Lower protocol in patient submitted to radiotherapy: Case report

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Abstract

Introduction: Combining surgery and radiotherapy is common to treat malignant tumors of the head and neck. Such procedure establishes tissue alterations that result in fragile mucosa, xerostomia, improper anatomical shape and myodynamic disorders, which hinders patient's oral function and rehabilitation. Placement of implant-supported prosthesis proves useful for rehabilitation of those patients. **Objective:** The present study reports a case of a patient subjected to high doses of radiotherapy after surgical removal of a malignant tumor located on the floor of the mouth. **Methods:** Six implants were installed in the anterior region of the mandible and a prosthesis was fabricated according to Brånemark's protocol. **Conclusion:** It is reasonable to conclude that osseointegrated implants can be safely employed, provided that special care be taken with regard to the adverse effects produced by resection and radiotherapy. Improvements in mastication, speech and esthetics promote patient's social reintegration, thus minimizing discomfort and suffering, in addition to optimizing therapeutic results and quality of life.

Keywords: Dental implants. Osseointegration. Radiotherapy.

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» The patient displayed in this article previously approved the use of their facial and intraoral photographs.

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Introduction

The use of osseointegrated implants placed in non-irradiated patients has been widely reported, however, little is known about implants placed in irradiated bone. Malignant neoplasms of head and neck are the seventh area most affected by cancer. Five-year survival rates for patients with oral cancer are of 59%, whereas for patients under treatment for salivary gland cancer it reaches 69%. Tumor stage at diagnosis as well as advanced age negatively influence prognosis. Proper functional rehabilitation proves necessary, given that a significant number of patients survive more than five years after diagnosis.[1,2]

Oral and maxillofacial tumors of head and neck may be treated by surgery, radiotherapy or a combination of both. Chemotherapy is also often used. All aforementioned treatment methods can produce adverse effects on soft and hard tissues of the oral cavity.[3] Surgical treatment for malignant neoplasm of oral mucosa followed by radiotherapy often result in unfavorable anatomical and physiological shape, which hinders prosthetic rehabilitation.[4] Additionally, these treatment methods may significantly affect function and esthetics, resulting in facial deformity, soft and hard tissue loss as well as speech, deglutition and mastication impairment. In these cases, conventional dental rehabilitation are less successful due to distortions between intraoral anatomical shape and the adverse effects caused by radiotherapy.[5] Thus, restoring function after oncological surgery in the oral cavity is one of the main challenges faced by oral and maxillofacial surgery.

In the past, implant rehabilitation was not recommended for irradiated patients. However, improvements in surgical techniques and the development of specific clinical protocols have enabled more predictable clinical outcomes. Prosthesis-based implant rehabilitation can significantly improve patient's quality of life after cancer treatment, thus promoting mastication, speech and deglutition, recovering soft and hard tissues support, improving patient's self-esteem and social coexistence.[6]

The adverse effects produced by radiotherapy on head and neck have been well reported in the literature. In these conditions, several changes may decrease the potential of cure of soft and hard tissues for implant therapy. Radiotherapy results in progressive fibrosis of blood vessels and soft tissues, xerostomia and decreased bone healing.[3] The prevalence and intensity of oral conditions caused as a result of radiotherapy depend on radiation dose and field as well as on patient's individual response. Complications occur approximately in 90% of patients carriers of malignant neoplasms of head and neck.[7] As for bone tissue, radiotherapy promotes reduction in the activity of osteoblasts and changes in blood vessels, which results in decreased bone irrigation and, as a consequence, higher vulnerability to infection and decreased healing capacity. Recent studies carried out with humans demonstrate that the risk of implant placement in irradiated bone was from two to three times higher in comparison to non-irradiated bone.[8] However, studies conducted with animals and human beings subjected to radiotherapy revealed that a radiation dose of 50 Gy assured long-term implant survival. Patients treated with radiation doses lower than 50 Gy run the same risk of implant loss as non-irradiated patients do.[9]

The literature reports irradiated mandible as the site of choice for implant placement, given that it ensures high survival rates. Many studies report high failure rates for implants placed in irradiated maxilla.[2] The majority of researches reports twice as much failure in the maxilla in comparison to the mandible.[8]

Time interval between the last radiation appointment and implant placement is also key to successful osseointegration. An ideal time interval has not been established yet. However, it is common sense that a time interval of 6 months or less, after the last radiation appointment, is more harmful due to carrying high risks of surgical complications. An interval between 6 and 24 months is considered less harmful. On the other hand, implant placement

many years after radiotherapy (over two years) is considered unfavorable, given that the effects produced by radiotherapy are progressive and cumulative.[8]

Case report

A 56-year-old male patient sought the Residency in Oral and Maxillofacial Surgery and Traumatology at the State University of Western Paraná (UNIOESTE) for oral rehabilitation through osseointegrated dental implants. The patient reported being hypertensive and having undergone treatment for oral cancer five years before. Patient's pathological analysis revealed keratinizing epidermoid carcinoma (stage pT2-N1-Mx) on the floor of the mouth, with metastasis in cervical lymph nodes. After diagnosis, he underwent surgery for tumor extraction and was subjected to 60-Gy-dose radiotherapy. Patient had become fully edentulous after treatment onset, since when he never used any type of dental prosthesis. He presented significant loss of vertical dimension and absence of lip support with collapse of perioral soft tissues, which gave him an older appearance (Fig 1). Treatment also resulted in anatomical defect of soft tissue because, after tumor extraction, the floor of the mouth was replaced by the tongue. Patient presented dry, fibrous mucosa,

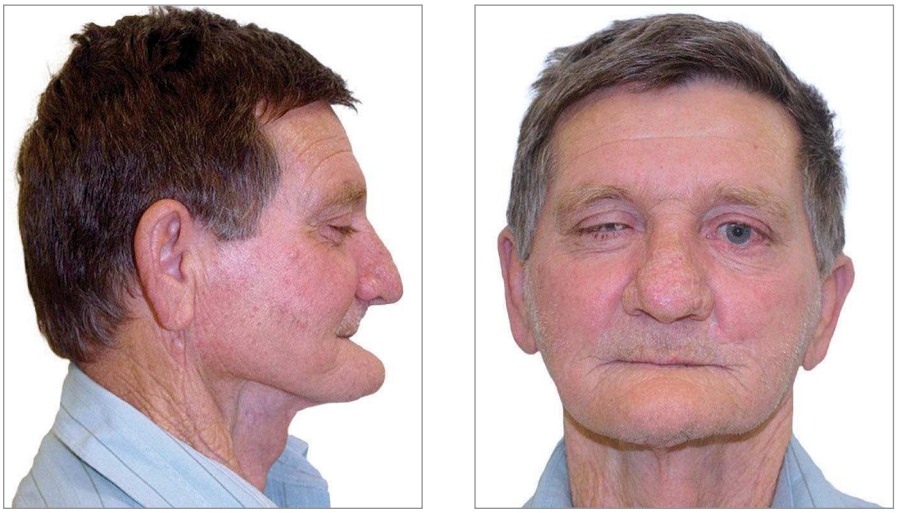

Figure 1 - Lateral and frontal view of patient's facial aspect.

Figure 2 - Initial intraoral aspect.

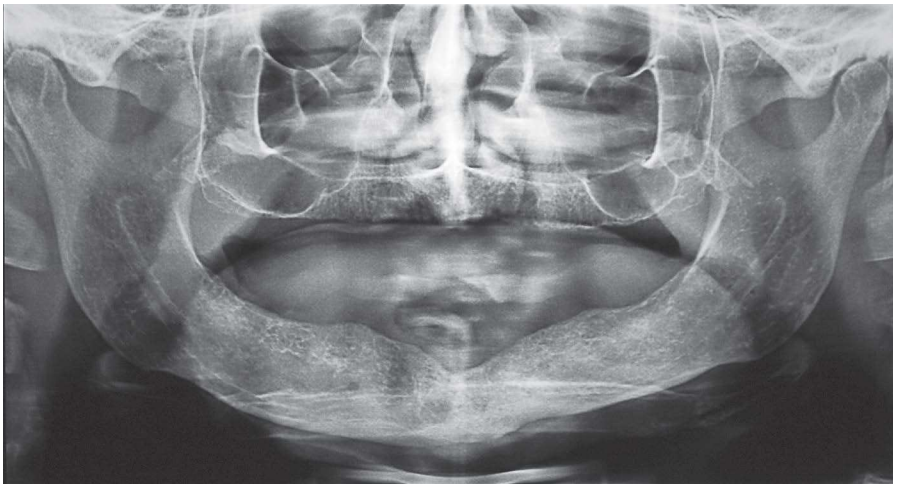

Figure 3 - Initial panoramic radiograph.

xerostomia, absence of attached gingiva, buccal and lingual fold, as well as cicatricial adhesions (Fig 2). He also had considerable difficulty in speech, mastication and deglutition as a result of the tongue being sutured to the floor of the mouth, a totally unfavorable condition for conventional prosthesis. Radiographic examination revealed healthy bone tissue without osteoradionecrosis, but with bone defect in the anterior region of the mandible (Fig 3).

Initially, three surgical procedures were carried out under local anesthesia so as to release patient's tongue (Fig 4). Subsequently, six cone-shaped implants, 4 mm in diameter and 10 mm (three implants), 11.5 mm (two implants) and 13 mm (one implant) in height were installed. Patient's amount of bone allowed four implants to be placed in the intermental foramen region, whereas two were placed posteriorly to the foramen. Implants underwent surface treatment by a physical-chemical process of subtraction through abrasive blasting and treatment. The pre-operative phase comprised antibiotic prophylaxis with amoxicillin (1 g) one hour before the procedure. During the post-operative phase, the patient remained under antibiotic therapy (amoxicillin — 500 mg every eight hours, during seven days), in addition to anti-inflammatory (nimesulide — 100 mg every 12 hours, during three days) and analgesic medication (dipyrone — 500 mg every six hours, during three days). Suture was placed with a 4.0-mononylon thread. Suture dehiscence and, as a consequence, bone exposure were observed after a one-week post-operative phase. For this reason, debridement and a new suture were carried out. Dehiscence remained in the following weeks, even though it progressively reduced. In the following weeks, de-epithelization of edges was carried out with scalpel blade 15 so as to induce healing by secondary intention. After 45 days, healing was satisfactory, with the covering screws of three implant exposed. During this period, mouth washes with 0.12% chlorhexidine were performed every 12 hours. The patient was advised about oral hygiene and monitored on a monthly basis (Fig 5).

Nine months after implant placement, the patient underwent a procedure for implant reopening. Patient's radiographic exams revealed healthy mucosa with osseointegrated implants without any signs of osteoradionecrosis (Figs 6, 7). Procedures for implant reopening as well as placement of intermediate abutment and cover cap were carried out (Fig 8). After 30 days, implant impression was performed and lower-protocol as well as antagonist-arch prostheses were fabricated.

Discussion

Dental implants are essential for rehabilitation of oral cancer patients after surgical resection. Radiotherapy was

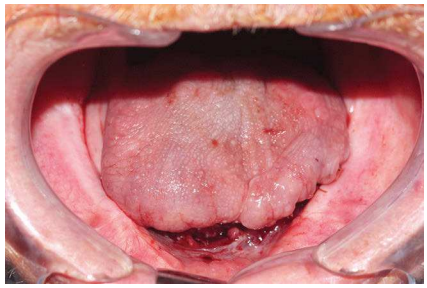

Figure 4 - Surgery immediate post-operative phase to release the tongue.

Figure 5 - 45-day post-operative phase after implant placement.

Figure 6 - Intraoral aspect nine months after implant placement.

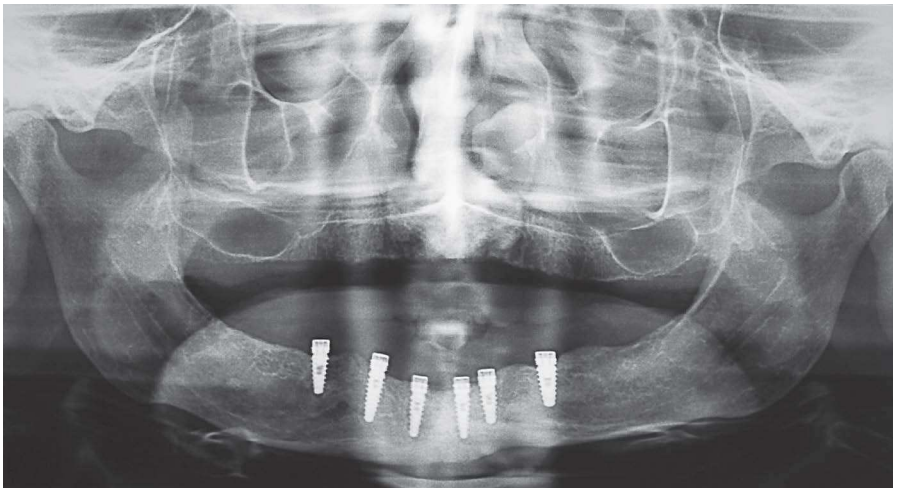

Figure 7 - Panoramic radiograph nine months after implant placement.

Figure 8 - Intermediate abutment and covering screws placed immediately after reopening.

Figure 9 - Finished lower protocol and complete upper prosthesis.

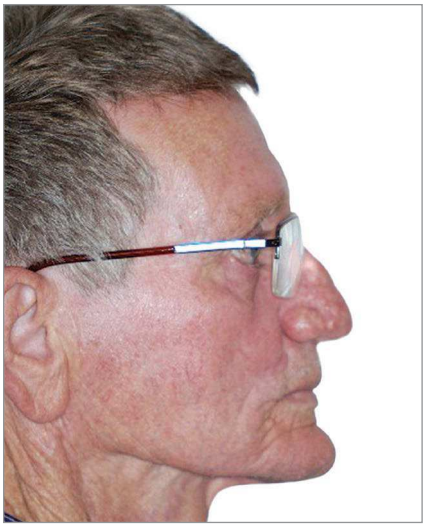

Figure 10 - Lateral and frontal view of patient's facial aspect after prosthesis placement.

Figure 11 - Patient's smile after prosthesis placement.

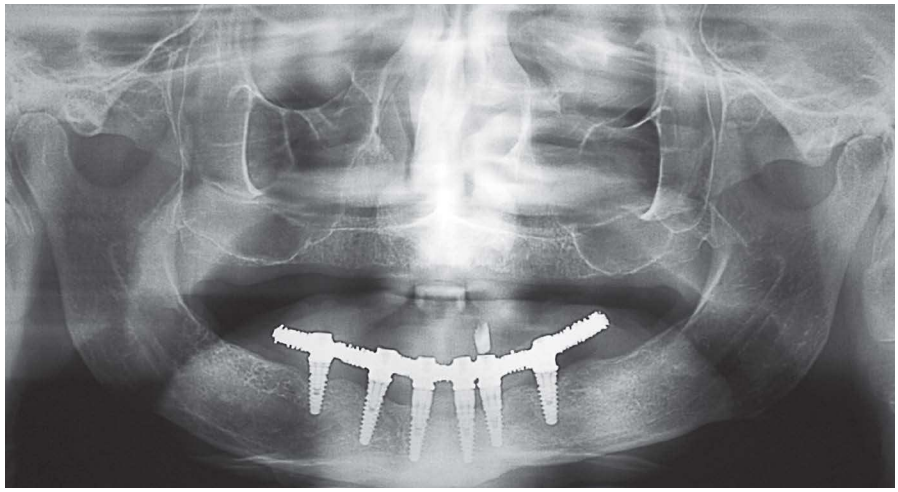

Figure 12 - Panoramic radiograph after rehabilitation.

originally a contraindication in cases of implant placement. However, the need to optimize the rehabilitation of patients with cancer has refuted such position. Precisely predicting the issues that risk osseointegration is key to successfully perform the treatment of irradiated patients.[10]

Orofacial alterations in patient's anatomical shape as a result of tumor resection, surgery, proprioceptive insensitivity, changes in buccal lip space and mobility of the tongue, in addition to irregular bone contour, hinder placement of conventional removable prosthesis in most patients. Additionally, should radiotherapy also be employed in these cases, patients will develop atrophic mucosa and xerostomia, which further hampers the use of removable prostheses as a result of local irritation, ulceration and bone exposure. Osseointegrated implants have contributed to solve the aforementioned issues, given that they allow proper tooth-bone rehabilitation by means of implant-supported and implant-retained stable prostheses.[5]

Radiotherapy aims at aiding or eradicating a tumor by exposing it to high doses of ionizing irradiation. Ideally, irradiation is well endured by surrounding structures. In practice, radiotherapy may result in some degree of damage, whether transient or permanent, caused to tissues. Oral complications of head and neck radiotherapy include xerostomia, loss of taste, alterations in the oral microflora and salivary composition, mucositis, glossitis, increased carious activity, salivary gland dysfunction, dysphagia, muscular fibrosis, temporomandibular joint dysfunction, mucosal dysfunction and bone necrosis.[10,11]

This research focused on rehabilitation with osseointegrated implants and implant-supported prostheses due to patient's unfavorable anatomical shape with thin and friable mucosa presenting xerostomia. Additionally, the patient presented bone height and thickness that favored implant placement also in post foramen regions. Implant-supported prosthesis is recommended to avoid contact with the mandibular mucosa. Implant-retained or implant-mucosa-supported prostheses allow movements that traumatize the fragile mucosa which, due to difficulties in adaptation, may result in bone exposure and, as a consequence,

osteoradionecrosis. Osteoradionecrosis is a morbid, chronic condition that results from the effects of radiation on tissues. Those effects lead to decreased blood supply to the mucosa and subjacent bone, causing hypervascularization, hypoxia and, as a result, major bone exposures, devitalization and pathologic fractures. Furthermore, the most adverse effect of radiotherapy is the development and persistence of xerostomia, which results in increased viscosity and decreased production of saliva, thus considerably removing or reducing salivary biofilm — a prerequisite for retention and comfort during the use of total and removable partial prostheses. Endothelial changes that result from decreased blood flow to soft and hard oral tissues influence the use of conventional mucosa-supported prostheses, causing it to be less safe and comfortable.[5,12]

The incidence of osteoradionecrosis after radiotherapy for oral cancer has decreased in the last decades from 11.8% (in 1960) to 5.4% (in 1970 and 1980), reaching 3% after 1997. It is believed that such reduction is the result of improvements in patients' oral health before treatment, in addition to the use of more directly applied radiation, in which only smaller portions of the mandible receive high-dose radiation.[13]

The traditional theory about the effects of radiation suggests that it causes endarteritis which leads to tissue hypoxia, hypocellularity and hypovascularity which, in turn, may lead to tissue degradation as well as chronic wounds that do not heal. Moreover, radiotherapy reduces the proliferation of bone marrow cells, collagen as well as cells from the endothelium and periosteum. New models suggest that damage caused to osteoclasts occur before vascular alterations and that, as a consequence, decreased bone remodeling is the essential core of tissue damage. The extension of change depends on the dose, field and type of radiation.[9] Thus, a radiation dose of 50 to 65 Gy is not the limit for implant treatment. The literature asserts that a radiation dose higher than 60 Gy is the main cause of failure. For this reason, doses higher than 50 Gy are considered less favorable for implant placement.[6] The absence of failure in implant placement with radiation doses lower than 45 Gy may be due to the low incidence of such low doses.[14]

Common procedures also include antibiotic prophylaxis carried out in patients subjected to surgical treatment in irradiated areas. In addition to being non-evidence based, the use of antibiotic prophylaxis to minimize the risk of osteoradionecrosis is not clinically supported.[4] Nevertheless, prophylaxis is recommended for implant placement due to the high risks of infection for this type of surgery (from 10 to 15%), as stated by the American College of Surgeons.[3]

Implant placement and reopening performed at the right moment are key to successful osseointegration in irradiated areas.[15] The time interval between radiotherapy and implant placement surgery may affect osseointegration.

Radiation applied a few decades ago seemed to have a more negative effect on implant survival than radiotherapy employed nowadays. That may be due to low-energy radiotherapy applied in the past, given that, today, the forms of energy are higher and fragmented. Another explanation includes progressive endarteritis in the irradiated bone, which tends to increase as time goes by.[10]

Most cases of bone damage seem to occur before the sixth month of radiotherapy. Implants placed within a short period of time (before six months) after radiotherapy may not undergo osseointegration. Partial recovery of microvascularization occurs between the third and sixth month, whereas recovery of bone healing capacity occurs 12 months after radiotherapy. Many researchers recommend a waiting period of 12 months after radiotherapy

before the onset of implant rehabilitation. A period of six to 18 months after radiotherapy offers low risks, however, such risks tend to increase over time. For this reason, a waiting period of 12 to 18 months is recommended between radiotherapy and implant placement.[2,6,10]

In addition to that, presurgical clinical and radiographic examinations should be taken not only to analyze the health of soft tissues, salivary flow and radiological appearance of bone, but also to perform digital palpation. Patients with soft tissue ulcer, exposed necrotic bone or history of healing issues should not undergo dental implant therapy due to their probability of complications.[16]

The surgical protocol includes careful and minimally invasive procedures for tissues: a small incision in the center of the crest with as little detached periosteum as possible — which is essential to maintain its blood supply —; bone drilling with low heat production; placement of long, wide-diameter implants; perfect adaptation and closing of wound edges; antibiotic therapy; use of provisional prostheses to avoid tissue trauma; careful oral hygiene.[16] During each step of perforation, receptor sites must be carefully assessed so as to identify evident bleeding in healthy bone tissue.[18]

In the case reported herein, the patient had a thin mucosa in spite of the waiting time after high-dose radiotherapy. Nevertheless, he proved to be healthy, without history of complications associated with radiotherapy, except for xerostomia. Additionally, he had good healing response during initial surgeries performed in soft tissues. During such procedures, patient's tissues proved to be feasible due to the substantial amount of bleeding observed in the mucosa and inner-bone surfaces after perforation for implant placement.

Experimental studies on the integration of implants in irradiated bone reveal that the integration in irradiated tissue happens at a slower pace. It has been recommended that the interval between implant placement and the second surgical procedure (reopening) must be extended to, at least, eight months.[19]

In terms of maintenance of osseointegration, three prospective studies assessed 744 implants placed in 206 patients who had been subjected to radiotherapy 3.5 and 14 years before. As the estimation of a time effect depends on the potential of radiotherapy for maintenance of osseointegration, those studies suggested an osseointegration rate that decreases with time: 93.9% in three years, 89.4% in five years and 78.0% in 14 years (744 implants, 206 patients).

Some researchers recommend adjuvant hyperbaric oxygen therapy (HBO) to increase the success of implant placement in irradiated patients. However, results are inconclusive and require highly developed devices, which increase the costs of treatment. Other studies yield good results, with a minimum implant loss rate for irradiated patients in spite of hyperbaric oxygen therapy.[2]

In addition to proper dental rehabilitation, masticatory function requires good mobility of the tongue, suction effect, appropriate soft palate and coordination of dental surfaces of the jaw. Only one third of patients subjected to implant-supported rehabilitation is able to recover masticatory function and deglutition. Dental restoration does not consist in providing benefits to mastication and nutrition only, but also to favor speech and facial esthetics. Furthermore, recovery of lower teeth properly directs salivary flow, whereas lower lip support increases salivary retention in the oral cavity.[5] The patient reported difficulties in mastication and deglutition, even after rehabilitation, due to decreased mobility of the tongue. Such fact hinders bolus positioning for food trituration during mastication and deglutition, causing the patient to drink a large amount of liquid while eating. On the other hand, he reported increased amount of saliva produced in the oral cavity, and clear weight gain after rehabilitation.

Conclusions

Dental surgeons must be aware of the side effects of radiotherapy as well as of the dose and waiting time before treatment onset so as to properly control osseointegrated implant treatment.

Osseointegrated implants can be safely employed in irradiated patients, provided that special care be taken.

Improvements in mastication, speech and esthetics promote patient's social reintegration, thus minimizing discomfort and suffering, in addition to optimizing therapeutic results and quality of life.

Carefully selecting patients, employing atraumatic surgical techniques and proper prosthetic rehabilitation are key to successful therapy.

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