétrospective

**Contexte/but:** Cette étude rétrospective détermine le devenir de 142 patients coopératifs traités pour parodontite sur une période de 10 ans à l’université de Kiel. Tous les patients avaient été traités pour des parodontites modérées à avancées et recevaient des thérapeutiques parodontales de soutien (SPT) régulièrement.

**Méthodes:** Les variables relatives aux patients et aux dents (perte dentaire et profondeur de poche au sondage [PPD]) furent analysées.

**Résultats:** Sur un total de 3353 dents, 167 furent extraites pendant le traitement actif et 99 pendant la SPT, principalement pour des raisons parodontales. 45% des patients ne perdirent aucune dent pendant les 11,7 années d’observation. 37% subirent des extractions pendant le traitement actif ou la SPT, 18% à la fois pendant le traitement actif et la SPT. La perte dentaire moyenne par patient était de 0,07 dent/an pendant la SPT. La mobilité, l’atteinte des furcations, le tabagisme et la prescription d’antibiotique avaient un impact négatif sur le pronostic. Des différences entre individus pour les PPD étaient significatives entre les dents multi et mono-radiculées pour une PPD initiale de $>4$ mm, suite au traitement actif et à la fin de la SPT, et entre les dents mobiles et les dents fermes. Des différences entre individus pour les PPD moyennes étaient seulement significatives entre les fumeurs et les non-fumeurs à la fin de la période d’observation.

**Conclusions:** La maintenance a long terme sur ces patients fut efficace. La maladie parodontale représente la cause principale de perte dentaire chez une minorité de la population.

**References**


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