Prevalence of furcation involvements in patients referred for periodontal treatment


Abstract. The aim of this study was to evaluate the prevalence of furcation-involved molars in a patient sample referred for periodontal treatment. A total of 222 patients aged 14–73 years (mean age 45 years), and with signs of destructive periodontal disease in at least 2 quadrants of the dentition were included in the study. The clinical examination involved assessments of oral hygiene status, gingival conditions, probing pocket depth and presence/degree of furcation involvement. In addition, a full mouth intraoral radiographic examination was performed. The results revealed that 4% of the patients presented with all 12 molars, while 3% had lost all molars. 52% of the individuals had at least 8 molars; 95% of subjects <30 years of age and 19% in the age 60+ years. In patients aged ≥40 years, every 2nd molar showed advanced periodontal destruction in the furcation area. The prevalence of furcation involved molars was higher in the maxilla than in the mandible. From the age of 30 years, about 50% of the 1st and 2nd molars in the maxilla showed at least 1 furcation site with deep involvement, while in the mandible a similar prevalence was observed first after the age of 40 years.

The highest frequency of furcation involvement was found at the distal site of the maxillary 1st molar (53%), and the mesial aspects of the maxillary 2nd molar showed the lowest frequency (20%). Furcation sites with a probeable trunk region were observed at a frequency of 17–22% at the various tooth sites. It was concluded that tooth morphology may be an important factor that accounts for the variability in prevalence of molar furcation involvement.

Data generated from epidemiological surveys on the prevalence and severity of periodontal disease indicate that independent of the age of the examined individuals, both the severity of the disease and the associated tooth mortality are more pronounced in the molar tooth regions (Hirschfeld & Wasserman 1978, Baelum & Fejerskov 1986, Hugoson et al. 1988, Papapanou et al. 1988, Håkansson 1991). There are several factors that may contribute to this distribution pattern, e.g., (i) less effective self-performed oral hygiene in the posterior than in the anterior tooth regions (Lang et al. 1973, Hugoson et al. 1986, Okamoto et al. 1988) and (ii) the complex tooth anatomy of the molars (Bower 1979a,b). Furthermore, treatment of periodontal lesions adjacent to molars with furcation involvement show less favourable outcome than lesions at single-rooted teeth (Lindhe et al. 1982, Nordland et al. 1987, Loos et al. 1989). The inferior treatment outcome at molars seems not to be related to their position in the dental arch per se, since no difference in the treatment result occurred between molar flat surfaces and non-molar surfaces, but rather the furcation site accounts for the impaired healing (Nordland et al. 1987, Loos et al. 1989). Wang et al. (1994) reported from an 8-year longitudinal study that molars with probeable furcation sites had a higher rate of periodontal breakdown and tooth loss following treatment than molars without furcation involvement. The fact that the furcation sites offer problems in the treatment of periodontal lesions was illustrated by Kalkwarf et al. (1988) in a study evaluating the effect of various forms of periodontal therapy in the furcation region. The authors reported that, independent of the mode of therapy, a further deterioration occurred in furcation sites during the 2 years of follow-up. However, an interesting question, that has not been addressed in the literature, is whether differences in the outcome of therapy may exist with respect to location of the furcation site. Studies on the anatomy of the furcation areas of molars (Svärdström & Wennström 1988, Mardam-Bey et al. 1991) have shown that large variations...
The aim of the present study, therefore, was to evaluate the prevalence of furcation involvement in a patient sample referred for periodontal treatment.

**Material and Methods**

The subject sample was derived from the 791 patients who were referred to the Periodontal Clinic, Public Dental Service of the Uppsala County in Sweden during the period 1978–84. Qualifying subjects for the study were all patients examined by one of the authors (GS) and who showed signs of destructive periodontal disease in at least 2 quadrants of the dentition. A total of 222 patients, 134 women and 88 men, fulfilled these selection criteria (Table 1). The age of the patients varied between 14 and 73 years; mean age 44.9 years. Clinical data were extracted from patient dental records and comprised the following variables:

- **Gingival condition**: assessed at mesial, buccal and lingual surfaces of all teeth according to the criteria of the gingival index (Silness & Löe 1964).
- **Probing pocket depth**: measured at the mesial, buccal, distal and lingual sites of all teeth with a calibrated periodontal probe (William/Ash; probe tip diameter 0.50 mm).
- **Furcation involvement**: assessed with a curved probe according to the following criteria (Fig. 1): score 0 the furcation site not probeable
  - score 1 the root trunk coronal to the furcation entrance probeable
  - score 2 the tip of the probe passes horizontally into the furcation but does not reach to the center of the furcation area
  - score 3 the tip of the probe reaches to or beyond the center of the furcation area

**Table 1. Distribution of the patient sample with respect to various age groups**

<table>
<thead>
<tr>
<th>Age group (years)</th>
<th>Number of individuals (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>-29</td>
<td>19 (9)</td>
</tr>
<tr>
<td>30-39</td>
<td>51 (23)</td>
</tr>
<tr>
<td>40-49</td>
<td>68 (31)</td>
</tr>
<tr>
<td>50-59</td>
<td>63 (28)</td>
</tr>
<tr>
<td>60-</td>
<td>21 (9)</td>
</tr>
<tr>
<td>total</td>
<td>222 (100)</td>
</tr>
</tbody>
</table>

**Table 2. Mean % (SD) plaque harbouring tooth surfaces in the various age groups**

<table>
<thead>
<tr>
<th>Age group (years)</th>
<th>Incisors-premolars mean % (SD)</th>
<th>Molars mean % (SD)</th>
<th>All teeth mean % (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>-29</td>
<td>23.1 (18.6)</td>
<td>54.6 (31.7)</td>
<td>34.0 (22.5)</td>
</tr>
<tr>
<td>30-39</td>
<td>34.4 (23.5)</td>
<td>63.7 (24.8)</td>
<td>42.8 (23.1)</td>
</tr>
<tr>
<td>40-49</td>
<td>40.5 (24.0)</td>
<td>64.5 (24.8)</td>
<td>47.3 (23.0)</td>
</tr>
<tr>
<td>50-59</td>
<td>41.6 (24.1)</td>
<td>64.2 (27.2)</td>
<td>46.8 (23.5)</td>
</tr>
<tr>
<td>60-</td>
<td>49.2 (26.1)</td>
<td>64.5 (30.3)</td>
<td>52.9 (24.6)</td>
</tr>
<tr>
<td>all</td>
<td>38.7 (24.3)</td>
<td>63.3 (26.5)</td>
<td>45.5 (23.5)</td>
</tr>
</tbody>
</table>

**Table 3. Mean % (SD) sites with gingival index scores 2+3 in the various age groups**

<table>
<thead>
<tr>
<th>Age group (years)</th>
<th>Incisors-premolars mean % (SD)</th>
<th>Molars mean % (SD)</th>
<th>All teeth mean % (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>-29</td>
<td>14.7 (14.4)</td>
<td>31.6 (24.2)</td>
<td>20.6 (16.8)</td>
</tr>
<tr>
<td>30-39</td>
<td>14.1 (16.8)</td>
<td>23.8 (24.4)</td>
<td>17.1 (18.2)</td>
</tr>
<tr>
<td>40-49</td>
<td>18.1 (20.1)</td>
<td>28.7 (24.8)</td>
<td>21.5 (20.1)</td>
</tr>
<tr>
<td>50-59</td>
<td>20.8 (20.6)</td>
<td>34.4 (28.9)</td>
<td>23.8 (21.6)</td>
</tr>
<tr>
<td>60-</td>
<td>22.6 (22.8)</td>
<td>37.6 (29.9)</td>
<td>25.2 (22.3)</td>
</tr>
<tr>
<td>all</td>
<td>18.1 (19.5)</td>
<td>30.1 (26.4)</td>
<td>21.4 (20.1)</td>
</tr>
</tbody>
</table>

**Table 4. Mean (SD) probing depth for remaining teeth in the various age groups**

<table>
<thead>
<tr>
<th>Age group (years)</th>
<th>Incisors-premolars mean % (SD)</th>
<th>Molars mean % (SD)</th>
<th>All teeth mean % (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>-29</td>
<td>2.44 (0.64)</td>
<td>3.45 (0.92)</td>
<td>2.78 (0.70)</td>
</tr>
<tr>
<td>30-39</td>
<td>2.91 (0.78)</td>
<td>4.09 (0.93)</td>
<td>3.26 (0.77)</td>
</tr>
<tr>
<td>40-49</td>
<td>3.30 (1.00)</td>
<td>4.58 (1.02)</td>
<td>3.68 (0.95)</td>
</tr>
<tr>
<td>50-59</td>
<td>3.28 (1.10)</td>
<td>4.54 (1.18)</td>
<td>3.56 (1.03)</td>
</tr>
<tr>
<td>60-</td>
<td>2.94 (0.78)</td>
<td>4.19 (0.96)</td>
<td>3.22 (0.79)</td>
</tr>
<tr>
<td>all</td>
<td>3.10 (0.96)</td>
<td>4.32 (1.08)</td>
<td>3.43 (0.93)</td>
</tr>
</tbody>
</table>
Prevalence of furcation involvements

PREVALENCE OF MOLARS IN THE VARIOUS AGE GROUPS

First upper molars

First lower molars

Second upper molars

Second lower molars

Third upper molars

Third lower molars

Fig. 3. Prevalence of molars (%) with respect to age groups.

Data analysis

For data description frequencies, mean values and standard deviations were calculated for the various variables. For calculation of mean plaque and gingival index values, the recorded score at the mesial tooth sites was doubled because only one proximal site had been included in the examination. Furcation involvement scores 2 and 3 were pooled in the data analysis since both scores may fall within the criteria for a degree II furcation involvement of the commonly used scoring system by Hamp & Nyman (1989).

Results

An overall description of the periodontal conditions in the patient sample examined is presented in Fig. 2 and Tables 2—4. The mean number of remaining teeth was in the youngest group (<30 years) 28.6, a figure that was reduced to 20.4 teeth in the age group 60+ years (Fig. 2). Predominantly molars accounted for this decrease in mean number of remaining teeth by showing a 50% reduction.

The oral hygiene conditions deteriorated slightly with increasing age; from a mean % of plaque carrying tooth surfaces of 34% in ages below 30 years to 53% in the age group 60+ years (Table 2). Independent of age, the molar tooth region showed the highest plaque scores. With respect to the condition of the gingiva (Table 3), the differences between the various age groups were less pronounced. In all age groups, the molar tooth regions showed higher prevalence of GI scores 2-3, i.e., bleeding sites, than the incisor/premolar tooth regions. Furthermore, the mean probing pocket depth was deeper at molars compared to other tooth regions (Table 4), with a tendency towards increasing depth with age.

Table 5 and Fig. 3 describe the distribution of remaining molars with respect to number of remaining molars.

Table 5. Frequency of individuals with respect to number of remaining molars

<table>
<thead>
<tr>
<th>Age group (years)</th>
<th>No. molars</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
</tr>
<tr>
<td>&lt;29</td>
<td>0</td>
</tr>
<tr>
<td>30-39</td>
<td>0</td>
</tr>
<tr>
<td>40-49</td>
<td>0</td>
</tr>
<tr>
<td>50-59</td>
<td>4</td>
</tr>
<tr>
<td>60+</td>
<td>2</td>
</tr>
<tr>
<td>all individuals</td>
<td></td>
</tr>
<tr>
<td>frequency</td>
<td>6</td>
</tr>
<tr>
<td>%</td>
<td>3</td>
</tr>
</tbody>
</table>

Fig. 4. Prevalence (%) of furcation involved molars in the various age groups according to the highest score per tooth.
DISTRIBUTION OF MOLARS BASED UPON MAXIMUM FURCATION INVOLVEMENT

### Remaining molars

- **First upper molars**
  - 50.0% 60-
  - 65.1% 50-59
  - 85.3% 40-49
  - 89.2% 30-39
  - 94.7% 20-29

- **First lower molars**
  - 47.6% 60-
  - 57.1% 50-59
  - 78.7% 40-49
  - 83.3% 30-39
  - 97.4% 20-29

### Second upper molars
- 45.2% 60-
- 54.8% 50-59
- 77.5% 40-49
- 80.4% 30-39
- 94.7% 20-29

### Second lower molars
- 59.5% 60-
- 61.9% 50-59
- 78.3% 40-49
- 84.3% 30-39
- 94.7% 20-29

### Third upper molars
- 9.5% 60-
- 11.9% 50-59
- 15.2% 40-49
- 18.6% 30-39
- 52.6% 20-29

### Third lower molars
- 16.7% 60-
- 15.1% 50-59
- 25.4% 40-49
- 37.3% 30-39
- 50.0% 20-29

**Fig. 5.** Prevalence (%) of furcation involved molars with regard to tooth position.

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DISTRIBUTION OF FURCATION INVOLVEMENT IN RELATION TO TOOTH SURFACE

### First upper molars

- **Mes**
  - 25 50 75 100 %
- **Bucc**
  - 25 50 75 100 %
- **Dist**
  - 25 50 75 100 %

### First lower molars

- **Bucc**
  - 25 50 75 100 %
- **Ling**
  - 25 50 75 100 %

### Second upper molars

- **Mes**
  - 25 50 75 100 %
- **Bucc**
  - 25 50 75 100 %
- **Dist**
  - 25 50 75 100 %

### Second lower molars

- **Bucc**
  - 25 50 75 100 %
- **Ling**
  - 25 50 75 100 %

**Fig. 6.** Prevalence (%) of different degrees of furcation involvement at the 1st and 2nd molars in the maxilla and mandible.

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Discussion

The present study included only subjects who had been referred for treat-
ment of periodontal disease. The findings revealed that in such individuals above 40 years of age every 2nd molar exhibited advanced breakdown of the periodontal support in the furcation area. Furthermore, the prevalence of furcation involved molars was found to be higher in the maxilla than in the mandible. The most commonly affected tooth site was the distal aspect of the 1st maxillary molar.

In comparison with data on periodontal conditions presented from national and regional surveys carried out in Sweden (Hugoson et al. 1986, 1992, Papapanou et al. 1988, Häkansson et al. 1991, Wennström et al. 1993), the patient sample in the present study had higher mean probing depth values, but had similar values regarding mean number of teeth and plaque and gingivitis scores. With regard to prevalence of furcation involvement, no comparable data are available in the literature. The higher mean probing depth value and the high prevalence of furcation involvement observed in our patient sample, together with the fact that the subjects had all been referred for periodontal treatment, indicate that the sample examined represent a selected group of patients with respect to periodontal disease severity. Consequently, the prevalence figures of furcation involvement reported is most likely higher than that for the population in general.

The presence of severe furcation involvement (score 2–3) was a frequent observation in the present patient sample. Thus, already in the age group 30–39 years, about 35% of the molars had deep involvements (Fig. 4), and such lesions increased to more than 50% in the age groups above 40 years. Within the dentition, the maxillary molars showed higher frequency of furcation engagement than the mandibular molars (Fig. 5). This observation is in correspondence with the distribution pattern of periodontal destruction previously reported (Ross & Thompson 1980, Papapanou et al. 1988, Okamoto et al. 1988). One explanation for this pattern may be that at maxillary molars two of the furcation entrances are located at proximal sites and, consequently, positioned in areas which usually show the highest frequency of plaque associated lesions (Lang et al. 1973, Okamoto et al. 1988). The distribution of furcation involvement in relation to various tooth surfaces (Fig. 6), showing that the distal site of the molars had the highest frequency of furcation involvements, supports this hypothesis.

An interesting observation made in the present sample was that the distal furcation site of the maxillary 1st molar had the highest prevalence of involvement, while the mesial site of the 2nd molar had a comparatively low prevalence of furcation exposure. From a plaque retention point of view, one would expect to find lesions of similar depth at the 2 furcation sites facing the same proximal area. One explanation for the difference noted in furcation involvement between the 2 teeth may be that pertinent morphological differences exist in the location of the actual furcation entrance at the 2 tooth sites. While the distal furcation of the first molar is located midway between the buccal and palatal prominences of the tooth, the mesial furcation area of the 2nd molar is located at the palatal third of the tooth and, consequently, it may be more easily reached for cleaning during regular toothbrushing. Furthermore, the furcation entrances in the 2nd maxillary molar are commonly located more apically than furcations of the first molar. Thus, if exposed to plaque induced lesions of the same magnitude, more advanced periodontal destruction is required before the furcations of the second molar will be engaged in the disease process. In fact, it was observed that in the oldest age group (60+ years), furcation involvement at the mesial aspect of the 2nd maxillary molar was as common as on the distal aspect of the 1st molar.

A difference in prevalence of advanced furcation involvement was also noticed when the mesial and distal furcation sites of the 1st maxillary molar were compared. Despite the fact that the mesial furcation entrance commonly is more coronally located than the distal entrance (Abrams & Trachtemberg 1974, Baima 1986, Svärdström & Wennström 1988), a higher prevalence of involvement was found at the distal surface. There may be several explanations to this apparent difference; (i) the mesial furcation site has a more palatal location on the approximal surface than the distal furcation, (ii) the neighbouring teeth, mesial and distal of the first molar, have different buccal-palatal width. Thus, it is likely that these morphological differences may account for the difference noticed in prevalence of furcation involvements.

This interpretation, i.e., that the accessibility for plaque control measures plays a decisive role in the development of furcation involvement, is also supported by the fact that the prevalence of furcation involvements was lowest for the buccal furcation despite its more coronal position (Svärdsström & Wennström 1988).

The prevalence of advanced furcation involvements was similar in the mandibular 1st and 2nd molars and at buccal and lingual sites. With the higher plaque scores normally found lingually than buccally (Lang et al. 1973, Hugoson et al. 1986), it would be expected that the prevalence of furcation involvement should be higher at the lingual than at the buccal surface. The lack of difference in furcation involvement may be due to the root morphology (Svärdsström & Wennström 1988) with a more apically located furcation entrance lingually, and therefore probably a later exposure for disease progression.

In conclusion, the present findings indicate that tooth morphology is a factor which may explain the observed variability in the prevalence of furcation involvement. It seems reasonable to suggest that such morphological variations also may influence the outcome of treatment of lesions in the furcation area. Results by Pontier et al. (1988, 1989, 1995a, b) on the effect of GTR therapy at furcation sites may be interpreted to support this hypothesis. The authors demonstrated that GTR attempts were less successful in maxillary than in mandibular molars and least effective at proximal sites. Further studies should evaluate whether furcation morphology is a factor that determines the outcome also of traditional surgical and nonsurgical therapies.

Acknowledgement
The study was supported by grants from the Colgate-Palmolive Co., Piscataway, N.J., USA, the County Council and the Public Dental Service, County of Uppsala, Sweden.

Zusammenfassung
Prävalenz des Furkationsbefalls bei Patienten, die zur Parodontalbehandlung überwiesen wurden
Das Ziel dieser Studie war es die Prävalenz des Furkationsbefalls an Molaren bei einer

Résumé
Prévalence des atteintes de la furcation chez les patients adressés pour traitement parodontal
Le but de cette étude était d’évaluer la prévalence des molaires avec atteinte des furcations dans un échantillon de patients adressés pour traitement parodontal. L’étude portait sur un total de 222 patients âgés de 14–73 ans (âge moyen 45 ans), et présentant des signes de parodontopathie destructrice dans au moins 2 des quadrants. L’examen clinique comprenait l’enregistrement du niveau de l’hygiène bucco-dentaire, de l’état gingival, de la profondeur des poches au sondage et de l’atteinte des furcations (présence/dégéré). Un bilan radiographique endo-buccal complet a été pratiqué. Les résultats montraient que 4% des patients avaient toutes leurs molaires (12 molaires), et que toutes les molaires étaient absentes chez 3% des patients. On constatait la présence d’au moins 8 molaires chez 52% des patients: 95% des sujets de <30 ans et 19% de ceux de 60 ans et plus. Chez les patients âgés de ≥40 ans, une 2ème molaire sur deux présentait une destruction parodontale avancée dans la région de la furcation. La prévalence des molaires avec atteinte de la furcation était plus élevée au maxillaire supérieur qu’à la mandibule. A partir de l’âge de 30 ans, environ 50% des 1ère et 2ème molaires du maxillaire supérieur présentaient au moins un site furcataire profondément atteint, alors qu’on n’observait une telle prévalence à la mandibule qu’après l’âge de 40 ans. La fréquence d’atteinte de la furcation la plus élevée a été constatée dans site distal de la 1ère molaire supérieure (53%), et la fréquence la plus basse du côté mésial de la 2ème molaire supérieure (20%). On observait des sites furcataires où il était possible de sonder la région du tronc cervical avec une fréquence allant de 17–22% dans les différents sites dentaires. En conclusion, la morphologie dentaire pourrait être un important facteur expliquant la variabilité de la prévalence de l’atteinte de la furcation dans les molaires.

References
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Prevalence of furcation involvements

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