K.Thanya et al /J. Pharm. Sci. & Res. Vol. 8(7), 2016, 635-637

ISSN:0975-1459
Journal of Pharmaceutical Sciences and Research
www.jpsr.pharmainfo.in

A Review on Dental Implants in Irradiated Bones

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Abstract

In the present era, the incidence of oral cancer is on surge. Oral rehabilitation after radiation therapy and surgical resection becomes a demanding procedure as most patients suffer from soft and hard tissue defects resulting in functional disabilities and esthetic deformity. Purpose of this review is to assess the literature for scope of dental implants in irradiated bone.

Keywords: Cancer, Irradiation, Dental implant, Osseointegration, Osteoradionecrosis.

INTRODUCTION

Cancers in the head and neck region is becoming the most common cancer worldwide with an estimated global incidence of 500,000 new cases annually, three-quarters of which are in underdeveloped countries. The vast majority (approximately 90%) of head-and-neck cancers are squamous cell carcinomas [1].Patients with oral cancer are treated with a combination of radiotherapy and ablative surgery. Reconstruction and oral rehabilitation after radiation and surgical resection, becomes a demanding procedure as most patients suffer from soft and hard tissue defects resulting in functional disabilities and esthetic deformity. Dental rehabilitation using conventional prostheses may be compromised or precluded by disadvantageous changes in oral anatomy, and radiotherapy can produce mucositis, xerostomia and disruption of bone healing processes [2].

Dental implants play a crucial role in the therapy of patients affected by malignancies in the head-and-neck region. The goal of implant rehabilitation is to improve the quality of life of these patients by allowing proper retention of removable prostheses and a reduction in the load placed on vulnerable soft tissues [3]. Implants result in a more effective oral rehabilitation in terms of mastication, esthetics and speech function. However, even implant treatment in oral cancer patients is challenging because the bone into which the dental implants are placed has often been within the field of irradiation, or is grafted. Thus it results in failure when they are placed in irradiated bone [2], because radiotherapy can result in progressive fibrosis of vessels and soft tissue, leading to diminished healing capacity. In addition radiation impedes the osseointegration of implants by reducing bone vascularity, clinically expressed as osteoradionecrosis. The interaction between ionizing radiation and tissue causes damage to the bone, periosteum, and connective tissue of the mucosa and the endothelium of the vessels, which at later stages leads to hypoxia, hypocellularity and hypovascularity in the affected tissues, and the loss of resistance against infection and trauma [4][5].

RADIOTHERAPY AND ITS ADVERSE EFFECTS

Radiation therapy is often the first line of treatment for patients with head and neck cancer and is often used as an adjunct to surgical excision. There are three different types of radiotherapy: external beam radiation, brachytherapy, and radioisotope therapy. For the treatment of head-and-neck cancer, external beam methods are most commonly used [6]

As cancer cells are in a continuous state of mitosis, on radiotherapy the ionizing radiation produces energy that injures or destroys cells by damaging nuclear DNA or altering the molecular characteristics of individual cells. Most patients with head and neck cancer receive between 50 and 70 Grays (Gy) as a curative dose. For concomitant use, 45 Gy are used preoperatively and 55 to 60 Gy postoperatively. These doses are typically fractionated over a period of 5 to 7 weeks, once a day, 5 days a week, with a daily dose of approximately 2 Gy.

Radiotherapy damages oncocytes ,also the normal viable cells and causes mucositis, hyposalivation, loss of taste, radiation caries, trismus, and osteoradionecrosis (ORN) of the jaw.ORN, ischemic necrosis of bone, is one of the most serious complications [7]. Initial changes in bone are caused by irradiation result from direct injury to the remodeling system (osteocytes, osteoblasts, and osteoclasts). In addition, vascular injury precedes hyperemia, followed by endarteritis, thrombosis, and a progressive occlusion and obliteration of small vessels. With time, the bone marrow exhibits marked acellularity and avascularity, with marked fibrosis and fatty degeneration [5].

RADIOTHERAPY AND DENTAL IMPLANTS

Factors that affect implant placement in irradiated bone are the primary or secondary placement of implants. Primary placement of the implants refers to the implant placement during ablative surgery i.e. before radiotherapy and secondary implant placement refers to implant placement after surgery & radiotherapy. Primary placement of implant shows more predictable Osseointegration (97%) as

compared to the secondary placement of implants after radiotherapy [8][9]. Studies have suggested that head and neck radiotherapy should not be considered as a contraindication for dental rehabilitation with implant [10]

Site of implant placement : The anatomical site of implant placement in preimplantation radiation therapy was the most pertinent variable affecting implant survival, with a better survival rate in the mandible compared to the maxilla and grafted bone [11]. It was observed that in most of the patients symphyseal region does not receive any radiation during radiotherapy; and the implants which were placed in irradiated symphyseal region confirmed a satisfactory success rate of 94-100% with decreased risk of osteoradionecrosis[12].

Time interval for placement of implant: It has been recommended that there should be a gap of at least 1 year between completion of radiotherapy and implant placement [13]. Certain studies favors an interval of 1.5 years between radiotherapy and implant placement [14].While few have suggested that there should be a waiting period of at least two years between radiotherapy and implant placement [15].

One year time interval as recommended by Jacobson seems to be logical as this period facilitates the tissue to recover from the immediate side effects of radiation [16]. This waiting period is also essential for bone remodeling and setting of vascularization. Generally implant loading and abutment placement is done after 3 to 4 months of implant placement in normal patients .But bone healing and osseointegration in irradiated patients occur at slower rate; hence the loading of the implants should be delayed to 6 months [15]. This extra time period helps in achieving uninterrupted osseointegration.

Effect of Hyperbaric Oxygen Therapy (HBOT):

There is lack of consensus amongst clinicians regarding the effectiveness of hyperbaric oxygen therapy. Few authors authenticate its usage [5] and some have declined it[17] ,[18]. Certain studies states HBO treatment did not have a significant impact on osseointergration of implants[19] whereas few have suggested that HBO treatment can reduce the risk of implant failure in irradiated bone when used as an adjuvant [20].

Experimental researches regarding the effect of HBO therapy in previously irradiated patients is scarce hence more research is necessary for final conclusion.

Type of the Prosthesis:

The highest survival rate among different type of prosthesis was for fixed retention [20].Few advocate use of implant retained over denture in most cases because these prostheses facilitate better occlusal contacts, require less number of implants, assist in maintaining gingival hygiene and are less expensive.[21]

Effect of Smoking:

Smoking has a negative effect on osseointegration [22].Vasoconstriction and vascular damage due to smoking cause decrease in vascular supply leading to implant failure. It is recommended that the patient should follow a smoking cessation protocol before implant placement. The irradiated patients who continue to smoke are considered as absolute contraindication for implant placement.

Length of the Implant:

Implant length is also a reliable factor for implant survival. Short implants (3-7mm) failed to a higher proportion than the longer implants in irradiated patients [20]

Type, size, stage and metastasis of tumor:

There is no correlation between tumor size, type, stage, involvement of nodes or metastasis or region and implant failure [20]

Type of Bone Graft: Non vascularized bone graft in irradiated areas was not advised to be used where implant placement is planned [23].Hence vascularized bone grafts are recommended at the insertion site of implants in irradiated patients. There was no significant difference in survival when implants were placed in native or grafted bone in irradiated head and neck cancer patients. For implants placed in native bone, there was a higher likelihood of failure when implants were placed in maxilla than those placed in mandible. Implants placed in the posterior region failed more than the ones placed in the anterior region for those placed in native bone [24].

Survival rate of implant in irradiated bones

Implant survival is significantly influenced by the location (maxilla or mandible, 59% and 85%), by the incidence of bone-resection surgery in the jaw where the implant was installed, and by the irradiation dose at the implant site (< 50 Gray or >/= 50 Gray, p = 0.05) [25].

CONCLUSION

Radiation therapy is not a contraindication for implant placement in oral cancer patients because they are in need of oral rehabilitation. The following factors should be considered before constructing the treatment plan such as the site of implant placement, time interval, type of prosthesis, type of implant material and bone graft. As there are more chances of implant failures in irradiated jaws, these factors when taken into account can enhance the longevity of implant.

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