

# Factors Affecting the Placement of Implant in Irradiated Bone: A Literature Review

D.R. Prithviraj<sup>1</sup>, Sounder Raj<sup>2</sup>, Mamatha. N<sup>3</sup>

<sup>1</sup>Dean cum Director, <sup>2</sup>Professor and Head of the Department, <sup>3</sup>Post Graduate student  
Department of Public Health Dentistry, Government Dental College and Research Institute, Bangalore,  
Karnataka 560002

Corresponding Author: Mamatha. N

## ABSTRACT

The success rates of osseointegrated implants used to restore patients who were irradiated for head and neck tumors are greatly influenced by radiation-induced changes in the hard and soft tissues. There are increasing number of reports indicate successful use of dental implants (DI) during oral rehabilitation for head and neck cancer patients undergoing tumor surgery and radiation therapy. Patients cannot use conventional dentures due to the adverse effects of radiation therapy, which include dryness of the mouth or fragile mucosa, in addition to compromised anatomy. Implant-supported dentures are a feasible option for such patients. However, the adverse effects of radiation including osteoradionecrosis, are well documented in the literature, and early loss of implants in irradiated bone has also been reported.

**Keywords:** dental implants, radiation, radiotherapy, rehabilitation, osseointegration, osteoradionecrosis.

## INTRODUCTION

Advanced carcinomas of the head and neck region are commonly treated with a combination of surgery, radiation and/or chemotherapy. Each of these treatment modalities has their own risk and side effects. <sup>[1]</sup> Long and short term treatment of oral carcinomas with radiation therapy can result in mucositis, xerostomia, periodontal attachment loss, dental caries, trismus, reduced vascularity of bone, loss of osteoprogenitor cells, fatty degeneration, susceptibility to osteoradionecrosis and compromised remodeling. <sup>[1,2]</sup> Depending on the size and location of the oral carcinoma, different rehabilitation procedures will be required. <sup>[3]</sup> Conventional prosthodontic treatment with fixed partial dentures and removable partial dentures has also been contraindicated in radio-irradiated jaws

because of atrophied and erythematous mucosa and or resected jaw bones. <sup>[4]</sup> All the above factors results in the decreased quality of life of cancer patients. <sup>[5]</sup> During the past few decades, due to advancements in materials science and surgical techniques use of implant supported prosthetic reconstruction has been increased. Implant supported dentures are the available option, when there are irradiation associated adverse effects. <sup>[6]</sup> This article reviews the factors affecting placement of implants in irradiated bone.

Factors affecting implant placement in irradiated bone-

1. Radiation therapy related factors <sup>[6]</sup>
  - a. Radiation dose
  - b. Radiation modality
  - c. adjunct hyperbaric oxygen therapy(HBO)
  - d. Conjunctive chemotherapy

- e. Adverse effect of radiation therapy
- 2. Dental implant related factors [6]
  - a. Timing of implant insertion
  - b. Integration period
  - c. Anatomic sites of insertion
  - d. Loading pattern
- 3. Patient related factors
  - a. Smoking
  - b. Comorbidities affecting bone qualities and healing
  - c. Parafunctional habits
  - d. Occlusal stability
  - e. Oral hygiene
  - f. Tumor magnitude

### **Irradiation therapy related factors**

Cancerous cells are destroyed by damaging the nuclear DNA or changing the molecular characteristics of individual cells, using ionizing radiations. [6] Radiation induced changes in both the hard and soft tissues causes reduction in implant success rates. [7] Success of dental implants depends on the radiation dose, time interval between radiation therapy and implant placement and HBO therapy. The radiation doses used in the treatment ranges between 25-72 Gy, reporting fractionated therapy. Dental implant survival was significantly more in cases where radiation dose <55Gy, than in situation when radiation dose of 55>Gy. [8] Many animal studies recommend that a delay between irradiation and implant placement is valuable parameter for implant Survival. A delay of 12 weeks shows a major increase in success rate of implants. [9] Hyperbaric oxygen acts in co-operation with a number of growth factors, which stimulate bone growth and turnover, and oxygen can act as a growth factor by itself. [3] HBO will neutralize some of the negative effects of radiation therapy and actually act as a stimulator of osseointegration. [3] HBO therapy is inhalation of 100% oxygen at elevated pressure above 1.5 atmospheres. It will make oxygen reach the hypoxic tissue by escalating the blood-tissue oxygen gradient; this will improve the wound healing by boosting the reconstruction of irradiated tissues and preventing necrosis.

HBO also acts as bacteriostatic and bactericidal for many microorganisms. [10] Source of radiotherapy used is Co(60). Many higher energy radiation therapy protocols and superfractions have been developed and their effects on the Osseointegration are still in the process of investigation. [11] Chemotherapeutic agents used in the treatment of cancerous tissues have cytotoxic effect on both malignant and normal tissue including bone. It has increased effect on grafted bone where the vascularity may be comprised. Despite these effects endosseous implants osseointegrated satisfactorily. [12]

### **Dental implant related factors**

Timing of placement of implant has major role in the success of implant surgery in irradiated bone. Few researchers have suggested a delay of 12 months between the radiotherapy and implant placement. Others recommend a delay of 2 years. [13] The numbers of osteoblasts are reduced by radiotherapy which in turn affects the healing capacity and osteointegration of implant. If microvascularized bone graft is used it shows better osteointegration in irradiated bone. [14] Dental implant shows an enhanced survival rate in the mandible compared to the maxilla and grafted bone. Implant length is also a dependable factor in implant placement, long implant shows increased success rate compared to short implants. [15] Implant shows 80% success rate in the anterior maxilla 66% in the posterior maxilla according to Roumanas et al. [4] Anterior mandible shows more success rate than the posterior mandible as most patients who are irradiated for head and neck tumors will not receive irradiation to the head and neck tumors. [5] Taylor et al, presume that bone healing and osseointegration take place at a slower rate than in normal tissue. Therefore abutment connection should be delayed for six months. [4] Soft tissues loading should also be avoided at the surgical site.

### **Patient related factors**

The dentist should take in to consideration a multiplicity of patient-reliant criteria when implant treatment is planned. Clinical criteria, that have to be considered before undergoing implant therapy are bone quality, bone quantity, oral and general health and patient's oral habits. Bone quality can be classified into four types- Type I bone is comprised of homogeneous, compact bone, Type II bone has a core of dense trabecular bone surrounded by a thick layer of compact bone, Type III bone has only a thin layer of cortical bone surrounding a core of dense trabecular bone, and Type IV bone has a core of low-density trabecular bone, encased in thin cortical bone. Using the above hierarchy, Types I and II exhibit successful implants. If the patient has systemic diseases like uncontrolled diabetes will experience increased implant failure. [16] Radiation therapy for head and neck tumors may cause local side effects like periodontal destruction, hyposalivation etc. which will lead to compromised oral health leading to increased implant failure. [6] Oral habits like smoking will also have deleterious effects on the implant therapy. [4]

## DISCUSSION

In the past three decades, use of implants for prosthetic reconstruction has been amplified due to improvement in materials science and surgical techniques. [6] Dental implants play a essential role in the treatment of patients with malignancies in the head-and-neck region. [17] Chambrone et al. concluded that radiotherapy was associated with elevated rates of implant failure in the majority of studies. Dental implant failure in patients getting head and neck radiation is primarily result of hard and soft tissue changes. Head and neck radiation causes irreversible changes in the blood vessels and bone forming cells, thus deteriorating bone turnover. All these above changes will cause defective osseointegration of dental implant in patients with head and neck malignancies. [1] However oral cancer patients with good

prognosis who have received the radiation dosage less than 50Gy can undergo successful dental implant therapy. Patients' psychological and physical tolerance will contribute for the success of dental implant therapy. A time span of 12 months is considered practical between the radiation therapy and implant placement from both the oncologic and dental prospective. [6] HBO therapy acts as a adjuvant to improve the success rate of implants in irradiated patients. [3] Oxygen under hyperbaric conditions acts in association with several growth factors, which will encourage bone turnover. General and oral health of the patient should be maintained throughout the implant treatment for success if the implants.

## CONCLUSION

Survival rates of dental implants may be affected unfavorably by radiotherapy. But nonetheless they can osseointegrate and remain functionally stable and hence they can be considered a viable treatment option for rehabilitation and improvement of the quality of life of head and neck cancer patients. Prospective studies and randomized controlled trails are still needed to draw more evidence based conclusions about survival of dental implants in head and neck cancer patients and also to assess the impact of HBO treatment. No clear positions exist on the use of HBO as a preventive or curative treatment for ORN.

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