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Effect of postoperative radiotherapy on the functional result of implants placed during ablative surgery for oral cancer

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Abstract. The purpose of this retrospective study was to evaluate the survival of dental implants placed during ablative surgery in the interforaminal region of the original edentulous mandible in patients with squamous cell carcinoma of the oral cavity in relation to postoperative radiotherapy. Forty-eight patients treated in 1996–2003 with surgery alone or in combination with postoperative radiotherapy were analysed. In all patients, 2 to 4 Brånemark Mk II/III 2-phase implants were placed during tumour resection. A total of 139 implants were placed of which 61 (21 patients) received postoperative radiotherapy: 60–68 Gy as a boost dose on the primary tumour site and 10–68 Gy on the symphyseal area. No difference was found in percentage of functional dentures on implants between the radiated and non-radiated groups. The success rate of osseointegration was 97% in the postoperative irradiated group and 100% in the non-irradiated group. The prosthetic success rate (75%) was lower because in 12 of the 48 patients (34 implants) a functional denture could not be fitted due to tumour recurrence or metastasis (7 patients, 22 implants) or for psychological reasons (4 patients, 12 implants), independent of whether radiotherapy was administered. Postoperative radiotherapy does not affect the osseointegration of dental implants placed during tumour ablation and the ultimate number of functional dentures. Primary implant placement in edentulous mandibles may have advantages over secondary implant placement in patients with oral squamous cell carcinoma.

Key words: oncology; implants; mandible; radiotherapy; ablative surgery; rehabilitation.

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The incidence of squamous cell carcinoma (SCC) of the oral cavity in the Netherlands is 9.3 per 100,000[21]. Surgery, whether or not followed by radiotherapy, is generally the treatment of choice. According to the guidelines of the Dutch Cooperative Head and Neck Oncology Group the indications for postoperative radiotherapy include irradical resection, a combination of close resection margins (<5 mm) and an aggressive growth pattern (perineural and spidery growth), and multiple nodal

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metastases or metastases with extracapsular extension[13]. After surgical treatment, mastication, swallowing, speech and oral comfort are often impaired[4]. Some of these problems can be solved by adequate dental rehabilitation[9], but this is often complicated by anatomical changes due to tumour resection and reconstruction. A decreased area of attached mucosa and limited freedom of movement of the tongue are the most frequently seen problems. Postoperative radiotherapy worsens these conditions, and has a negative effect on salivary flow rates, resulting in xerostomia and making the already 'damaged' mucosa of the oral cavity even more prone to injury[2,10].

Up to 40% of the patients are edentulous in the mandible when the tumour is diagnosed or become so after surgery[15]. Dental implants may improve denture retention and stability without unnecessary loading of the vulnerable mucosa[7,9,18]. Function, comfort, aesthetics and finally quality of life can be improved[14].

Dental implants can be inserted during ablative surgery (primary) or after completed tumour therapy (secondary)[18]. The advantage of secondary placement is that the anatomical situation, residual function and prognosis can be taken into account in the decision of whether to use implants. There are disadvantages to secondarily placed implants[9]. After radiotherapy, the vascularization and regenerative ability of the irradiated tissues can be decreased, which may lessen the prospect of successful osseointegration of the dental implants. Surgical intervention in irradiated bone is also thought to increase the risk of osteoradionecrosis when a curative dose (>60 Gy) of radiotherapy is administered[5,6]. There is no scientific evidence for the optimal timing of secondary implant placement[18]. Because of the acute side effects of radiotherapy, it seems best to wait at least 3–4 months after completion of tumour therapy. Patients are often psychologically and physically weakened by the therapy, resulting in postponement or even cancellation of prosthetic rehabilitation[4].

It is known that secondary placement of mandibular implants in patients with oral or oropharyngeal SCC results in osseointegration of 65–100% (weighted mean 88.6%) of the implants[1,3,9,11,18,20,22,23]. Up to 35% of the implants secondarily placed in irradiated mandibular bone are reported to be lost because of problems in osseointegration[4]. This is in contrast to non-oncological patients in which implant survival in mandibles is up to 90–100%[8,18]. It is presently unknown whether postoperative radiotherapy has a negative effect on the survival of primary placed implants located in the radiation field. It has recently been advocated to insert dental implants during the ablative surgical session, if possible[17,18]. Prosthetic dental rehabilitation can start early and problems related to postoperative radiotherapy may be prevented. A large part of the integration will occur in the period between surgery and radiotherapy, i.e. within 4–6 weeks[17]. In a healthy mandible, the whole integration process will take nearly 3 months. Until now no scientific clinical data have been reported indicating that radiotherapy affects the osseointegration process negatively. In an animal study (rats), impaired osteogenesis and absence of osseointegration of titanium laminar implants in tibiae were seen when placed 4-day postirradiation[12]. The purpose of this study was to analyse the yield of primary implant placement in patients with SCC of the oral cavity with or without adjuvant radiotherapy.

Material and methods

Population

In this study 48 consecutive patients diagnosed with a primary SCC in the oral cavity and treated in the period 1996–2003 were included. There were 29 men and 19 women with a mean age of 64.8 years (±10.2) and 68.1 years (±10.4), respectively. All patients were already edentulous and wearing a full denture at the time of diagnosis. They expressed the wish to have a full denture prosthesis fitted after finishing oncology treatment. An experienced prosthodontist, as a member of the head and neck oncology team, suggested in these 48 patients a new full denture supported by dental implants.

In all patients, 2–4 Brånemark Mk II/III 2-phase implants were inserted in the symphyseal area during ablative surgery (Fig. 1). In patients receiving postoperative radiotherapy, the symphyseal area and all implants were positioned in the radiation field. Patients who had mandibular reconstructions using microrevascularized bone grafts or homologous bone transplants were excluded. All patients had a regional (levels I–III) or modified radical (levels I–V) neck dissection. The ablative oral defects were closed primarily, or covered with a split-thickness skin graft or revascularized soft-tissue free flap. Based on the histological findings, postoperative radiotherapy was offered in accordance with Dutch guidelines in a dose of 60–68 Gy within 6 weeks of ablation of the tumour on the primary tumour site[13]. The period of implant insertion until abutment placement was kept to a minimum of 3 months in non-radiated patients, whereas in irradiated patients there was a minimum interval of 3 months between the end of radiotherapy and abutment placement.

Data were obtained from patient files of the departments of Oral and Maxillofacial Surgery, Radiotherapy and Special Dental Care of the Radboud University Nijmegen Medical Centre (The Netherlands). The following data were collected: TNM classification[19], tumour location, number of implants (functional or non-functional), individual implant-related radiation dose, time interval between the end of radiotherapy and abutment placement, functioning of the mandibular denture on implants, and causes and time of prosthesis failure. To determine the radiation dose delivered to the individual implants, radiotherapy treatment plans and simulation X-ray films were reviewed. Patients who received postoperative radiation were compared to those who did not.

Statistical analysis

Data are shown as mean ± standard deviation (SD). The χ^2-test was used to compare the 2 groups with regard to time interval between implant insertion and abutment placement and the number of soft-tissue corrections. Differences were considered significant at $P < 0.05$. Statistical analysis was performed using SPSS 12.0 (SPSS Inc., Chicago, USA).

Results

In 48 consecutive patients with a SCC of the oral cavity 139 implants were placed during ablative surgery (Table 1). Twenty-one patients (61 implants) received postoperative radiotherapy (60–68 Gy as a boost dose on the primary tumour site and 10–68 Gy on the symphyseal area; Fig. 2), while 27 patients (78 implants) were treated with surgery alone (Table 1). The average time interval between surgery and the start of radiotherapy was 6 weeks. The average time interval between insertion of implants and abutment placement in the postoperative irradiated group was 9 months (SD 3.6) and in the surgery-only group 4.7 months (SD 1.9) ($P = 0.01$). The average time interval between the last radiation session and the last prosthesis evaluation was 29.6 months ($n = 14$, maximum = 89) for the patients still alive at the time of data collection (May 2004). The difference in time interval between the end of the overall oncological treat-