ACTA SCIENTIFIC OTOLARYNGOLOGY

Volume 2 Issue 1 January 2020

Research Article

Implant Success in Irradiated Free Fibula Flaps for Mandible Reconstruction

A Varidel*, P Mollica and D Leinkram

Westmead Hospital, Sydney, Australia

***Corresponding Author:** A Varidel, Westmead Hospital, Sydney, Australia

Received: December 20, 2019; **Published:** January 06, 2019

Abstract

Background: Free fibula reconstruction of segmental mandible defects is a commonly accepted method of rehabilitation following ablation for head and neck squamous cell carcinoma. Fibula reconstruction is made particularly useful by its ability to successfully osseointegrate dental implants, thus allowing for improved functional and aesthetic rehabilitation. However, in cases requiring post reconstruction radiotherapy, the intention to continue with implant placement should be reevaluated. While it is commonly understood that irradiated tissues have much poorer healing qualities than non-irradiated tissues, very little evidence exists as to the specific success rates and risks of placing implants in these neo-mandibles.

Methods: Three databases were searched for all papers related to implant placement in irradiated free fibula mandible reconstructions.

Findings: Limited studies considered implants in irradiated fibula flaps. Retrospective studies appear to support that these implants have over 80 percent survival. At this stage, the specific associated complications are largely unreported.

Conclusion: Current data on implant success in irradiated free fibula mandible reconstructions is limited. However, present literature suggests that these implants pose a reasonable success rate. This piece found that the survival of implants in these patients is certainly less than the accepted success of implants in non-irradiated free fibula reconstructions. However, the authors of this paper propose that continuing with implant placement in irradiated fibulas is a reasonable and somewhat reliable option for oral rehabilitation.

Keywords: Free Fibula; Radiation; Implant; Rehabilitation

Background

Free fibula reconstruction of segmental mandible defects is a commonly accepted method of rehabilitation following ablation for head and neck cancer. Fibula reconstruction is made particularly useful by its ability to successfully osseointegrate dental implants, thus allowing for improved functional and aesthetic rehabilitation. The insetting of the free fibula flap is undertaken as a second stage in the initial ablative operation, directly following removal of the offending tumour. However, in cases requiring post reconstruction radiotherapy, the intention to continue with implant placement should be re-evaluated. Current literature has established that implant success in non-irradiated free fibula flaps is consistent and only marginally reduced compared to implants placed in native bone. However, it is commonly understood that irradiated tissues have much poorer healing qualities than non-irradiated tissues. The success of the rehabilitation procedures is particularly important in those who have already undertaken a major reconstructive operation and extensive radiotherapy. The dental rehabilitation plan should consider the significant morbidity of both of these treatments and look to provide a reliable treatment option with evidence-based validity. Currently, very little evidence exists as to the specific success rates and risks of placing implants in these irradiated neo-mandibles.

Objectives

The purpose of this systematic review was to critically analyse the current literature regarding the success of dental implants placed in previously irradiated free fibular flaps. This review focusses on the primary comparison between irradiated and non-irradiated free fibulas. The aim of the study is not to compare the success to native bone, irrespective of its radiation status. For the purposes of clarification in reporting, this review will consider previously irradiated cases to involve cases that have received the completed therapeutic dose of radiation prior to commencing any operative implant placement. The authors of this paper therefore undertake to clarify the validity of implant rehabilitation in this particular subset of reconstruction patients.

Search methods

A search was performed on three databases in August 2017; PubMed, Medline and Embase. The following key terms were used in the search: implant, fibula, radiation. The keywords were searched in PubMed as a complete set – searched items were required to fulfil an 'implant and fibula and radiation' search. The keywords were exploded in the Embase search. The articles were then reviewed to identify any piece that considered implant placement in irradiated free fibula flaps. There was no publication time limit, language restriction or population age restriction.

Selection criteria

All citations were independently reviewed by 2 reviewers. Given the nature of the clinical question, it was determined that randomised controlled trials were unlikely to have been completed. Therefore, there was no restriction in regards to level of evidence and type of publication included. The studies were included whether they were prospective, or retrospective trials, along with all case studies and case series. Articles were excluded if the fibula free flap was irradiated after placement of the dental implant commenced. No other exclusion criteria were used. Due to the limitation in evidence in the field, there was no exclusion criteria based on length of follow-up.

Data collection and analysis

Data extraction

Two independent reviewers reviewed relevant papers according to the inclusion and exclusion criteria. Any disagreements were resolved by consensus. The data was sought for a population which had undertaken both free fibula reconstruction and subsequent radiotherapy to the fibula, where implant-based oral rehabilitation was indicated. The comparator group was defined as those patients who had undergone fibula reconstruction, but had not received radiotherapy prior to implant placement. The outcome studied was implant success, determined by the ability for the implant to be used effectively for prosthetic oral rehabilitation purposes. For simplification purposes, no distinction was made between the radiation doses received, the characteristics of the implants used or the timing of the rehabilitation in comparison to the free flap inset or subsequent radiotherapy.

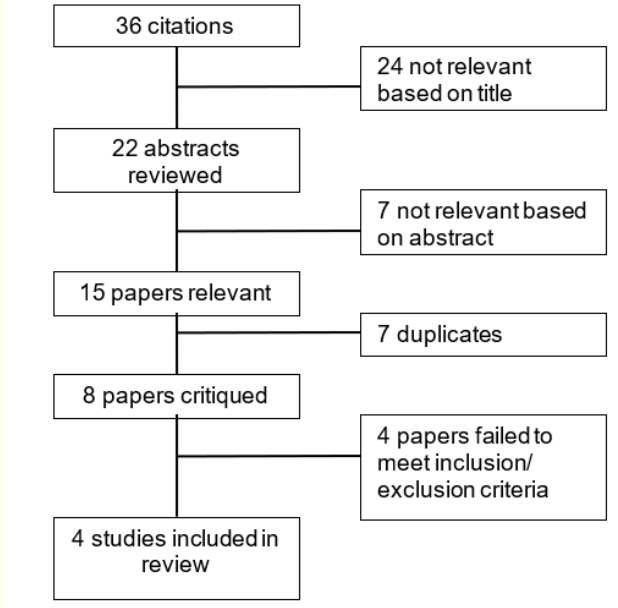

Figure 1: Literature Search and Paper Selection.

Study characteristics

A total of 36 citations were attained across 2 databases and Embase. After filtering the title, 24 of the articles were subsequently excluded as not relevant. A further 7 papers were deemed not relevant based on review of abstract. 7 duplicates were removed. The remaining 8 papers were critically reviewed and included in the review, deemed to be relevant to the clinical question. The search strategy reviled no randomised controlled trials.

Paper Reviewed	Inclusion/Exclusion criteria met	Details of failure to meet criteria	Included in systematic review
Jackson., *et al.*	Yes	-	Yes
He., *et al.*	No	Any free fibulas that received radiation were rehabilitated with dentures	No
Salinas., *et al.*	Yes	-	Yes
Teoh., *et al.*	No	No free fibulas received irradiation	No
Roumanas., *et al.*	No	No free fibulas received irradiation	No
Barber., *et al.*	Yes	-	Yes
Chiapiasco., *et al.*	No	No free fibulas received irradiation	No
Ch'ng., *et al.*	Yes	-	Yes

Table 1: Implementation of Inclusion/Exclusion Criteria.

Level of evidence of included studies

All studies included in this review are retrospective cohort studies with the exception of the case series by Barber., *et al*. According the the NHMRC Level of Evidence Hierarchy, cohort studied represents level III-3 prognostic evidence. This is a low level of evidence.

Author	Study Type	STROBE score	Assessment of Quality
Jackson., *et al.*	Retrospective Cohort Study	20	High
Ch'ng., *et al.*	Prospective Cohort Study	19	High
Salinas., *et al.*	Retrospective Cohort Study	18	High
Barber., *et al.*	Case Series	16	Low

Table 2: Assessment of quality of studies according to the STROBE statement.

Quality of included studies

The 3 cohort studies provided comparative data between implants placed in non-irradiated free fibulas and irradiated free fibulas. Barber., *et al.* only included irradiated free fibulas in a case series, with no control group. The STROBE score was used to assess the quality of the included studies [1].

Outcome measure

The clinical question of this piece relates to the overall success of oral rehabilitation of the implants placed. Thus, the paper considered implant success and implant survival in patients who received dental implants in previously irradiated free fibula flaps.

Publication bias

This piece notes a very limited number of papers on the topic with low level of supporting evidence. Given the limited population included in the current literature, the authors note a substantial bias.

Results

Three paper were included in this review. 1 trial prospectively and 2 trials retrospectively assessed the topic of this study – the success of dental implant placement in previously irradiated free fibula reconstructions. A further paper was included which looked at the intervention of hyperbaric oxygen treatment in possibly improving the success of implants placed in this context. The four included papers have been discussed below. A summary table of the results of these papers in included in table 3.

Jackson., *et al.* 2016

Jackson., *et al*. undertook an evaluation of clinical outcomes of implants placed in free fibula flaps in mandibles as both immediate (primary) and delayed (secondary) procedures. The comparison

between irradiated and non-irradiated free fibula reconstructions was well addressed as part of the subgroup analysis. The study was clearly defined and the paper appropriately addressed the primary aims, methods and findings. Limitations of the study were clearly and comprehensively discussed. While confounding factors were tabulated, the statistical methods used to control these factors were not clearly described. Funding for the trial was not addressed.

Of the 46 patients included in the retrospective review, 6 received implant placement following irradiation of the fibula free flap. 19 implants were placed in these 6 patients, with 5 failures, giving a 26 percent failure rate (P=0.35) [2]. While this failure rate was marginally higher than success in the non-irradiated free fibula group, this was not statistically significant.

Ch'ng., *et al.* 2016

Ch'ng., *et al*. undertook a large scale prospective cohort study of dental rehabilitation in head and neck reconstructed patients. While the recruitment to the study was limited by financial concerns, this is not inconsistent with general clinical practice. The study design was excellent and a thorough sub-group analysis was undertaken. The variable comparison between implant success in irradiated and non-irradiated fibulas was addressed as part of the subgroup analysis. The trial included a large population group, adding significance to the results. However, the population who received implants in irradiated free fibulas was distinctly limited. Unfortunately, sources of bias were not discussed, nor funding for the trial. While limitations of the study were inferred, the authors feel this was not addressed specifically.

In this study 246 patients were included, receiving a total of 1132 dental implants. Of these, 18 patients received dental implants after radiation therapy. The study noted an overall trend of decreased implant survival in fibula free flaps compared to native mandibles. 43 implants were placed in patients who received pre-implant radiation to a free fibula flap. Of these, 8 implants failed (18.6%, P=0.041) [3]. This was higher than the 9% failure rate in the 177 implants placed in fibula free flaps that did not receive irradiation. Again, this data was not statistically significant.

Salinas., *et al.* 2010

Salinas., *et al.* conducted an excellent retrospective cohort analysis specifically aimed at determining the success of implants placed in irradiated free fibulas, compared to non-irradiated free fibulas. A clear study design and analytical method was used. The author of this paper feels that a detailed explanation of all confounding factors was not clearly addressed, nor a description of the sources of data or methods of assessment for these confounders outlined. A description of missing data and loss to follow-up was not included. There was no clear description of potential bias of reference to funding for the trial.

44 patients were included in the study. 114 implants were placed in fibula free flaps. 51 implants were placed in non-irradiated flaps, while 63 implants were placed in irradiated flaps. Of these, there was a higher success rate noted in patients who did not receive irradiation 90.4% vs 72.5%, though this was not found to be statistically significant [4].

Barber., *et al*. 1995

Barber., *et al*. considered the effect of hyperbaric oxygen on irradiated free fibulas where dental implants where placed with both pre- and post-surgical hyperbaric oxygen therapy. The primary limitation of this study, for the purposes of this systematic review, was the lack of a control group. All patients who received implants after radiotherapy also received the HBO regimen. Interestingly, there was no discussion of patient characteristics outside of the reasons for ablation and smoking or alcohol consumption. There was subsequently no discussion of eligibility criteria, methods of patient selection or other potential confounders. Loss to follow-up and missing data was not discussed. Further, the authors of this paper propose that the population included in this trial is insufficient to provide substantive evidence of outcome measures.

The trial included 5 head and neck cancer patients who had received free fibula reconstruction with post reconstruction radiotherapy. Each patient in this pilot study received 20 sessions of hyperbaric oxygen (HBO) preoperatively and 10 HBO sessions postoperatively. All of the 20 implants placed were successful [5].

Author	Implants placed in non-irradiated fibula free flaps: successful/ total (successful percent)	Implants placed in irradiated fibula free flaps: successful/ total (successful percent)
Jackson., *et al*.	16/19 (84.2%)	14/19 (73.7%)
Ch'ng., *et al*.	168/177 (94.9%)	35/43 (81.4%)
Salinas., *et al*.	57/63 (90.4%)	37/51 (72.5%)
Barber., *et al*.	Not assessed	20/20 (100%)

Table 3: Comparative success of implants placed in non-irradiated and irradiated free fibulas following ablation and reconstruction.

Summary measures

The principal summary measure for this review was the percentage of successful implants placed. In the context of the review, success was defined as the survival of the implant such that definitive prosthodontic oral rehabilitation techniques could be provided to the patient.

Risk of bias

The risk of bias in this review, based on the papers included, is not unsubstantial. Many of the trails did not adequately delineate all confounders or seek to minimise these variables. Particularly, given the small populations involved in many of the trials, this increases the risk of publication bias. There was also considerable risk of selective reporting across the studies.

Discussion

The oral rehabilitation of patients receiving free fibula reconstruction following ablative cancer surgery with postoperative radiotherapy is complex. Many operators are hesitant to undertake implant placement in these patients in light of healing difficulties associated with irradiated tissues. The 4 trials detailed in this systematic review provide further light on the comparative success rate of dental implants placed in irradiated free fibulas and non-irradiated free fibulas. A broad search of the literature revealed limited research in this field. The trials located were all cohort studies or case reports, with only a single prospective cohort study. Further, many of the studies only considered implant success in irradiated versus non irradiated free fibulas as a subgroup component of a larger trial. To date, only Salinas., *et al.* have specifically looked at implant success in riiradiated versus non-irradiated fibulas as the primary comparison. All three papers which compared success in irradiated versus non-irradiated patients were of high quality. However, in each case the results were not statistically significant and the power of the findings limited by cohort size.

Unfortunately the level of evidence is currently very low. The three cohort studies indeed suggest implant placement in irradiated free fibulas may warrant caution, with the possibility of a slightly higher failure rate. However, given the extensive restrictions in level of evidence and power of the current trials, this is certainly yet to be confirmed or quantified.

Various methods have been suggested to improve implant success in irradiated bone. Hyperbaric oxygen therapy has been utilised for some time in the management of healing complications in native irradiated bone. Its use has also been described for prophylaxis in extracting teeth in patients at risk of medication-related osteonecrosis of the jaw, with evidence-based benefit. This method has since been extrapolated to be used as prophylactic management in implant placement in irradiated native bone. A systematic review was undertaken by Esposito and Worthington in 2013, found only a single randomised controlled trial looking into this, with low quality evidence [6]. This limited evidence did not show a clear benefit for hyperbaric oxygen used prophylactically for implant placement in irradiated native bone. Significantly, Barber., *et al.* found good success in using hyperbaric oxygen before and after implant surgery in irradiated free fibulas. This case series should be realised to be a low level of evidence. There was clearly a very limited population, with high risk of bias and no control group. The authors of this piece pose that there is insufficient evidence to comment on the proposed benefit of hyperbaric oxygen on implant success in irradiated free fibulas.

Alternative implant-based rehabilitation methods are available in patients who require post-reconstruction radiotherapy. Sclaroff., *et al.* described a technique wherein implants were placed at the time of fibula reconstruction in 1994 [7]. He proposed that immediate placement obviates the necessity for hyperbaric oxygen and avoids the complications of placing implant in irradiated free flaps.

While this approach certainly warrants consideration, it does not answer the clinical question of this piece – whether implant placement is still a viable option in free fibula reconstruction, where the fibula has been irradiated prior to rehabilitation efforts.

Conclusion

Current data on implant success in irradiated free fibula mandible reconstructions is limited. However, present literature suggests that these implants may have a reasonable success rate. This piece found that the survival of implants in these patients is possibly less than the accepted success of implants in non-irradiated free fibula reconstructions. There is a definite need for more research into this field. High quality randomised controlled trials with sufficient power are indicated. At this stage there are no randomised controlled trials and the available evidence is of very low clinical validity. The authors of this piece therefore recommend a guarded approach when considering implant placement in this particular cohort of patients. Patients who are planned for this treatment should be made aware that there is very limited evidence in this area and success rates and complication rates cannot be accurately advised. However, the authors of this paper propose that continuing with implant placement in irradiated fibulas is not unreasonable, and may be appropriate in certain clinical situations.

Bibliography

1. von Elm E., *et al*. "The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) Statement: guidelines for reporting observational studies". *International Journal of Surgery* (London, England) 12.12 (2014): 1495-1499.

2. Jackson RS., *et al*. "Evaluation of Clinical Outcomes of Osseointegrated Dental Implantation of Fibula Free Flaps for Mandibular Reconstruction". *JAMA Facial Plastic Surgery* 18.3 (2016): 201-206.

3. Ch'ng S., *et al*. "Osseointegrated implant-based dental rehabilitation in head and neck reconstruction patients". *Head and Neck* 38 (2016): E321-327.

4. Salinas TJ., *et al*. "Clinical evaluation of implants in radiated fibula flaps". *Journal of Oral and Maxillofacial Surgery* 68.3 (2010): 524-529.

5. Barber HD., *et al*. "Evaluation of osseointegration of endosseous implants in radiated, vascularized fibula flaps to the mandible: a pilot study". *Journal of Oral and Maxillofacial Surgery* 53 (1995): 640-644.

6. Esposito M and Worthington HV. "Interventions for replacing missing teeth: hyperbaric oxygen therapy for irradiated patients who require dental implants". *The Cochrane Database of Systematic Reviews* (2013): Cd003603.

7. Sclaroff A., *et al*. "Immediate mandibular reconstruction and placement of dental implants. At the time of ablative surgery". *Oral Surgery, Oral Medicine, and Oral Pathology* 78 (1994): 711-717.

Volume 2 Issue 1 January 2020