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Clinical Paper
Dental Implants

Long-term success of dental implants in patients with head and neck cancer after radiation therapy

M. M. Curi[a,b], A. F. B. Condezo[c], K. d. C. B. Ribeiro[d], C. L. Cardoso[c]
[a]Department of Stomatology, Hospital Santa Catarina, São Paulo, SP, Brazil; [b]Faculdade do Centro Oeste Paulista, Bauru, SP, Brazil; [c]Department of Oral Surgery, Universidade do Sagrado Coração, Bauru, São Paulo, Brazil; [d]Department of Social Medicine, Faculdade de Ciências Médicas da Santa Casa de São Paulo, Brazil

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Abstract. The purpose of this study was to analyze the long-term success and factors potentially influencing the success of dental implants placed in patients with head and neck cancer who underwent radiation therapy with a minimum total dose of 50 Gy during the years 1995–2010. Thirty-five patients (169 dental implants) were included in this study. Data on demographic characteristics, tumour type, radiation therapy, implant sites, implant dimensions, and hyperbaric oxygen therapy (HBOT) were obtained from the medical records and analyzed. Implant survival was estimated using Kaplan–Meier survival curves. Seventy-nine dental implants were placed in the maxilla and 90 in the mandible. The mean follow-up after implant installation was 7.4 years (range 0.3–14.7 years). The overall 5-year survival rate for all implants was 92.9%. Sex ($P < 0.001$) and the mode of radiation therapy delivery ($P = 0.005$) had a statistically significant influence on implant survival. Age, time of implantation after irradiation, implant brand and dimensions, and HBOT had no statistically significant influence on implant survival. Osseointegrated dental implants can be used successfully in the oral rehabilitation of patients with head and neck cancer with a history of radiation therapy. Risk factors such as sex and the mode of radiation therapy delivery can affect implant survival.

Key words: dental implants; head and neck cancer; radiation therapy; irradiated patients.

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Patients with head and neck cancer are commonly treated using a combination of ablative surgery and radiation therapy. Several oral complications may occur as a result of these treatments modalities, including reduced and altered anatomical structure, reduced salivary flow rate, and defects of the soft and hard tissues, resulting in functional disabilities and aesthetic deformity[1–9]. These defects usually require tissue grafting procedures with vascularized or non-vascularized flaps for oral reconstruction[2,10]. Dental and prosthodontic rehabilitation can significantly improve the quality of life of patients after head and neck cancer treatment; however, it can be considered a challenging procedure[2,3,10,11].

Irradiation injury to the bone and surrounding soft tissues is a critical factor for oral rehabilitation using dental implant-

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supported prostheses. Radiation injury directly affects bone cells, collagen, and blood vessels[9,12]. Endothelial cell injury triggers an acute inflammatory response characterized by increased vascular permeability with local edema and destruction of endothelial cells, followed by vascular thrombosis[9]. Late irradiation injuries in bone marrow and the soft tissues, such as hypocellularity and hypovascularity with a markedly dense extracellular matrix, lead to compromised bone and soft tissue healing capacity, which may affect the osseointegration of dental implants[9,12]. It has been concluded that irradiation-induced injuries such as cellular loss (hypocellularity) and fibrosis are expressed to a greater extent in bone tissue than in the surrounding soft tissues[9,12].

As a result of these post-treatment conditions, the possibility of oral rehabilitation using mucosa-supported prostheses or tissue grafting procedures is much more difficult or even impossible. Adjunctive radiotherapy to the jaws is no longer considered an absolute contraindication to dental implant placement[1–8,11,13–22,23–29]. Dental implants in combination with prostheses have been used to restore function, speech, comfort, and quality of life[1–8,11,13–22,23–29]. However, to achieve satisfactory dental rehabilitation results in irradiated patients with head and neck cancer using implant-supported prostheses, many risk factors such as age, sex, implant site, total radiation dose, time period between the end of radiotherapy and implant surgery, and type of radiation therapy should be considered.

In view of the limited number of studies on implant survival rates in irradiated patients with head and neck cancer[2,4,5,7,13,14], the aim of this study was to evaluate the long-term survival of dental implants in the oral rehabilitation of these patients and to analyze the clinical risk factors that could adversely affect implant survival.

Patients and methods

Study design

The institutional review board granted approval for this retrospective cohort study. The medical records of all patients who had undergone oral rehabilitation with dental implants after treatment for head and neck cancer consisting of ablative surgery followed by adjunctive radiotherapy, between 1995 and 2010, were identified and reviewed. The oncological treatment was investigated. This included the cancer type, all oncological surgical procedures, and the irradiation protocols (type of radiotherapy, dose fraction, timing, and total dose). Data on age, sex, cancer type, surgery, radiation therapy (type, dose fraction, and total dose), use of hyperbaric oxygen therapy (HBOT), and dental implant treatment (surgery date, type, location site, dimensions, and success) were also reviewed retrospectively. Long-term follow-up data were also collected from the patient records. Implant installation surgery was performed by a single oral and maxillofacial surgeon (M. M.C.).

The following inclusion criteria were applied: head and neck cancer patients; postoperative adjunctive radiation therapy administered before implant placement with a minimum total dose of 50 Gy; the only suitable option to preserve mastication, swallowing, and speech was implant placement; and prosthetic rehabilitation had been completed. Patients were excluded if they had received a total radiation dose lower than 50 Gy, had a past or current medical history of bisphosphonate medication use, if complete data collection was not possible, or if prosthetic rehabilitation had not been completed.

Data collection

The data were collected retrospectively from the oncology database and dental and medical case records, radiographs, and radiotherapy planning records by a single author (M.M.C).

Patients and treatments

All dental implants were installed inside the irradiation field. (The anatomical region of implant placement was checked by means of reports of the radiotherapy protocols provided by the radiotherapist.) The treatment of the patients with dental implants, as well as the prosthodontic rehabilitation with implant-supported prostheses, was performed at the Department of Oral Maxillofacial Surgery, Hospital Santa Catarina, São Paulo, Brazil. Patients who dropped out during the study observation period had their implants documented according to the last follow-up assessment. All dental implants were installed in a two-stage surgical procedure and only one implant type was used for oral rehabilitation (Replace Select Tapered TiUnite; Nobel Biocare, Yorba Linda, CA, USA). None of the patients developed osteoradionecrosis (ORN) after implant installation surgery or even when implants were lost during follow-up. The length of dental implants used varied from 10 mm to 16 mm. The implant healing time was 6 months in all cases. Antibiotic therapy was administered to all patients with clindamycin 300 mg, four times daily for a week (started 1 day preoperative and extended for 6 days postoperative).

Implant success was assessed according to the criteria proposed by Buser et al.[30]. These parameters included implants in function without pain, absence of mobility, absence of recurrent peri-implant infection, absence of peri-implant radiolucency during radiographic evaluation, and absence of progressive marginal bone loss. Subjective patient satisfaction was evaluated using the parameters of improvement in mastication, speech intelligibility, and facial aesthetics after prosthesis delivery. Survival time was observed from implant installation surgery to failure or last control of the implant.

Patients who were treated with prophylactic HBOT received the Marx protocol[9] (2.4 atmospheres absolute, 2 h per session; 20 sessions preoperatively and 10 sessions after implant surgery). All patients were followed-up postoperatively by clinical examination at 3-month intervals during the first year after implant surgery and at 6-month intervals during the further course of this study. Implant success was assessed via clinical examination and radiographic investigation.

Statistical analysis

Implant success rates were analyzed as cumulative survival using the Kaplan–Meier method (time-to-event analysis). Success rates were estimated for an implant-based analysis, and each implant was considered independently. Differences between curves were evaluated by log-rank test, in terms of age, sex, type of radiation therapy, HBOT, and implant location. Cox regression analysis was used to identify independent predictors of implant failure, including the estimation of crude and adjusted hazard ratios (HR) and corresponding 95% confidence intervals (95% CI). Results were considered statistically significant when $P < 0.05$. Stata for Mac version 13.0 was used for all statistical analyses (StataCorp LP, College Station, TX, USA).

Results

This study had a mean follow-up period of 7.43 years after implant installation surgery, ranging from 0.3 to 14.7 years (0.28 to 14.73 years). The series consisted of 35

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