CHAPTER 5

Association of tooth loss with dental status and dental risk factors in a sample of patients with head and neck cancer

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Submitted
Abstract

Objective
This study was designed to investigate the association of tooth loss with patient's dental status (number of teeth present at baseline), dental risk factors (DRFs), and radiotherapy-related factors, respectively, in a sample of head and neck cancer patients. A further objective was to study the incidence of radiation caries and osteoradionecrosis.

Study Design
A retrospective and follow-up analysis was performed on 209 head and neck cancer patients in the Netherlands who had received a dental evaluation prior to radiotherapy for head and neck cancer. Patients were subsequently evaluated 1-5 years postradiation (median 3 years).

Results
Tooth loss was greater in the study population compared to data on tooth loss in the general population, and is significantly associated with dental status, DRF's, and radiotherapy-related factors. Radiation caries at the time of the follow-up evaluation was significantly associated with the number of DRFs at baseline. The incidence of osteoradionecrosis was relatively low (5 cases; 2.3%).

Conclusions
The survey supports the clinician's judgment to be uncompromising in preradiation treatment planning, especially in patients initially presenting with poor oral health. A survey study that would further define the relationship between a head and neck cancer patient's perception regarding the need for dental rehabilitation and his or her ability to comply with the advised dental treatment and oral hygiene measures is recommended.
CHAPTER 5

Introduction

It has long been known that head and neck cancer patients tend to have higher levels of dental pathosis compared to the general population.\(^1\) In particular, elderly persons and those of lower socioeconomic status form a substantial proportion of patients with head and neck cancer.\(^2,3\) The prevalence and incidence of dental disease in these groups are high and compliance with dental care is usually poor.\(^4-9\)

Numerous reports indicate that head and neck cancer therapies induce a wide spectrum of undesirable side effects, particularly affecting the mouth and jaws.\(^10\) This is especially true if radiotherapy to the oral and maxillofacial structures is part of the overall treatment regimen.\(^11\) It has been shown that these side effects seriously affect both the tolerance of treatment and the quality of life.\(^12,13\)

To reduce oral complications, extensive dental preventive and treatment measures before, during, and after cancer therapy are mandatory.\(^10,13,14\) Implicit in the preventive approach is preradiation oral screening to identify and eliminate dental risk factors (DRFs). Preradiation dental decision-making has been described in previous publications.\(^15,16\) The dental risk factors (DRFs) were found to be the most important factors in this process.\(^15\) DRFs include caries, periodontal disease, periapical dental pathosis, impacted teeth, residual root tips, cysts, and other radiographic abnormalities. Table 5.1 summarizes the DRFs.

Elimination of DRFs is possible through dental treatment or tooth extraction. Criteria for the extraction of teeth before radiotherapy include the following:\(^14\)

- moderate to advanced periodontal disease,
- extensive periapical lesions of the teeth,
- extensive dental caries,
- partially impacted or incompletely erupted teeth,
- residual root tips not fully covered by bone and/or showing radiolucency to x-rays.

Pre-existing dental pathoses logically seem to be a risk factor for tooth loss. Patients with high levels of dental pathosis prior to radiotherapy need extensive dental intervention, frequently resulting in partial or even total loss of dentition.\(^17\) In addition, patients with remaining teeth would also seem to be at risk for development of novel dental pathoses, such as radiation caries. Although this association has long been apparent,\(^1\) its strength and functional form has not yet been clearly recognized in an evidence-based approach.\(^18,19\)

The objective of the present clinical survey was to investigate the association of pre and postradiation tooth loss with patient's dental status (number of teeth present at baseline), dental risk factors (DRFs), and radiotherapy-related factors, respectively, in a sample of patients with head and neck cancer. A further objective was to study the incidence of radiation caries and osteoradionecrosis. For these purposes, a retrospective and follow-up evaluation was performed on 209 head and neck cancer patients in the Netherlands, who had received a dental evaluation prior to radiotherapy for head and neck cancer.
### Table 5.1 Dental Conditions to assign Dental Risk Factor (DRF) Score

<table>
<thead>
<tr>
<th>Clinical and Radiographic Findings (CRF)(a)</th>
<th>Weighting</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Periodontal disease</strong></td>
<td></td>
</tr>
<tr>
<td>Probing depth / Proximal bone loss: (b) 3 to 6 mm</td>
<td>Medium</td>
</tr>
<tr>
<td>Probing depth / Proximal bone loss: (&gt; 6 \text{ mm})</td>
<td>High</td>
</tr>
<tr>
<td>Gingival recession: 3 to 6 mm</td>
<td>Medium</td>
</tr>
<tr>
<td>Gingival recession: (&gt; 6 \text{ mm})</td>
<td>High</td>
</tr>
<tr>
<td>Bleeding upon probing</td>
<td>Medium</td>
</tr>
<tr>
<td>Spontaneous gingival bleeding</td>
<td>High</td>
</tr>
<tr>
<td>Furcation involvement / Bone loss in furcation area</td>
<td>High</td>
</tr>
<tr>
<td>Mobility 1-2 mm side to side</td>
<td>Medium</td>
</tr>
<tr>
<td>Mobility (&gt; 2 \text{ mm) side to side and/or 1 mm vertical}</td>
<td>High</td>
</tr>
<tr>
<td><strong>PULPAL DISEASE AND PERIAPICAL LESIONS</strong></td>
<td></td>
</tr>
<tr>
<td>Abnormal response to tests, no previous endodontic treatment, no rarefying osteitis(d)</td>
<td>Medium</td>
</tr>
<tr>
<td>Abnormal response to tests, no previous endodontic treatment, rarefying osteitis</td>
<td>High</td>
</tr>
<tr>
<td>Swellings and/or sinus tracts</td>
<td>High</td>
</tr>
<tr>
<td>Rarefying osteitis, (\Theta &lt; 3 \text{ mm) with adequate root canal filling,(e) without (percussion) pain</td>
<td>Low/Medium</td>
</tr>
<tr>
<td>Rarefying osteitis, (\Theta &lt; 3 \text{ mm) with inadequate root canal filling,(e) with (percussion) pain</td>
<td>High</td>
</tr>
<tr>
<td>Rarefying osteitis, (\Theta &gt; 3 \text{ mm)</td>
<td>High</td>
</tr>
<tr>
<td>Condensing osteitis/ hypercementosis(g) with normal reactions to tests</td>
<td>Low</td>
</tr>
<tr>
<td>Condensing osteitis with abnormal reactions to tests</td>
<td>Medium</td>
</tr>
<tr>
<td>Internal/external root resorption</td>
<td>High</td>
</tr>
<tr>
<td><strong>EXTENSIVE CARIES</strong></td>
<td></td>
</tr>
<tr>
<td>Primary caries &lt; 2/3 of the clinical crown</td>
<td>Medium</td>
</tr>
<tr>
<td>Primary caries &gt; 2/3 of the clinical crown/pulpal involvement</td>
<td>High</td>
</tr>
<tr>
<td>Defective restoration(h) with secondary caries,(i) no pulpal involvement</td>
<td>Medium</td>
</tr>
<tr>
<td>Root caries &lt; 1/2 of root circumference, no pulpal involvement</td>
<td>Medium</td>
</tr>
<tr>
<td>Root caries &gt; 1/2 of root circumference</td>
<td>High</td>
</tr>
<tr>
<td><strong>NON FUNCTIONAL TEETH</strong></td>
<td></td>
</tr>
<tr>
<td>Partially impacted (incompletely erupted) teeth or permucosal residual roots</td>
<td>High</td>
</tr>
<tr>
<td>Residual root tips not fully covered by alveolar bone and/or showing periodontal ligament or radiolucency</td>
<td>High</td>
</tr>
<tr>
<td>Fully impacted teeth, without follicle enlargement and fully covered by bone</td>
<td>Low</td>
</tr>
<tr>
<td>Fully impacted teeth, with follicle enlargement and/or not fully covered by bone,</td>
<td>High</td>
</tr>
<tr>
<td><strong>ORAL HYGIENE, DENTAL AWARENESS, CO-OPERATION</strong></td>
<td></td>
</tr>
<tr>
<td>Low level of oral hygiene, low dental awareness, lack of cooperation</td>
<td>High</td>
</tr>
</tbody>
</table>

\(a\) Identified at tooth level, which means tooth-related.

\(b\) Radiographic standard for interpretation of proximal bone loss is that the alveolar crestal bone must be greater than 3 mm from the CEJ.\(^{(20)}\)

\(c\) Pulp sensitivity: cold, heat, electric (EPT) and percussion tests.

\(d\) Rarefying osteitis: radiolucent periapical bone destruction communicating with the periodontal ligament space via a discontinuity in the lamina dura.\(^{(21)}\)

\(e\) Criteria for assessment of root canal obturation: The prepared and filled canal should contain the original canal and should be filled completely (0.5-2 mm from radiographic apex). No space between canal filling and canal wall should be seen. No canal space should be visible beyond the end point of the root canal filling. The whole canal system/ all roots should be obturated (Consensus Report European Society of Endodontology)\(^{(22)}\)

\(f\) Hypersclerotic bone trabeculi adjacent to the periapical region and communicating with the periodontal ligament space.\(^{(21)}\)

\(g\) Distortion of the apical third of the tooth root characterized by increased width while the periodontal ligament space and lamina dura remain unaltered.\(^{(21)}\)

\(h\) Restorations are defective if any of the following conditions are present: marginal discrepancies >0.5 mm, part of the restoration missing, bulk fracture, or marginal staining of composites suggesting leakage.\(^{(23)}\)

\(i\) True radiographic secondary (i.e., recurrent) caries and/or residual caries.\(^{(23)}\)
Methods

Subjects

The subjects of this clinical survey, conducted in 1999, were patients who had undergone head and neck cancer therapy at the Department of Ot oro h inolaryngology and allied departments of the University Medical Center Utrecht, the Netherlands, between 1993 and 1998. Patients selected for inclusion in the clinical survey were required to satisfy the following conditions, they:

1. were in the regular oncology follow-up schedule;
2. had undergone primary cancer treatment, including radiotherapy, for squamous cell carcinoma in head and neck, one to five years previously;
3. were treated with the intention of curing the disease (patients receiving only palliative treatment or patients with active disease were not included for medico-ethical reasons);
4. had undergone preradiation dental screening;
5. were able to be examined postradiation.

Informed consent was acquired from the patients who were found to meet the criteria for entry in the study protocol.

Measures

The data on patient characteristics (i.e. age, gender) and comprehensive information on the head and neck cancer were retrieved from the hospital's ONCDAT database (courtesy of Prof. Dr. G.J. Hordijk). Data on radiotherapy, such as doses and fields, were obtained from the appropriate records, simulation radiographs, and computerized treatment planning. Using a specially designed clinical assessment form (the SCREDENT form, see Appendix 2), data on dental health status and tooth loss were obtained from the clinical records and from intraoral and extraoral radiographs by one examiner, a hospital dentist (HHB). A number of clinical records were re-analyzed in order to be able to assure satisfactory levels of intra-examiner reliability.

The clinical follow-up evaluation was carried out only on dentate patients and consisted of the same procedure as the preradiation oral screening. Patients' dental status was measured in terms of the number of teeth present (tooth retention). In addition, other essential findings of the clinical examination were recorded. DRFs that were measured according to the methods described earlier\(^{16}\) are in outlined in Table 5.1. In this survey, radiation caries is defined as extensive, primary circumferential caries involving more then one third of the crown and/or root circumference in patients who underwent high-dose radiotherapy in the head and neck region. Information on the incidence of osteoradionecrosis was retrieved from hospital records and the ONCDAT database.

Analysis

Initially, all data were transferred to a data matrix. The statistical analyses were done in SPSS 9.0 with the Advanced Statistic option (SPSS Inc. Chicago, Il) and S-PLUS 2000 for Windows (MathSoft Inc., Cambridge, MA), using a personal computer.
We first used descriptive statistics for the purpose of data screening and description of the sample of patients. We anticipated that tooth loss would not follow the normal distribution. A stem-and-leaf plot (Fig 5.1) indicated that tooth loss followed a Poisson distribution. Therefore, associations of tooth loss with age, gender, dental status, DRFs, and radiotherapy-related factors, respectively, were analyzed by means of a Poisson regression analysis. In addition, the Poisson regression analysis was done to test possible predictors for radiation caries at the time of the follow-up evaluation. In this survey, radiation caries is defined as extensive, primary root caries involving more than one third of root circumference. Statistically significant levels are designated as two-sided probability values, with \( p < 0.05 \).

**Figure 5.1** Stem and leaf plot of tooth loss in 98 patients, indicating a Poisson distribution.

**Results**

In total, 398 patients were initially selected for this clinical survey. Two hundred and nine patients (78.5% male and 21.5% female) fulfilled all inclusion criteria. The mean age was 60 years (median 60; range 33-84). The age distribution of males and females did not differ significantly (\( p > 0.05 \)). The median of follow-up time was 36 months (range 12-60).

The prevalence of head and neck cancer by site of occurrence for males and females is presented in Table 5.2.
It was found that 111 patients (53%) were edentulous, and 98 patients (47%) had a (reduced) natural dentition at the time of the preradiation oral screening (baseline). The total number of teeth present in 98 patients at baseline was 1,475 (mean number of teeth per patient: 15, range 31), of which 559 (37%) were situated in the upper jaw and 916 (63%) in the lower jaw. The total number of DRFs with high-risk level in the 98 dentate patients at baseline was 339 (mean number of high DRFs per patient: 3, range 15).

The incidence of total tooth loss in the 98 dentate patients was 602 (mean tooth loss per patient: 6, range 24). Prior to radiotherapy, 441 teeth (31% of the total number of teeth at baseline) were lost, and 161 teeth (11%) were lost thereafter. Table 5.3 presents a cross-tabulation of tooth loss by time and arch. As a result of the preradiation tooth extractions, 33 patients became edentulous. Thus, a full mouth clearance prior to radiotherapy was performed in 34% of the dentulous patients. In addition, 7 patients (7%) became edentulous in the follow-up period after radiotherapy.

Table 5.2  Frequency of head and neck cancer by site

<table>
<thead>
<tr>
<th>Sites of Squamous Cell Carcinoma (SCC)</th>
<th>ICD -9-CM code</th>
<th>Number of patients</th>
<th>Frequency %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oral cavity</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>lips</td>
<td>140</td>
<td>4</td>
<td>0.0</td>
</tr>
<tr>
<td>tongue</td>
<td>141</td>
<td>13</td>
<td>6.2</td>
</tr>
<tr>
<td>floor of the mouth</td>
<td>144</td>
<td>10</td>
<td>6.6</td>
</tr>
<tr>
<td>unspecified</td>
<td>145</td>
<td>11</td>
<td>5.2</td>
</tr>
<tr>
<td>Oropharynx</td>
<td>146</td>
<td>9</td>
<td>4.3</td>
</tr>
<tr>
<td>Nasopharynx</td>
<td>147</td>
<td>4</td>
<td>1.8</td>
</tr>
<tr>
<td>Hypopharynx</td>
<td>148</td>
<td>12</td>
<td>5.7</td>
</tr>
<tr>
<td>Nasal cavities</td>
<td>160</td>
<td>5</td>
<td>2.4</td>
</tr>
<tr>
<td>Larynx</td>
<td>161</td>
<td>94</td>
<td>44.8</td>
</tr>
<tr>
<td>Unspecified head and neck</td>
<td>199</td>
<td>3</td>
<td>1.4</td>
</tr>
<tr>
<td>Total</td>
<td>209</td>
<td>100</td>
<td></td>
</tr>
</tbody>
</table>

a International Classification of Diseases, Ninth Revision, Clinical Modification, as published by the U.S. Public Health Service and Health Care Financing Administration. M= male, F=female.

Table 5.3  Cross-tabulation of total tooth loss by time and arch (in 98 patients)

<table>
<thead>
<tr>
<th></th>
<th>Preradiation Tooth Loss</th>
<th>Postradiation Tooth Loss</th>
<th>Total Tooth Loss</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>in 98 patients</td>
<td>in 65 patients</td>
<td>in 98 patients</td>
</tr>
<tr>
<td></td>
<td>number</td>
<td>mean</td>
<td>range</td>
</tr>
<tr>
<td>Upper Arch</td>
<td>112</td>
<td>1.14</td>
<td>10</td>
</tr>
<tr>
<td>Lower Arch</td>
<td>329</td>
<td>3.36</td>
<td>13</td>
</tr>
<tr>
<td>Total</td>
<td>441 (73%)</td>
<td>4.50</td>
<td>24</td>
</tr>
</tbody>
</table>

75
Review of the simulation radiographs and computer-based treatment planning revealed that 185 teeth (12%) present at baseline in 35 patients would be in the planned field of radiation (dose > 55 Gy). Using the same radiation planning information, we estimated that the major salivary glands (parotid and/or submandibular glands) of 165 patients (79 %) were bilaterally, partially (at least for 50%), or totally in these radiation fields of 55 Gy or more. After preradiation dental extractions, 125 teeth (8% of the teeth present at baseline) in only 24 patients (24%) were actually in the field of radiation and received a dose of > 55 Gy.

At the time of the follow-up evaluation, 25 of the 56 dentate patients (45%) had one or more teeth affected by radiation caries that required extensive dental treatment or tooth extraction. This treatment need would of course further increase total tooth loss.

The Poisson regression analysis showed that association of tooth loss with dental status, the number of high DRFs, and the number of teeth in the high-dose field of radiation, are statistically significant, p < 0.001. The estimated association between expected tooth loss and dental status is shown in Fig 5.2. There was no statistically significant association between age and gender respectively, and total tooth loss. In addition, the Poisson regression analysis revealed that patients' number of teeth with radiation caries at the time of the follow-up evaluation was statistically significantly associated with the number of high DRFs at baseline with; p < 0.001).

The incidence of osteoradionecrosis (ORN) was 2.3%, i.e. 5 cases in the lower jaws of 1 edentulous and 4 dentate patients. These documented cases of osteoradionecrosis were successfully treated according to accepted protocols.(27)

**Discussion**

This clinical survey involved a retrospective and follow-up evaluation of 209 patients treated for cancer of the head and neck. The main objective was to investigate the association of tooth loss with dental status, dental risk factors (DRFs), and radiotherapy-related factors, respectively.

Analysis of patient-related and cancer-related characteristics revealed that the sample in the main compared with epidemiological data on age and gender of head and neck cancer patients.(12) At baseline, 53% of the patients were edentulous. This proportion is rather large compared to other countries. For example, in the United States, Marcus et al.(28) and Hunt et al.(29) found a proportion of about 24-29% in similar age groups, i.e. older white males and females. However, patients included in this study did not differ significantly from the population in the Netherlands within the same age groups.(30)

Total tooth loss in all patients was 602 (mean per patient: 6, range 24), which can be considered quite high. For example, in comparable age groups in the United States, the mean tooth loss among older white adults in an 18-month period was 0.4.(29) From the present study, it may be concluded that tooth loss in the head and neck cancer patients in this sample is considerably higher than the amount of tooth loss described in epidemiological studies concerning the general population. (4,6,28-30,32-44)
Figure 5.2  The estimated association of tooth loss with dental status. Each black circle represents a patient. Those on the diagonal represent patients who became edentulous as the result of pre- and/or postradiation tooth extractions. The dome-shaped line represents the fitted Poisson regression line, with covariate values: gender = male, and age = 60.

Logically, we may conclude that this substantial tooth loss is initiated by the circumstance that these patients underwent radiotherapy for a head and neck malignancy. Dental intervention in these cancer patients is important because dental pathology is a potentially significant problem. There is a strong need for dental treatment including tooth extractions, which is usually not perceived by the patients themselves, in order to prevent oral sequelae of radiotherapy.

The results of the Poisson regression analysis indicate that tooth loss was statistically significantly associated primarily with dental status at baseline and the number of high DRFs, and secondarily with factors concerning radiotherapy. This finding compares to our earlier conclusion that the decision policies of dental clinicians seem to be based primarily on dental factors, and to a lesser extent on factors concerning radiotherapy. It was noted that the association between dental status and tooth loss has a shallow dome-shape function form (see Fig 5.2). Thus, the amount of tooth loss increases when the number of retained teeth increases. However, the amount of tooth loss gradually decreases in patients who have more than 15 teeth, although these patients have more teeth that are "at risk" for potential tooth loss. It is plausible that patients who did not
experience substantial tooth loss in the past have better levels of dental health\(^{(46)}\) and therefore required less dental treatment, including tooth extraction, prior to radiotherapy.

The incidence of postradiation tooth loss (161 teeth, which is 27% of total tooth loss) and amount of radiation caries requiring extensive dental treatment including tooth extractions at the time of the follow-up evaluations was rather high. Possible explanations for postradiation tooth loss are that for practical considerations, tooth extraction of teeth not within the high-dose radiation field was postponed until after radiotherapy. In addition, poor patient compliance could have resulted in failure to adhere to dental treatment and oral hygiene recommendations. This may also explain the rather high levels of radiation caries at the time of the follow-up evaluation.

Patterns of non-compliance for dental treatment in head and neck cancer patients have been reported by several investigators.\(^{(4-9)}\) A review of the medical and dental literature by Ainamo & Ainamo\(^{(47)}\) shows that patients with chronic illness tend to comply poorly, especially when the treatment time is lengthy or the complexity high. Typical reasons for non-compliance are, among others, stressful life events,\(^{(48)}\) depression,\(^{(49)}\) and alcoholism.\(^{(50)}\) In addition, the lack of social network and social support, low interest in oral health, and "external locus of control" have been suggested as reasons for non-compliance.\(^{(9,51,52)}\) Whereas "internal locus of control" means that a person takes charge of his or her own health-care situation, an "external locus of control" is determined by the individual's perception that various environmental factors are beyond his/her control. It has been shown that patients with head and neck cancer tend more toward external locus of control.\(^{(9)}\) Non-compliance with dental care and oral hygiene is an important issue that deserves further attention.

The findings of this clinical survey also indicate that when a head and neck cancer patient presents with reduced dentition and/or with poor dental health at the preradiation oral screening, substantial tooth loss may result. Moreover, patients who have remaining teeth during irradiation are at risk of developing new dental pathosis, such as radiation caries. Subsequent to the radiation, a patient who presented initially with poor dental health may again need extensive dental treatment, including tooth extractions. Consequently, the preradiation treatment plan, enhanced by dental decision-making, should include this anticipation. Uncompromising preradiation dental intervention is therefore warranted. However, we believe that our findings justify undertaking a survey study that would further define the relationship between a head and neck cancer patient's perceptions regarding the need for dental rehabilitation and his or her ability to comply with the recommended dental treatment and oral hygiene measures. This could result in better-targeted recommendations, leading to optimization of dental and oral-hygiene care regimens in patients with head and neck cancer.

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References


