Article

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Hammond, D, Dover, MS, Parmar, S, McMillan, K, Van Den Bergh, B and Bayoumi, S (2014) Does the advent of modern implant systems and the refinement of free flap technique negate the effect of radiotherapy in oral cancer dental implant based oral rehabilitation. Oral Surgery, 8 (3). pp. 152-155. ISSN 1752-2471

ORAL SURGERY

Oral Surgery ISSN 1752-2471

ORIGINAL ARTICLE

Does the advent of modern implant systems and refinement of free flap techniques negate the effect of radiotherapy in patients with oral cancer undergoing dental implant–based oral rehabilitation?

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Key words:
Post radiotherapy implant success

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Accepted: 21 October 2014

doi:10.1111/ors.12135

Abstract

Aim: The aim of this study was to see whether the advent of modern implant systems, and the refinement of free flap techniques, negate the effect of radiotherapy in patients with oral cancer who undergo dental implant–based oral rehabilitation.

Materials and method: A retrospective study was performed to look at the success rates of implants placed in all patients, in a 3 year period at the Queen Elizabeth Hospital, Birmingham. Survival rates in irradiated patients were compared with success rates in patients who did receive radiotherapy.

Results and conclusions: The rate of failure is comparable in the no radiotherapy group (1.12%) and post-radiotherapy group (1.76%). Our study shows that there was no significant difference in survival when implants were placed in native, grafted bone or in free flap reconstructions in irradiated head and neck cancer patients. Ultimately, the current evidence is not strong enough to prove whether the advent of modern implants systems, and the refinement of free flap techniques, does negate the effect of radiotherapy in patients with oral cancer undergoing dental implant–based oral rehabilitation. There is a need to perform a prospective clinical trial to observe clinical outcomes in both patients who have received radiotherapy and those who have not received radiotherapy.

Clinical relevance

It is an integral part of the rehabilitation of patients with oral cancer to attempt to return them to their previous functional state. Radiotherapy is seen to be a major factor in the exclusion of patients receiving dental implant–based rehabilitation. The refinement of both newer implant systems, combined with free flap surgical technique, has led to improved implant-based oral rehabilitation as well as a reduced failure rate. This article, while being a retrospective study, may show evidence that the gap in implant failure rate is closing between patients who have been irradiated and those who have not.

Introduction

Historically, the placement of implants into native bone in an irradiated field, or into a bony free flap within an irradiated field had a significantly higher failure rate than implants placed into virgin native bone. Even in small studies[1] the success rates for implants placed into an irradiated mandible were 77.5% and as low as 63%[2] in the maxilla. Currently, the expected success rates of implant supported, cantilevered, fixed dental prostheses in non-irradiated native bone (combined mandible and maxilla) are 94.3% at 5 years[3].

It is an integral part of the rehabilitation of patients with oral cancer to attempt to return them to their

previous functional state. For patients treated for oral cancer, major concerns may include their ability to chew, speak and swallow. If these issues are not addressed, this can lead to psychological difficulties[4]. The loss of teeth is a determinant of a patient's health-related quality of life, with a reduced self-perceived oral health status associated with greater numbers of missing teeth. This was confirmed by the Second National Survey of Health-Related Quality of Life Questionnaires in Head and Neck Oncology[5]. There is, therefore, a patient need and demand for dental rehabilitation that aims to restore oro-facial form and function and general well-being.

Materials and method

A retrospective study was performed to look at the success rate of implants placed at Queen Elizabeth Hospital, Birmingham, between March 2009 and March 2012. A variety of modalities were used to acquire the data for this study. Theatre and laboratory log books were used to identify those patients who had dental implants placed in this period. The clinical notes were then reviewed for each patient, and the patients were categorised into:

1 Oncology patients with free flap reconstruction of the maxilla or mandible who had received post-operative radiotherapy.

2 Oncology patients with free flap reconstruction who had not received post-operative radiotherapy and non-oncology patients (trauma, deformity, hypodontia, cleft, other).

For each case, the site of the implant or implants was recorded, whether hard and/or soft tissue augmentation was required and the outcome of each implant. If there was an adverse outcome or complication, then the reason for this was recorded. Only those patients who had had Straumann implants placed were included in this study, to reduce variability. Average follow-up was 2.7 years. All patients in the post-radiotherapy group had received their implants after they had received radiotherapy. All implants were placed by either a consultant, or a Specialist Registrar under the supervision of a consultant. All patients had intravenous antibiotics given on induction and were given a 5 day post-operative course of oral antibiotics. The survival of the implants was assessed by analysis of notes, clinic letters and radiographs.

These results were then analysed.

Results

Table 1 shows that proportionately more implants were placed in the maxilla of the no radiotherapy group, and proportionately more implants were placed in the mandible of the post-radiotherapy group. A chi-squared test was performed on these data, and it was found to be statistically significant (chi-square = 13.82, 1 degree of freedom, two-tailed *P*-value = 0.0002).

Table 1 Number of implants placed, in each jaw and whether the patients had undergone radiotherapy or not

	Number of implants	
	Post-radiotherapy	No radiotherapy
Maxilla	152	159
Mandible	189	107
Total	341	266

Table 2 Relevant smoking information regarding patients

	Post-radiotherapy group (%)	No radiotherapy group (%)
Percentage of patients smoking at time of implant placement	46	15
Percentage of patients who were previous smokers	73	27

Table 3 American Society of Anaesthesiologist (ASA) Physical Status Classification of the patients in whom the implants were placed

ASA classification	Post-radiotherapy group (%)	No radiotherapy group (%)
1	5	73
2	40	17
3	53	10
4	2	0
5	0	0
6	0	0

Table 2 demonstrates that the post-radiotherapy group had a higher proportion of active smokers than the no radiotherapy group. A chi-squared test was performed on these data, and it was not found to be statistically significant (two-tailed *P*-value = 0.879).

Table 3 shows that the no radiotherapy group had significantly more patients in the American Society of Anaesthesiologists (ASA) group 1 than the post-radiotherapy group. There was a much greater proportion of patients with ASA = 2 and 3 in the post-radiotherapy group. This suggests that this group has greater comorbidities than the no radiotherapy group.

Table 4 shows that 18% of the implants placed in post-radiotherapy group were placed in bony free flaps, and 82% were placed in native bone.

Table 5 shows that a greater proportion of implants were loaded in the no radiotherapy group (88%) compared with the post-radiotherapy group (70%). This may well be due to recurrence of disease, new

comorbidities and willingness to undergo further treatment.

Table 6 shows that an implant failure rate of 1.76% in the post-radiotherapy group compared with the no radiotherapy group (1.12%). The loss of one free flap was a significant complication and resulted in the need for a second bony free flap, a 16 day hospital stay and the additional free flap donor site morbidity to the patient. There was an increased rate of peri-implantitis in the post-radiotherapy group (2.90%) compared with the no radiotherapy group (1.50%). Nerve injuries only occurred in the no radiotherapy group ($n = 2$); however, these were both temporary and resolved within 3 months. There was no statistical difference in the complication rates between the two groups.

Discussion

The causes contributing to implant failure are recognised as (a) implant location and (b) radiotherapy. Neither smoking nor systemic health factors were found to adversely affect implant integration from abutment connection through 2 years active function[6]. Seventy-three per cent of the no radiotherapy group (Table 3) were ASA grade 1 compared with 5% of the post-radiotherapy group. This suggests that the no radiotherapy group had significantly less comorbidities than the post-radiotherapy group, which had the highest proportion of patients in the ASA 3 Group (53%). This difference in the level of comorbidities may contribute to the failure rate of the implants. It is likely that loco-regional disease recurrence and a higher rate of ASA 3 patients is the reason behind the 30% (Table 5) post-radiotherapy patients not having their implants restored.

In our study (Table 2), this demonstrated that there was no statistically significant difference in the number of smokers and past smokers between the two groups ($P = 0.879$). Given that the rate of failure is comparable in the no radiotherapy group (1.12%) and post-radiotherapy group (1.76%), this suggests that smoking is not a significant cause of failure.

There is controversy over whether placing implants in bone within a period shorter than 12 months after radiotherapy may result in a higher risk of failure. In a meta-analysis, the pooled relative risk (RR) of failure was $RR_{pooled} = 1.34$. However, if one study was removed, it gave an overall RR of failure of $RR_{pooled} = 1.08$[7].

This article suggests that radiotherapy may not play as significant a role in the failure of implants as was thought. Our study (Table 6) shows a 1.76% failure rate that is similar to the failure rate (1.4%) in a prospective 5 year clinical trial[8] of implants placed in non-irradiated patients.

The same trial[8] found that during a 5 year period from 2004 to 2009 implants placed in irradiated bone had a success rate of 89.4%. This shows that expectations of survival have improved markedly from 1997 when success rates in irradiated patients ranged from 77.5% to 85.5%. The improvement may be influenced by which implant system was used[9], or it may be due to improved surgical technique, better restorative techniques, improved oral hygiene[10] and restorative consultants who have rehabilitation of oral cancer patients as part of their job plan. The advent of intensity-modulated radiotherapy treatment (IMRT) may in the

Table 4 Proportion of implants placed into free flap and implants placed into native bone

	Post-radiotherapy group (%)	No radiotherapy group (%)
Implants placed in free flap bone	18	7
Implants placed in native bone	82	93

Table 5 Number of implants loaded (as of August 2013)

	Post-radiotherapy group	No radiotherapy group
Maxilla	106	142
Mandible	134	93
Total	240	235

Table 6 Number of complications that arose

	Post-radiotherapy	No radiotherapy	Fisher exact test score	Significant – yes/no
Implant failure	6 (1.76%)	3 (1.12%)	0.73	No
Nerve injury	0 (0.00%)	2 (0.75%)	0.19	No
Peri-implantitis	10 (2.90%)	4 (1.50%)	0.29	No
Free flap failure	1 (0.29%)	0 (0.00%)	N/A	N/A
Soft tissue problem (i.e. loss of overlying skin paddle or split thickness skin graft or gingival loss)	2 (0.58%)	1 (0.38%)	1.0	No
Total	19 (5.57%)	10 (3.75%)	0.34	No

future reduce the failure rate of dental implants in the post-radiotherapy group. This is because IMRT allows higher radiation doses to be focused to regions within the tumour while minimising the dose to the surrounding normal structures.

Our study shows that there was no significant difference in survival when implants were placed in native, grafted bone or in free flap reconstructions in irradiated head and neck cancer patients. Roumanas[2] and Esser[1] showed that outcomes for implants that are placed in native bone, the survival was significantly influenced by the location of the implant (maxilla or mandible, anterior or posterior).

The loss of a free flap is a significant cause of morbidity to the patient and must not be underestimated. However free flap failure is a recognised risk if dental implants are placed, as in the process of placing implant the blood supply to the free flap may be compromised. In a case series of 59 fibula-free flaps (into which implants were placed), three failed and had to be removed, nine underwent partial necrosis involving the bone segment and/or the skin paddle but survived, whereas the remaining 47 healed uneventfully[11].

Nooh[12] performed a review of 38 articles on implant survival in irradiated patients, which were published between 1990 and 2012. He found that overall implant survival rates with radiation therapy done pre- and post-implantation were 88.9% and 92.2%, respectively. He found that in patients who had had pre-implantation radiation therapy, the implant survival rate was significantly higher for the mandible (93.3%) than for the maxilla (78.9%). It was concluded that the anatomical site of implant placement in pre-implantation radiation therapy was the most pertinent variable affecting implant survival, with a better survival rate in the mandible compared with the maxilla. Although these success rates are lower than the one in this study, it must be noted that studies that were published 23 years ago were included in the article, and it is well acknowledged that success rates have increased in recent years[3].

Ultimately, the current evidence is not strong enough to prove whether the advent of modern implants systems, and the refinement of free flap techniques does negate the effect of radiotherapy in patients with oral cancer undergoing dental implant–based oral rehabilitation. There is a need to perform a prospective clinical trial to observe clinical outcomes in both patients who have received radiotherapy and those who have not received radiotherapy. This should look at comorbidities in both groups, standard radiotherapy versus IMRT, osteoradionecrosis rates, as well as quality of life improvements associated with dental implants.

Conflict of interest

The authors confirm that they have no conflict of interest.

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