

Assessment of the Survival of Dental Implants in Irradiated Jaws Following Treatment of Oral Cancer: A Retrospective Study

Meenakshi Chauhan Rana, Swati Solanki¹, Sudarshan C Pujari², Eisha Shaw¹, Swati Sharma³, Abhishek Anand³, Harkanwal Preet Singh⁴

Department of Oral and Maxillofacial Surgery, Manav Rachna Dental College, Faridabad, Haryana, ¹Department of Prosthodontics, Rama Dental College, Hospital and Research Centre, Kanpur, Uttar Pradesh, ²Department of Conservative Dentistry and Endodontics, PDU Dental College, Solapur, Maharashtra, ³Department of Pedodontics, Buddha Institute of Dental Sciences and Hospital, Patna, Bihar, ⁴Department of Oral Pathology and Microbiology, Dasmesh Institute of Research and Dental Sciences, Faridkot, Punjab, India

ABSTRACT

Background: In patients undergoing head and neck surgery for various pathologic conditions, implants are one of the best restorative options and are increasing widely used. Therefore, we evaluated the success of dental implants in the irradiated jaws of patients following treatment of oral cancer oral cancer treated patients. **Materials and Methods:** Data of oral cancer treated patients was collected retrospectively from 2002 to 2008. We took 46 oral cancer treated patients in which implants were placed in irradiated jaws for rehabilitation. **Results:** It was found that out of 162 dental implants placed, 52 failed. Furthermore, there was no variation in the implant survival rate in between both the jaws. Radiation dose of <50 Gy units also showed significantly increased amount of implant survival rate. **Conclusions:** Implant survival is multifactorial and depends upon a number of factors like level of radiation exposure in that area, time gap between last radiation doses etc., Further research is required in this field to improve the esthetics and quality of life of cancer treated patients.

KEYWORDS: Cancer, dental implants, radiation therapy

INTRODUCTION

In patients undergoing head and neck surgery for various pathologic conditions, implants are one of the best restorative options and are increasingly widely used.^[1] The healing process of a wounded, diseased or an injured bone is a normal phenomenon. It begins with fibrin clot formation that alters the normal flow of blood and feeds and supports the osteoprogenitor cells.^[2] Successful implant insertion occurs in human bone due to optimum osseointegration at the junction or interface of bone and implants.^[3]

Most common form of malignancy occurring in humans is the head and neck cancer with over 0.5 million new cases occurring every year. The treatment modality for malignant lesions involves most commonly surgical intervention in combination with

Address for correspondence:

Dr. Harkanwal Preet Singh,
Department of Oral Pathology and Microbiology, Dasmesh
Institute of Research and Dental Sciences, Faridkot, Punjab, India.
E-mail: hkps0320@gmail.com

Access this article online

Quick Response Code: 	Website: www.nigerianjsurg.com
	DOI: 10.4103/1117-6806.182741

radiotherapy. Since, surgical therapy for cancer patients' results in loss of considerable amount of tissue, oral rehabilitation by artificial prosthesis, implants, etc., is a necessary procedure to redress both functional and esthetic disabilities. Artificial prosthesis has certain side-effects such as having the capability of producing xerostomia, mucositis, and altering the healing process in irradiated tissues. Dental implants avoid these side-effects to a much extent but successfully placing implants in patients treated for oral cancer is itself a difficult task because some have had radiation exposure in the tissues.^[4] Patients exposed to radiotherapy for treatment of cancer have reduced healing capacity due to progressive fibrosis of vasculature. Radiation

This is an open access article distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 3.0 License, which allows others to remix, tweak, and build upon the work non-commercially, as long as the author is credited and the new creations are licensed under the identical terms.

For reprints contact: reprints@medknow.com

How to cite this article: Rana MC, Solanki S, Pujari SC, Shaw E, Sharma S, Anand AA, *et al.* Assessment of the survival of dental implants in irradiated jaws following treatment of oral cancer: A retrospective study. *Niger J Surg* 0;0:0.

exposure of tissues during radiotherapy causes negative changes in the bone and connective tissue stroma of the mucosa leading to decreased body resistance against infection and trauma.^[5,6]

These structural changes can lead to prosthesis or implant failure. Therefore, implant placement in such patients is largely dependent on a number of factors such as time gap between the radiotherapy and implant placement, location of implant, status of bone of that particular area, amount of radiation dose received by that tissue area.^[7,8] Therefore, we carried out this research to assess the survival of dental implants in irradiated jaws of patients treated for oral cancer.

MATERIALS AND METHODS

The research was a retrospective study conducted by collecting patient record and database from the year 2003 to 2009. We included 46 oral cancer treated patients (30 males, 16 females) who had undergone oral rehabilitation by dental implants. These subjects had undergone surgical phase for the treatment along with the radiotherapy. The patient's mean age was 60 + 25 years at the time of surgical treatment. Exclusion criteria: Subjects giving history of any systemic disease, drug allergy, any bone disorder, hypertension, and uncontrolled diabetes were excluded from the study. Patients who died during the follow-up period were excluded from the study. Structural defects due to surgery were reconstructed through flap procedure and a total of 162 dental implants were placed in the irradiated tissue areas. The average time gap kept in the patients of the study, between last irradiation therapy and implant placement was 15 months with range of 6 months to 24 months.^[8] The BIOMET 3i implants were used for rehabilitation and all the surgical implant placement procedures were performed by registered oro-maxillo facial surgeon. The minimum dimension of implants for the reconstructive procedure was kept at 9 mm. The patients, after dental implant placement, were kept on regular follow-up at time interval of every 2 months to check for osseous bone healing. All the implants were placed in the irradiated jaws. The patients with no infection or pain, mobility, or radiolucencies in the areas of peri-implant region were considered as successful.^[9] Evaluation of survival of implants was done by dividing the patients into various groups, namely; jaw location (mandible or maxilla), sex (male or female), and region of placement of implant in a single jaw (anterior position or posterior position). The implants placed were used as abutment for various prosthesis which included implant supported complete denture, screw supported over denture, cemented implant prosthesis. Implant survival rate was assessed within all the subgroups. Pearson's Chi-square test was used to evaluate implant survival. Cumulative Kaplan–Meier survival curve was used to analyze the time-dependent variables and failure rate. $P < 0.05$ is considered as statistically significant.

RESULTS

Of 162 implants placed in 46 patients, 110 implants were successful (survival rate = 67%). Table 1 shows the yearly

frequency of dental implant placement in irradiated jaws from 2002 to 2008 in India. Table 2 shows age wise and gender distribution implant failure among the given sample. Table 3 shows that 70 implants were placed in maxilla out of which 20 implants failed during follow-up, while in mandible, 92 implants were placed out of which 32 failed. We also assessed the implant success and failure rate when placed in the same jaw at different sites; anteriorly and posteriorly. Of total of 70 implants placed in maxilla, 35 were placed anteriorly and 35 were placed posteriorly. Similarly in mandible, out of total 92 implants, 52 were placed anteriorly and 40 were placed posteriorly. The failure rate of dental implants in both the jaws at anterior and posterior position is given in Table 3. The difference was statistically nonsignificant ($P > 0.005$). After 5 year follow-up, the survival rate of dental implants in maxilla and mandible was 65% and 71%, respectively ($P < 0.005$). The difference in survival percentages between anterior and posterior locations in the mandible or maxilla was not significant ($P > 0.005$). We also analyzed the radiation dose effect on implant survival rate by assessing the radiotherapy reports of the patients [Table 4]. Implants receiving <50 Gy units of radiation therapy showed a high 5 year survival rate of implants ($P < 0.005$). No significant difference was observed while assessing the survival rate of dental implants on the basis of time gap between last dose of radiation and time of placement of dental implant [Table 5].

Table 1: Frequency of dental implant placement and failure in irradiated jaws year wise among the given sample

Year	Number of patients	Number of implants placed	Number of implants failures
2002	6	20	5
2003	6	22	6
2004	7	30	10
2005	5	22	6
2006	8	26	9
2007	9	25	9
2008	5	17	7
Total	46	162	52

Table 2: Age wise and gender distribution implant failure among the given sample

Frequency	<40 years (%)	40-65 years (%)	>65 years (%)	Total (%)
Male	7 (13)	10 (19)	12 (23)	29 (56)
Female	5 (9)	8 (15)	10 (19)	23 (44)
Total	12 (23)	18 (34)	22 (41)	52 (100)

Table 3: Dental implant failure in both the irradiated jaws (mandible and maxilla) among the given sample

Frequency	Anterior jaw portion (%)	Posterior jaw portion (%)	Total (%)
Mandible	18 (34)	14 (26)	32 (62)
Maxilla	12 (23)	8 (15)	20 (38)
Total	30 (58)	22 (42)	52 (100)

$P=0.878$

Table 4: Frequency and distribution of patients grouped according to irradiation doses delivered to patients

Number of patients (%)	Dose (gray) (%)	Number of implants (%)	Number of implants failed (%)
19 (41)	<50	31 (19)	10 (20)
16 (35)	51–70	61 (38)	21 (40)
11 (24)	>71	70 (43)	21 (40)
Total: 46 (100)		Total: 162 (100)	Total: 52 (100)

P=0.001

Table 5: Dental implant failure in the given population grouped on the basis of time gap between the last radiation dose and implant placed

Frequency (months)	Implants placed (%)	Implants failure (%)
6-12	49 (30)	16 (31)
12-18	54 (33)	17 (33)
18-24	59 (37)	19 (36)
Total	162 (100)	52 (100)

P=0.864

DISCUSSION

Oro-pharyngeal cancer comprises of the majority of cancers occurring in head and neck region.^[10] Treatment of oral cancer is a complex procedure and depends on number of criteria, mainly the extent of lesion, lymph node metastasis, clinical and histopathological stage of cancer etc. Surgical treatment alone or in combination with radiation therapy and/or chemotherapy forms the mainstay of treatment.^[11]

Following surgical intervention, one of the challenging tasks in the cancer treated patients is the esthetic and structural rehabilitation. There had been drastic increase in demand for dental implants during past few decades, for rehabilitation and reconstruction of the structural part lost to surgery and or disease in cancer patients due to advances in medical field.^[12] Whether implants are successful or not in oral cancer treated patients irradiated with radiotherapy is a topic of debate. While on one sides, researches and reports show high success rate of dental implants in irradiated jaws of oral cancer treated patients, data indicating the negative effects are also well documented in the literature.^[5,13-17] Animal experimentation models also show rate of failure of dental implants under similar conditions.^[18-20] In the present scenario, there are no strict criteria about the success or failure of dental implants in irradiated jaws of cancer treated patients, therefore, we evaluated retrospectively, the clinical outcome of dental implants in a series of patients.

The total life of implants for this study was taken as the time between placements of implant to the time till last follow-up of evaluation of implant was done (5 years). In the present study, survival rate of dental implants in both irradiated maxilla and mandible were different (65% and 71% respectively), although the results were statistically nonsignificant [Table 3]. These results

were consistent with those of Pompa *et al.*, who also found no correlation between dental implant success and the site of implant placement (maxilla vs. mandible).^[20] Our results were in contrast to the results of Visch *et al.*,^[21] who found significant difference in the survival rate of dental implants in between mandible and maxilla. The difference of the results may be due to the small sample size in our study. The results of survival rate of implants in both jaws show considerable amount of variation. Keller *et al.* found a very high survival rate of implants (99%) in irradiated mandible whereas results obtained by Babin *et al.* showed a low survival rate of dental implants (70%).^[22,23] Dental implants survival in irradiated maxilla also show significant amount of variation. While one hand, studies show high survival rate of approximately 100%, on the other hand, some studies quote it to be as low as 40%.^[1] The high failure rate of dental implants in irradiated jaws in some of the studies may be attributed to the difference in bone density, bone volume and the amount of vascular supply of both the jaws.^[24,25]

Radiotherapy involves different sources, doses and fractionation schedules of radiation which further depends on various factors such as site and size, location, and the stage of cancer. Guideline protocol of radiation therapy for oral cancer chiefly involves radiations of approximately 50–70 Gy units.^[26] Table 4 shows the survival rates of implants placed in jaw bones following treatment with different doses of radiation. We found that, implant areas irradiated with dose of more than 50 Gy units had significantly more failure rate (failure rate 20%) as compared to the areas irradiated with dose of <50 Gy units (failure rate 25%) ($P < 0.005$). Our results correspond with other studies that found significant higher failure rate of implants in patients who received radiation dose of higher than 50 Gy units.^[14,21] This difference in failure rate of dental implants in groups irradiated with different doses of radiation may be due to dose dependant decrease in vascular supply of the irradiated area.^[6] In a study by Javed *et al.*, 100% of dental implant cases survived when radiation dose was up to 65 Gy units. He concluded that dose up to 65 Gy unit do not have any negative effect in implant healing and integration with the bone.^[27] In contrast, many authors, in their study founded that to reduce the negative effect of radiation on dental implant healing, radiation dose should be less than 50 Gy units.^[28,29]

In both the mandible and maxilla respectively, we found differences in the survival rate of dental implants placed at anterior and posterior positions was statistically non-significant. Similar results were noted by Pompa *et al.* who also did not notice any correlation between the survival of dental implant and site of placement. Since there is large variability in context of size of the tissue defect and its depth, large inter-individual variability exists between different observers which may be responsible for variation of results of different studies regarding the survival of implants depending upon site of implant in the same arch. Therefore, the effect of the site of implant placement in the area irradiated with radiation therapy remains controversial.^[20]

Finally, we also assessed the implant survival based on the time gap between the last radiation dose and implant placement procedure. Table 5 showed that the difference in the survival rate of dental implants in irradiated jaws was nonsignificant. Different researchers supports different concept on time of implant placement in irradiated jaws. However, most of the surgeons believe in maintaining a minimum time gap of months to 1 year after radiation therapy to avoid complications and implant failure while some other clinicians advocate a little longer duration before the placement of implants to give adequate time for healing of muscles and bone remodeling to occur.^[30-32] Werkmeister R noticed similar results as found in our study, reporting a dental implant failure rate of over 25% in their study.^[33]

CONCLUSION

Prosthesis based on dental implants in irradiated jaws offer a great amount of functional and esthetic rehabilitation. At the same time, implant survival in such patients is dependent on a number of factors like radiation exposure in that area, time gap between last radiation dose and the implant placement, position, and location in which implant has to be placed etc. Therefore, further research is required in this field to improve the esthetics and quality of life of cancer treated patients.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

REFERENCES

- Zheng M, Li L, Tang Y, Liang XH. How to improve the survival rate of implants after radiotherapy for head and neck cancer? *J Periodontal Implant Sci* 2014;44:2-7.
- Vanegas-Acosta JC, Landinez P NS, Garzón-Alvarado DA. Mathematical model of the coagulation in the bone-dental implant interface. *Comput Biol Med* 2010;40:791-801.
- Dholam KP, Gurav SV. Dental implants in irradiated jaws: A literature review. *J Cancer Res Ther* 2012;8 Suppl 1:S85-93.
- Mancha de la Plata M, Gías LN, Díez PM, Muñoz-Guerra M, González-García R, Lee GY, *et al.* Osseointegrated implant rehabilitation of irradiated oral cancer patients. *J Oral Maxillofac Surg* 2012;70:1052-63.
- Yerit KC, Posch M, Seemann M, Hainich S, Dörtbudak O, Turhani D, *et al.* Implant survival in mandibles of irradiated oral cancer patients. *Clin Oral Implants Res* 2006;17:337-44.
- Marx RE, Johnson RP. Studies in the radiobiology of osteoradionecrosis and their clinical significance. *Oral Surg Oral Med Oral Pathol* 1987;64:379-90.
- Jacobsson M, Tjellström A, Thomsen P, Albrektsson T, Turesson I. Integration of titanium implants in irradiated bone. Histologic and clinical study. *Ann Otol Rhinol Laryngol* 1988;97(4 Pt 1):337-40.
- Chiapasco M. Implants for patients with maxillofacial defects and following irradiation. In: Lang NP, Karring T, Lindhe J, editors. *Proceedings of the 3rd European Workshop on Periodontology*. Berlin: Quintessenz Verlags-GmbH; 1999. p. 557-607.
- van Steenberghe D. Outcomes and their measurement in clinical trials of endosseous oral implants. *Ann Periodontol* 1997;2:291-8.
- American Cancer Society: Cancer Treatment and Survivorship; 2012. Available from: <http://www.cancer.org/acs/groups/content/%40epidemiology-surveillance/documents/document/acspc-027766.pdf>. [Last accessed on 2012 Sep 09].
- Schepers RH, Slagter AP, Kaanders JH, van den Hoogen FJ, Merckx MA. Effect of postoperative radiotherapy on the functional result of implants placed during ablative surgery for oral cancer. *Int J Oral Maxillofac Surg* 2006;35:803-8.
- Granström G. Osseointegration in irradiated cancer patients: An analysis with respect to implant failures. *J Oral Maxillofac Surg* 2005;63:579-85.
- Barrowman RA, Wilson PR, Wiesenfeld D. Oral rehabilitation with dental implants after cancer treatment. *Aust Dent J* 2011;56:160-5.
- Jisander S, Grenthe B, Alberius P. Dental implant survival in the irradiated jaw: A preliminary report. *Int J Oral Maxillofac Implants* 1997;12:643-8.
- Korfage A, Schoen PJ, Raghoebar GM, Roodenburg JL, Vissink A, Reintsema H. Benefits of dental implants installed during ablative tumour surgery in oral cancer patients: A prospective 5-year clinical trial. *Clin Oral Implants Res* 2010;21:971-9.
- Linsen SS, Martini M, Stark H. Long-term results of endosteal implants following radical oral cancer surgery with and without adjuvant radiation therapy. *Clin Implant Dent Relat Res* 2012;14:250-8.
- Vissink A, Burlage FR, Spijkervet FK, Jansma J, Coppes RP. Prevention and treatment of the consequences of head and neck radiotherapy. *Crit Rev Oral Biol Med* 2003;14:213-25.
- Buddula A, Assad DA, Salinas TJ, Garces YI. Survival of dental implants in native and grafted bone in irradiated head and neck cancer patients: A retrospective analysis. *Indian J Dent Res* 2011;22:644-8.
- Verdonck HW, Meijer GJ, Laurin T, Nieman FH, Stoll C, Riediger D, *et al.* Implant stability during osseointegration in irradiated and non-irradiated minipig alveolar bone: An experimental study. *Clin Oral Implants Res* 2008;19:201-6.
- Pompa G, Saccucci M, Carlo GD, Brauner E, Valentini V, Carlo SD, *et al.* Survival of dental implants in patients with oral cancer treated by surgery and radiotherapy: A retrospective study. *BMC Oral Health* 2015;5:1-6.
- Visch LL, van Waas MA, Schmitz PI, Levendag PC. A clinical evaluation of implants in irradiated oral cancer patients. *J Dent Res* 2002;81:856-9.
- Keller EE, Tolman DE, Zuck SL, Eckert SE. Mandibular endosseous implants and autogenous bone grafting in irradiated tissue: A 10-year retrospective study. *Int J Oral Maxillofac Implants* 1997;12:800-13.
- Babin RW, Ryu JH, Gantz BJ, Maynard JA. Survival of implanted irradiated cartilage. *Otolaryngol Head Neck Surg* 1982;90:75-80.
- Jemt T, Chai J, Harnett J, Heath MR, Hutton JE, Johns RB, *et al.* A 5-year prospective multicenter follow-up report on overdentures supported by osseointegrated implants. *Int J Oral Maxillofac Implants* 1996;11:291-8.
- Nishimura RD, Roumanas E, Beumer J 3rd, Moy PK, Shimizu KT. Restoration of irradiated patients using osseointegrated implants: Current perspectives. *J Prosthet Dent* 1998;79:641-7.
- Harrison JS, Stratemann S, Redding SW. Dental implants for patients who have had radiation treatment for head and neck cancer. *Spec Care Dentist* 2003;23:223-9.
- Javed F, Al-Hezaimi K, Al-Rasheed A, Almas K, Romanos GE. Implant survival rate after oral cancer therapy: A review. *Oral*

- Oncol 2010;46:854-9.
28. Granström G. Radiotherapy, osseointegration and hyperbaric oxygen therapy. *Periodontol* 2000 2003;33:145-62.
 29. SchoenPJ, ReintsemaH, RaghoobarGM, Vissink A, RoodenburgJL. The use of implant retained mandibular prostheses in the oral rehabilitation of head and neck cancer patients. A review and rationale for treatment planning. *Oral Oncol* 2004;40:862-71.
 30. Asikainen P, Klemetti E, Kotilainen R, Vuillemin T, Sutter F, Voipio HM, *et al.* Osseointegration of dental implants in bone irradiated with 40, 50 or 60 Gy doses. An experimental study with beagle dogs. *Clin Oral Implants Res* 1998;9:20-5.
 31. Epstein JB, Wong FL, Stevenson-Moore P. Osteoradionecrosis: Clinical experience and a proposal for classification. *J Oral Maxillofac Surg* 1987;45:104-10.
 32. Meraw SJ, Reeve CM. Dental considerations and treatment of the oncology patient receiving radiation therapy. *J Am Dent Assoc* 1998;129:201-5.
 33. Werkmeister R, Szulczewski D, Walteros-Benz P, Joos U. Rehabilitation with dental implants of oral cancer patients. *J Craniomaxillofac Surg* 1999;27:38-41.