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Pre-irradiation dental care: Ready-to-use templates for oropharyngeal cancers

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ABSTRACT

Aim: To develop a tool in order to guide pre-irradiation dental care (PIDC) for patients with oropharyngeal cancers.
Background: Osteoradionecrosis of the jaws is a potential complication of radiotherapy (RT) for head and neck cancers. To prevent this complication, PIDC can involve multiple dental extractions as a preventative measure to avoid post-RT complications. However, there is no standardized tool to guide PIDC.
Materials and methods: From January 2005 to October 2015, 120 head and neck cancer patients were prospectively included in a study investigating dysgeusia after RT. From this cohort, patients were enrolled according to the following inclusion criteria: histopathological confirmation of oropharyngeal squamous cell carcinoma; stage T1-4 N1-3 M0; ≤10 missing teeth. Individual teeth were retrospectively delineated on planning computed tomography and doses to dentition were assessed to generate templates.
Results: Thirty-three patients were included. Molars received highest doses with a mean dose of 50 Gy (range; 19–75 Gy). Ipsi-lateral and contralateral wisdom teeth received RT dose superior to 50 Gy in 92% and 56% of cases, respectively. Patients with advanced disease (T4 or N2c-3) received higher mean doses on inferior and ipsi-lateral dental arches compared to other patients (T1-3 N0-2b): 42 Gy *vs.* 39 Gy and 44 Gy *vs.* 39 Gy ($p < 0.05$), respectively.
Conclusion: Pre-RT dose distribution templates are an objective way to prepare PIDC. Further studies with a larger cohort are needed to validate these templates.

1. Background

In Europe, head and neck cancer (HNC) accounts for approximately 140,000 cases corresponding to 4% of newly diagnosed cancers.[1] In recent years, advances in treatment have been associated with an increasing number of long term cancer survivors, stressing the need for decreasing long-term complications from treatments and improving patient's quality of life. Radiotherapy (RT), alone or associated with chemother-

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apy, is a cornerstone of care for HNC, requiring 30–35 days of treatment over 6–7 weeks.[2]

Irradiation of the oral cavity, mandible and salivary glands leads to various oral complications, including mucositis,[3] xerostomia,[4] radiation-induced caries,[5,6] trismus[7] or osteoradionecrosis.[8] Osteoradionecrosis is a serious complication that can be associated with significant morbidity that can sometimes lead to radical mandibulectomy.[9] To prevent this complication, pre-irradiation dental care (PIDC) in HNC patients undergoing RT is crucial.[10] PIDC involves elimination of oral disease such as caries, abscess and periodontal disease.[11] PIDC can lead to multiple dental extractions knowing the dose on dental arches as a preventive measure to avoid post-radiotherapy complications.[12] To guide oral health professionals during PIDC, an individualized dental map is typically requested from radiation oncologists based on an estimation of expected dose distribution to dental arches.

In the last decade, intensity modulated radiotherapy (IMRT) has become the standard of care for HNC RT treatment. IMRT has been associated with significant difference in dose distribution compared with older tri-dimensional techniques.[13] However, there is currently no standardized tool to guide PIDC for locally advanced HNC.

2. Aim

The aim of this study was to develop predictive dose distribution templates, ready-to-use by oral health professionals, to guide PIDC for locally advanced oropharyngeal cancers treated with IMRT.

3. Materials and methods

3.1. *Patients characteristics*

From January 2005 to October 2015, 120 HNC patients from our institution were prospectively included in a study investigating dysgeusia after RT of the oral cavity, nasopharynx, larynx/hypopharynx, and oropharynx. From this cohort, patients with locally advanced oropharyngeal squamous cell carcinoma were included. Patients with more than 10 missing teeth were excluded from this study. All patients received IMRT with a bilateral irradiation of the neck. This study was approved by our institutional review board and ethics committee.

3.2. *Treatment characteristics*

All patients had a 1.5 mm slice thickness planning computed tomography (CT) scan in a supine position from the vertex to the carina with and without intravenous contrast injection. Immobilization was achieved with a thermoplastic mask of the head and shoulder fixed to the treatment table. When available, positron tomography (PET)-CT scan and magnetic resonance imaging for tumor imaging were fused with the planning CT.

Treatment volumes were as follows: the gross tumor volume (GTV) was defined as the macroscopic primary tumor and involved lymph nodes based on planning CT as well as multimodality imaging when available; the clinical tumor volume (CTV1) was defined as the GTV volume with an additional margin for microscopic spread (2–5 mm); the high-risk CTV (CTV2) was defined as the CTV1 with an additional 1 cm margin and inclusion of nearby high risk anatomic areas, as well as the adjacent lymph node levels; the low-risk CTV (CTV3) included the contralateral uninvolved lymph node level. An additional 2–5 mm margin was added to each CTV for planning target volume (PTV). Patients were planned to receive a dose of 59.4 in 33 fractions Gy to PTV2, with a simultaneous integrated boost to 69.96 Gy in 33 fractions to PTV1. Low risk PTV (PTV3) was treated with 50.4 Gy in 28 fractions. Patients were treated using 6-MV photons, and treatment was given in 5 daily fractions per week. Treatment plans were normalized so that the prescription dose (100%) covered at least 95% of the PTV volume. Treatment techniques included Helical Tomotherapy and volumetric modulated arc therapy (VMAT).

3.3. *Teeth delineation*

Because dose to individual teeth was not routinely evaluated, each tooth was retrospectively delineated on all planning CTs. Teeth delineation was done under a window level and width of 650 and 2000 Hounsfield unit. Teeth delineation was reviewed with an expert oral and maxillofacial surgeon and included the crown as well as the entire root and adjacent bony structure. In the case of a missing tooth, the corresponding dental alveoli, including tooth socket and adjacent bony structure, were contoured. The international teeth numbering system was used for numerical identification of individual teeth[14] (Fig. 1).

3.4. *Statistics*

Statistical analysis was performed by SPSS software (SPSS Inc., Chicago, IL, USA). Teeth structures were used to evaluate the maximum point dose (Dmax) received by each tooth and the mean dose to dental arches (superior, inferior, ipsi-lateral and contralateral). All dosimetric parameters were extracted from dose-volume histogram analysis. Teeth receiving >60 Gy, 50–60 Gy and 40–50 Gy were considered as high risk, intermediate risk and low risk, respectively.[15,16] Doses to dental arches were then compared using Student's *T*-test. p values less than 0.05 were considered statistically significant.

4. Results

4.1. *Patients and lesions characteristics*

Among the 120 patients from the dysgeusia database, 33 were eligible for analysis. Patient and lesion characteristics are summarized in Table 1. Regarding RT technique, 27 (82%) patients were treated with Helical Tomotherapy while 6 (18%) patients were treated using VMAT.

4.2. *Dental arches*

Superior dental arches received lower RT dose than inferior dental arches: 36 Gy *vs.* 40 Gy ($p < 0.05$); and ipsi-lateral hemiarches received higher RT dose than contralateral: 41 Gy *vs.*