Tooth Loss Prior to Radiation in Relation to Tumor Location in Patients with Head and Neck Cancer

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Purpose: This study aimed to investigate the impact of preradiation tooth loss in patients with head and neck cancer. ***Materials and Methods:*** Records of 397 (partially) dentate patients who were referred for preradiation oral screening were included. Number and location of teeth lost and occluding pairs lost were determined for different tumor locations. ***Results:*** The majority of patients (54%) were affected by tooth loss. Proportion of teeth lost, their location, and proportion of occluding pairs lost were not evenly distributed across tumor locations. The highest proportions of teeth were removed with oral tumors (maxilla: 25%; mandible: 47%). For preradiation preventive extractions only, ie, not taking into account teeth that were lost due to ablative surgery, tooth loss in the mandible was still not evenly distributed across tumor locations, but tooth loss in the maxilla and occluding pairs lost were. ***Conclusions:*** Tumor location affects preradiation tooth loss, though this is primarily a consequence of ablative surgery rather than a consequence of preradiation dental extraction decisions. Since patients with oral cavity tumors are affected most by preradiation tooth loss, treatment planning with regard to functional rehabilitation is desirable for this patient group in particular. *Int J Prosthodont 2015;28:252–257. doi: 10.11607/ijp.4097*

Patients with head and neck cancer who have to undergo radiotherapy have an increased risk of caries, periodontal disease, oral infections, and impaired healing after surgical procedures in the oral cavity.[1–3] A systematic review revealed an incidence of 7% for osteoradionecrosis after tooth extraction in irradiated patients.[4] Preradiation oral screening is commonly applied to prevent complications related to radiotherapy by identification and removal of dental foci prior to the start of radiotherapy.[1,3,5–7] This often leads to extraction of teeth and oral rehabilitative needs, though the effectiveness of this therapy in the prevention of osteoradionecrosis can be questioned.[8,9] A recent evaluation revealed that periodontal disease, in particular, is a risk factor for osteoradionecrosis.[3]

Preradiation tooth loss may, in addition to the impact of surgical treatment and radiotherapy, lead to reduced oral function. A systematic review provided evidence that tooth loss is associated with impairment of oral health–related quality of life and that location and distribution of tooth loss affect the severity of the impairment.[10] For patients with head and neck cancer who have to undergo radiotherapy, average extraction numbers of 5.2 to 7.7 teeth per patient have been described.[1,3,7] Little information, however, is available on the number of preradiation dental extractions in relation to the number of teeth retained and on the location of preradiation tooth loss.

Preradiation dental extraction decisions are based on the anticipated radiation field and dose. It can, therefore, be expected that tooth loss depends on the location of the tumor, with regard to both the number and location of the teeth lost. Effective oral radiation dose for a larynx tumor may, for instance, be lower and more distally located than for a tumor in the oral cavity. This can have consequences for preradiation dental extraction decisions and the need for rehabilitation of oral function. Furthermore, preradiation tooth loss is not only caused by preventive dental extraction

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decisions, but also by ablative surgery. Ablative surgery for tumors in the oral cavity may more often lead to tooth loss than ablative surgery for larynx tumors. Data on the effect of tumor location on preradiation tooth loss are, however, not available.

The objective of this study was to investigate the impact of preradiation tooth loss in patients with head and neck cancer for different tumor locations. The null hypothesis was that there was no difference in preradiation tooth loss between tumor locations, with regard to both the number of teeth lost and their location.

Materials and Methods

Patient Sample

All patients with head and neck cancer who were referred to the hospital dental service for oral preradiation oral screening between January 2006 and December 2011 were selected from the hospital's database (n = 1,131). The majority of patients were referred by the department of otolaryngology (70%), followed by the department of oral and maxillofacial surgery (27%) and the department of radiotherapy (3%).

Patients who did not receive radiotherapy following oral screening were excluded from the study. When no preradiation panoramic radiograph was present, or when the quality of the radiograph did not allow adequate interpretation of the presence or absence of teeth, patients were also excluded from the study. Furthermore, patients were excluded whose postradiation chart did not reveal information on the presence of teeth, as were 145 patients who where edentulous or only had residual tooth roots or impacted teeth.

Of the original 1,131 patients who were referred for oral preradiation screening, 397 (35%) patients were included in this study. The mean age of the patients was 59.6 (SE = 11.5) years.

Clinical and Radiographic Examination

One dentist conducted the clinical and radiographic examination of patients with head and neck cancer as part of the oral preradiation screening. Panoramic radiographs were made for all patients. Preradiation extraction decisions were based on anticipated radiation field and dose, pretherapy dental status, dental hygiene, and ability to comply with preventive measures. Extraction was in general advised for teeth in the expected field of radiation in case of tooth mobility score 3,[11] periodontal pocket depths of more than 5 mm, extensive caries lesions, and/or periapical lesions.

Table 1 Distribution of Patients by Tumor Location (n = 397)

Tumor location	Patients (%)	Age (y) (SE)
Nose and paranasal sinuses	3	59.6 (4.6)
Oral cavity	20	60.3 (1.4)
Lip	0.5	
Tongue	4	
Other tissues	15	
Pharynx	44	58.1 (0.8)
Nasopharynx	5	
Oropharynx	29	
Hypopharynx	10	
Larynx	23	62.8 (1.0)
Glottic	15	
Supraglottic	8	
Subglottic	0	
Salivary glands	9	56.4 (2.7)
Parotid	7	
Submandibular	1	
Sublingual	0	
Other	1	
Skin	0.3	68.0 (NA)
Unknown primary tumor	1	62.4 (5.6)

SE = standard error; NA = not available.

Another dentist compared the preradiation radiographs with the postradiation records with regard to the presence or absence of teeth. Information was recorded on tooth type and tooth number. Teeth with the same type and number in opposing arches were recorded as occluding pairs. Residual tooth roots and impacted teeth were recorded as missing. Next to the clinical and radiographic examination, patients' charts were reviewed to record the reason for tooth loss. Reasons for tooth loss were classified as "preventive dental extraction decision" or "due to ablative surgery." Furthermore, patients' charts were reviewed to verify the location of the tumor (Table 1).

Data Analysis

The number of teeth lost, the location of teeth lost, and the number of occluding pairs lost were determined. These three aspects of tooth loss were analyzed for all teeth lost and also for teeth lost due to preradiation extraction decisions only, ie, not taking into account teeth that were lost due to ablative surgery. Tooth positions were indexed 1 for central incisors through 8 for third molars. For groups of teeth, the average positions were calculated. Occluding pairs were recorded as lost when at least one of the opposing teeth was lost after radiation therapy. Occluding pairs were subdivided in anterior occluding pairs (AOP, incisors and canines), premolar occluding pairs (POP), or molar occluding pairs (MOP).

The numbers of teeth present at screening or removed during treatment and locations of teeth generally are not normally distributed. Therefore, comparisons

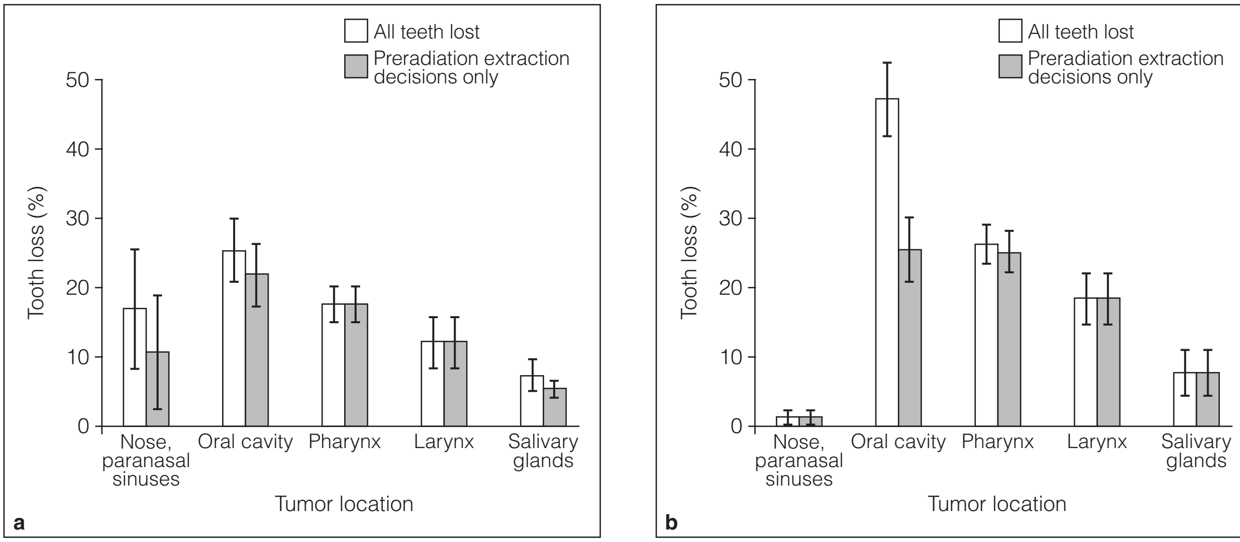

Fig 1 Percentages (and SE) of teeth lost for the different tumor locations in the **(a)** maxilla and **(b)** mandible.

Table 2 Numbers of Occluding Pairs Present at Preradiation Screening

Tumor location	Patients (n)	OP	AOP	POP	MOP
Nose and paranasal sinuses	12	10.2 ± 0.9	5.3 ± 0.4	2.9 ± 0.4	2.0 ± 0.3
Oral cavity	79	7.4 ± 0.6	3.9 ± 0.3	1.9 ± 0.2	1.5 ± 0.2
Pharynx	176	7.0 ± 0.4	3.8 ± 0.2	1.8 ± 0.1	1.4 ± 0.1
Larynx	90	6.6 ± 0.5	3.6 ± 0.3	1.7 ± 0.3	1.2 ± 0.2
Salivary glands	34	10.8 ± 0.6	5.5 ± 0.2	2.7 ± 0.2	2.6 ± 0.3
Total	391	7.4 ± 0.3	4.0 ± 0.1	1.9 ± 0.1	1.5 ± 0.1

OP = occluding pairs; AOP = anterior occluding pairs; POP = premolar occluding pairs; MOP = molar occluding pairs.

were performed with nonparametric tests. For differences between mandible and maxilla, the Mann-Whitney *U* test was used. The Kruskal-Wallis test was used to determine whether the distribution of variables was the same across categories of tumor locations. For this, the tumor locations were grouped into six categories (Table 1). In this analysis, patients with a skin tumor (n = 1) or with an unknown primary tumor (n = 5) were excluded. All tests were performed at a significance level of 5% (SPSS version 20, SPSS).

Results

At preradiation oral screening, 387 (97%) of the 397 patients were partially or completely dentate in the mandible, 320 (81%) patients had teeth in the maxilla, and 310 (78%) patients had teeth in both arches. The average numbers of teeth in the maxilla (11.0; SE 0.2) and the mandible (10.8; SE 0.2) did not differ significantly ($P = .52$). The majority of patients (54%) were affected by preradiation tooth loss. More teeth were lost in the mandible than in the maxilla (2.49; SE 0.19 versus 1.51; SE 0.16, $P < .001$). When teeth that were lost due to ablative surgery were not taken into account, this difference was smaller, but still significant (1.99; SE 0.17 versus 1.37; SE 0.15, $P < .003$).

At the oral screening, the number of teeth present was not evenly distributed across the tumor locations, in particular for the mandible (maxilla: $P = .055$, mandible: $P = .005$). As a consequence, the proportions of teeth lost per tumor location were compared rather than the numbers of teeth lost (Fig 1). For both arches, tooth loss was not evenly distributed across the tumor locations (maxilla: $P = .024$; mandible: $P < .001$). The highest proportions of teeth were removed with oral tumors: 25% from the maxilla and 47% from the mandible. The lowest proportions of teeth were removed with salivary glands tumors: 7.2% from the maxilla and 7.7% from the mandible. Only 1.4% of the teeth were removed from the mandible when the tumor was in the nose or paranasal sinuses. When only preradiation preventive extractions were considered, tooth loss decreased for tumors in the oral cavity in particular. As a consequence, tumor location no longer affected tooth loss in the maxilla ($P = .117$) but still in the mandible ($P = .012$).

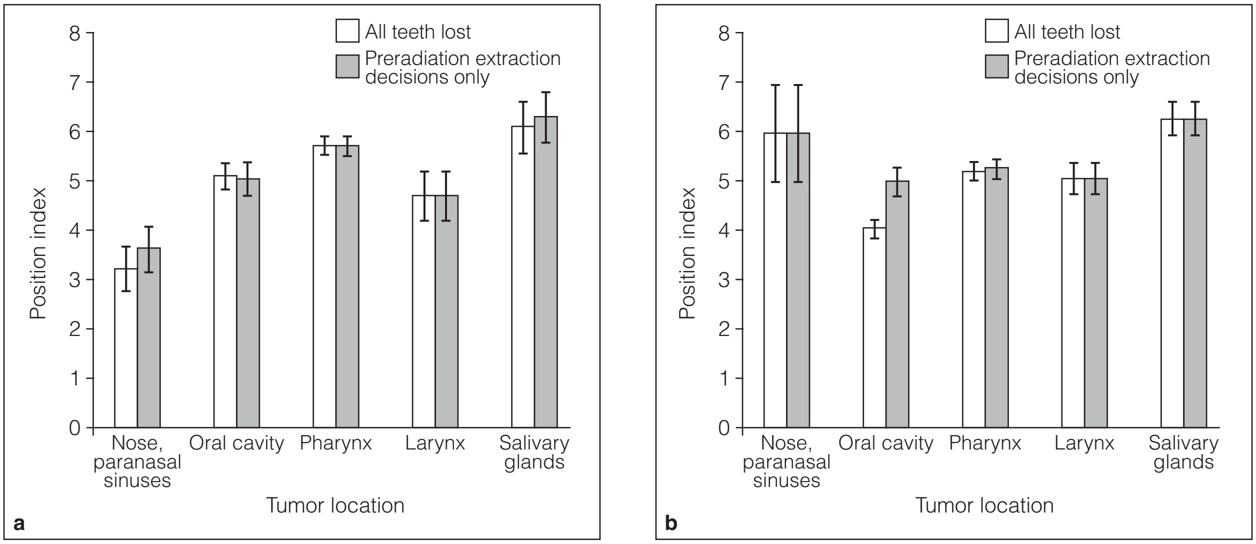

Fig 2 Position indices (and SE) for teeth lost for the different tumor locations in **(a)** maxilla and **(b)** mandible.

Table 3 Proportions (%) of Occluding Pairs Lost Due to Dental Extraction Decisions and/or Ablative Surgery

Tumor location	Patients (n)*	OP	AOP	POP	MOP
Nose and paranasal sinuses	11–12	20.3 ± 9.4	25.0 ± 12	13.6 ± 10	15.2 ± 10
Oral cavity	40–60	43.4 ± 5.5	37.7 ± 6.0	43.6 ± 5.8	48.0 ± 7.1
Pharynx	93–131	19.4 ± 2.8	13.0 ± 2.8	17.5 ± 3.2	38.6 ± 4.7
Larynx	43–64	15.6 ± 4.0	10.8 ± 3.9	14.4 ± 4.4	22.1 ± 5.8
Salivary glands	27–33	7.1 ± 2.5	3.0 ± 2.5	5.7 ± 2.8	25.1 ± 7.3
Total	214–300	22.1 ± 2.0	16.8 ± 2.1	20.5 ± 2.2	34.1 ± 3.0

OP = occluding pairs; AOP = anterior occluding pairs; POP = premolar occluding pairs; MOP = molar occluding pairs.
*Number of patients with occluding pairs present at preradiation screening for the different categories of occluding pairs.

Table 2 shows the number of occluding pairs present at preradiation screening. The number of occluding pairs was not evenly distributed among the different tumor locations ($P < .01$ to $P < .001$ for the different categories of occluding pairs). Patients with a tumor in the nasal cavity or the salivary glands had more occluding pairs at preradiation screening than patients with a tumor in the oral cavity, pharynx, or larynx. Table 3 shows the proportional loss of occluding pairs. The proportional loss of occluding pairs was also not evenly distributed among the different tumor locations ($P < .05$ to $P < .001$). Loss of occluding pairs was highest with oral cavity tumors. The lowest losses of occluding pairs were observed with salivary glands tumors, with the exception of the molar region. When only preradiation preventive extractions were considered, loss of occluding pairs did not differ significantly among the tumor locations ($P = .17$ to $P = .71$).

Figure 2 shows the positions of the teeth removed prior to the start of radiotherapy. The average position of the teeth that were lost was higher in the maxilla than in the mandible (5.39; SE 0.15 versus 4.95; SE 0.13, $P < .035$). This means that teeth lost from the maxilla were on average 0.44 tooth position distal to teeth lost from the mandible. Tumor location affected the position of the teeth lost, both in the maxilla ($P = .002$) and in the mandible ($P < .001$). When only preradiation extractions were considered, the average position of the teeth removed from the mandible increased, ie, became more distal, with tumors located in the oral cavity. In that case, the average position of the teeth removed no longer differed between maxilla and mandible (5.45; SE 0.16 versus 5.26; SE 0.13, $P = .45$) and tumor location still affected the position of tooth loss in the maxilla ($P = .008$), but no longer in the mandible ($P = .28$).

Discussion

Preradiation oral screening is applied as a preventive measure for osteoradionecrosis, and several models for decision making are available.[6,12,13] Since development of osteoradionecrosis has major consequences, a generally accepted approach is to remove potential oral foci prior to the start of radiotherapy. This retrospective study assessed the impact of preradiation tooth loss on dental status.

The patients included in this study were treated over the course of 6 years, during which new cancer therapies were introduced, such as intensity modulated radiotherapy (IMRT).[14] This technique should reduce exposure of healthy tissue to radiation and, consequently, the incidence of osteoradionecrosis. However, a systematic review showed that new cancer treatment modalities have minimal effect on the prevalence of osteoradionecrosis.[15] Furthermore, no evidence is available yet that IMRT leads to decreased tooth loss postradiation.[16] This suggests that preradiation oral screening is still necessary for patients with head and neck cancer who have to undergo radiotherapy.

The majority of patients included in this study were affected by preradiation tooth loss. The number of teeth lost as well as their position depended on the location of the tumor. Therefore, the authors reject the null hypothesis that tumor location does not affect preradiation tooth loss with respect to the number of teeth lost and their location. When teeth lost to ablative surgery were not taken into account, however, the effect of tumor location on number and position of lost teeth decreased. This suggests that differences in preradiation tooth loss between tumor locations are caused by ablative surgery rather than preradiation dental extraction decisions. As a consequence, the results of this study confirm the practice of preradiation oral screening with cancers of the head and neck region that are relatively distant from the oral cavity.

An unexpected finding of this study was that patients with a tumor in the oral cavity, pharynx, or larynx had fewer occluding pairs at preradiation screening than patients with a tumor in the nose or the salivary glands. The distribution of patient age proved to differ across the tumor locations ($P = .017$). Patients with a tumor in the salivary glands were on average youngest (56.4 years; SE = 2.7), and patients with a tumor in the larynx were oldest (62.8 years; SE = 1.0). The authors did not expect, however, that age was the main factor contributing to the variation in the amount of occluding pairs at preradiation screening. It seemed more likely that risk factors for cancer in the oral cavity, pharynx, or larynx (eg, smoking habits, alcohol) also have consequences for the dental status. Dental health behavior is associated with lifestyle, including smoking habits and alcohol consumption.[17] Furthermore, smoking is a significant factor for the probability of not planning regular dental visits.[18]

With regard to the impact of preradiation tooth loss, patients with oral cavity tumors were affected most severely. In general, the authors strive to conserve anterior and premolar occluding pairs to maintain a shortened dental arch.[19] Consequently, the highest proportions of occluding pairs are lost in the molar region, except with tumors in the nose and paranasal sinuses. With tumors in the oral cavity, however, not only were 48% of molar occluding pairs lost, but also about 40% of occluding pairs in the premolar and anterior regions. With a reduced dentition at preradiation screening, treatment planning with regard to functional rehabilitation seemed to be desirable for this patient group in particular. The placement of interforaminal implants during ablative surgery is a treatment option in these cases, though implant positioning can be difficult because of the unpredictably altered anatomy, scar tissue formation, and trismus.[20]

The results of this study indicate that the majority of patients with head and neck cancer who have to undergo radiotherapy are prone to preradiation tooth loss. The cancer and subsequent radiotherapy treatment can have a major impact on oral function and quality of life.[21,22] Given the association between tooth loss and oral health–related quality of life in healthy patients,[10] it can be expected that tooth loss in patients with head and neck cancer has an additional impact on oral function and quality of life. A prospective study design is necessary to assess the association between preradiation tooth loss on oral function and oral health–related quality of life.

Conclusions

The results of this study suggest that tumor location affects preradiation tooth loss, though this is primarily a consequence of ablative surgery rather than a consequence of preradiation dental extraction decisions. Because patients with oral cavity tumors are affected most by preradiation tooth loss, treatment planning with regard to functional rehabilitation is desirable for this patient group in particular.

Acknowledgments

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Literature Abstract

Immediate nonfunctional versus immediate functional loading and dental implant failure rates: A systematic review and meta-analysis

This study investigated and compared implant survival rates, postoperative infection and marginal bone loss for patients with dental implants subjected to immediate functional loading (IFL) and immediate nonfunctional loading (INFL) protocols. An electronic search undertaken in March 2014 yielded 11 studies that included human clinical trials (7 studies of high risk bias and 4 studies of low risk bias). From these studies, 821 implants received INFL with 17 failures (2.1%), and 1,231 implants received IFL with 26 failures (2.1%). The estimates of relative effect were expressed in risk ratio and in mean difference in millimeters with a 95% confidence interval (CI). The results showed that the procedure (INFL versus IFL) did not significantly affect implant failure rates ($P = .07$), with a risk ratio of 0.87 (95% CI: 0.44 to 1.75). Meta-analysis of the occurrence of postoperative infection was not possible due to the lack of data. No statistically significant effect on marginal bone loss was found between the procedures. The authors concluded that differences between INFL and IFL might not affect implant failure rates and marginal bone loss. However, these results should be interpreted with caution due to limitations of this study that involve confounding factors such as the use of grafting in some studies, different implant sites, different brands of implant, and other uncontrolled variables.

Chrcanovic BR, Albrektsson T, Wennerberg A. *J Dent* 2014;42:1052–1059. **References:** 32. **Reprints:** Bruno Ramos Chrcanovic, Department of Prosthodontics, Faculty of Odontology, Malmö University, Carl Gustafs väg 34, SE-205 06, Malmö, Sweden. Fax: +46 40 6658503. Email: bruno.chrcanovic@mah.se—*Teo Juin Wei, Singapore*