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Histologic Evidence of Osseointegration in the Irradiated and Reconstructed Mandible: A Case Report

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Osseointegrated implants are widely used in dental rehabilitation. They are particularly valuable if the structures supporting a denture had to be removed because of oral cancer. Additionally, many of these patients undergo radiotherapy, but cancer and radiotherapy are seen as relative contraindications for implant therapy. In the literature, there are few clinical studies documenting successful oral rehabilitation using implants in such patients. The authors report a clinical case in which histologic evidence of osseointegration can be demonstrated in an irradiated and reconstructed mandible. This observation should encourage the extended application of implants in rehabilitation following oral cancer surgery. (Int J Oral Maxillofac Implants 1999;14:113–117)

Key words: dental implants, mandibular reconstruction, oral cancer, radiotherapy

Osseointegrated implants are a widely accepted means of rehabilitating edentulous patients. Nevertheless, the criteria for patient selection in the literature are quite rigid. Systemic diseases, compromised general health, and untreatable malignant tumors are frequently mentioned as contraindications for the use of implants.

The loss of teeth in conjunction with an oral malignancy usually creates a severe handicap for patients. If during cancer surgery, portions of the alveolar process or bony facial structures together with the neighboring soft tissues are resected and the patient undergoes radiotherapy, speech, masticatory function, and esthetics may be severely compromised. In such cases, implant-supported prostheses can be an effective treatment modality.

With respect to the treatment regimen of patients, one must differentiate between successfully placed implants that have been irradiated and implant surgery performed after radiation therapy. There are reports that when radiotherapy is provided with pre-existing osseointegrated implants in place, the implant success rate is diminished only slightly.[1–3] Implantation in previously irradiated sites is also possible. This has been demonstrated in animal experiments, as well as in clinical studies.[4] When implants are placed in irradiated bone, the blood supply of this bone will have been altered, and therefore the risk of infectious complications is markedly increased. This is in accordance with the lower success rates of such implants published in the literature.[5] Nevertheless, bone tissue damaged by irradiation represents only a relative contraindication for dental implants, since in these patients there may be no other alternative for their prosthetic rehabilitation. Often there is radiogenic xerostomia, which, along with severe defects of the supporting structures, would not allow fabrication of a successful removable prosthesis. Nevertheless, successful reports with this kind of treat-

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ment have also been reported.[6] Recent studies document the beneficial effect of adjunctive hyperbaric oxygenation therapy (HBO).[7–9]

Human histologic data concerning irradiated bone that supports oral implants have not been published until now. Therefore, in this light, a clinical history is presented here, wherein endosseous screw-form titanium implants were placed in a previously irradiated and reconstructed mandible and then examined histologically[10] after osseous healing for 6 months and functional loading for 2 months.

Case Report

A 62-year-old patient was referred by his physician to the Department of Maxillofacial Surgery of the University Hospital of Zurich because of clinical signs of osteoradionecrosis of the mandible. A few weeks previously a dentist had removed the mandibular left second molar without using antibiotics.

Three years prior to this, a squamous cell carcinoma (low differentiated) of the left palatoglossal arch, stage T2N0M0, had been diagnosed. Since the patient had refused several times to undergo surgical treatment, percutaneous radiotherapy with a 72 Gy cumulative dose, including the lymphatic vessels and the floor of the mouth, was performed. No recurrence of the tumor was found in follow-up examinations. However, the patient was hospitalized numerous times because of problems related to alcohol abuse. Therapy was planned in 2 stages; first, a partial resection and reconstruction of the mandible be performed; and second, full dental rehabilitation would take place.

Mandibular Reconstruction. Prior to surgery, the usual preoperative examinations (eg, computed tomography [CT] scans, panoramic radiographs, ultrasound of the neck and abdomen, and extensive laboratory tests) were done to confirm extension of the osteoradionecrosis and especially to exclude recurrence of the tumor. Partial resection of the mandible was performed from the mandibular left central incisor to include half the height of the left ascending ramus together with the coronoid process. Because of irradiation damage, some of the surrounding soft tissue had to be removed. Reconstruction of the resected mandible was performed using autologous calvarial bone and a vascularized temporal muscle flap. No immediate postoperative complications were noted.

Placement of Dental Implants. Fifteen months after the osseous reconstruction, one 3.75-mm-diameter dental implant was placed in the anterior region (in the area of the right lateral incisor) of the mandible (Brånemark System, Nobel Biocare AB, Göteborg, Sweden). A second implant 3.75 mm in diameter and 15 mm in length was placed in the reconstructed mandible in the area of the left lateral incisor (Brånemark). The implant in the area of the right lateral incisor was placed in the original irradiated mandibular bone. After 6 months of healing to allow for osseointegration, the implants were prepared for an overdenture.

The patient was then hospitalized because of recurrence of the tumor in the left parotid area, which extended into the middle cranial fossa, and liver metastasis. He died 2 months after receiving the implant-supported prosthesis. During the autopsy, the whole mandible was disarticulated to examine the extent of osseointegration of the implants in the irradiated mandible after functional loading. Conventional radiography (Fig 1) and autoradiography of the mandible were performed. The bone was then embedded in acrylic resin, and sections of the implant bearing areas were made.

Histologic Results

In the histologic examination, apparent osseointegration (Fig 2) of both dental implants was found. There was no space between the implant surface and the osteocytes of the transplanted calvarial bone, as well as in the original irradiated local mandibular bone. The thickness of the histologic sections was approximately 70 to 80 μm.

Discussion

This patient report presents clinical data and histologic sections of 2 Brånemark implants placed in a previously irradiated mandible and treated for osteoradionecrosis. The mandibular reconstruction with calvarial bone and osseointegrated implants is one treatment possibility for this situation in our hospital. In the patient discussed, implants proved to be clinically successful in the short time period of functional loading. The histologic examination revealed close osseous contact to the surface of the implant, confirming evidence of osseointegration. The peri-implant soft tissue showed no signs of peri-implantitis, even with insufficient oral hygiene. Of special interest was the observation that neither clinical nor histologic differences existed between the implant placed in the irradiated original bone and the implant placed in the transplanted calvarial bone used for reconstruction of the mandible.

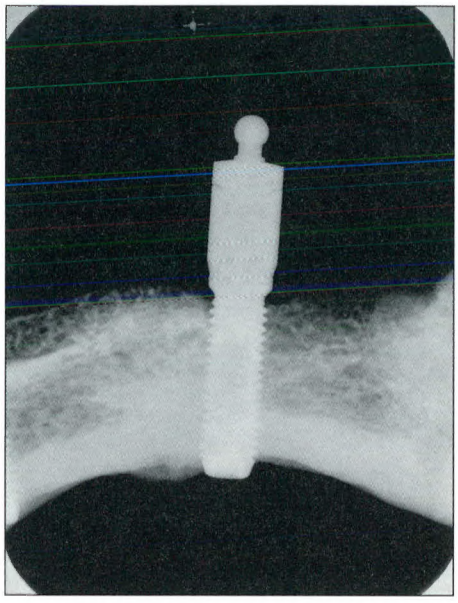


Fig 1a Radiograph of right mandibular lateral incisor region (original mandibular bone) irradiated with 72 Gy.

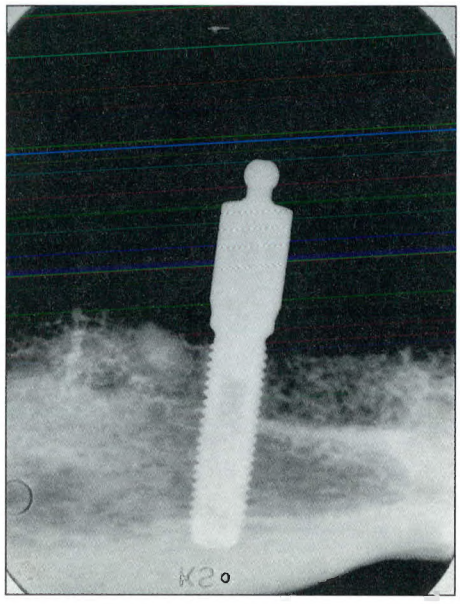


Fig 1b Radiograph of left mandibular molar region site of mandible reconstructed with full-thickness calvarial bone.

Despite the fact that in the last decade an increasing number of clinically successful oral and craniofacial titanium implants in irradiated tissues have been described, histologic evidence of osseointegration in patients under such circumstances has rarely been documented. A literature summary is presented in Table 1, with special focus on implants placed following radiotherapy. Obviously, the same situation exists in nonirradiated implantation sites, where published histologic data are almost always based on case reports.[11] Granström et al, who published a series of studies on implants in irradiated tissue, reported on histologic sections of 2 craniofacial implants, with results comparable to this patient.[1,2] But data have not been published on specimens from intraoral implant sites. In the opinion of the authors, the intraoral situation after radiotherapy may be judged as worse than the conditions for implant placement in extraoral sites. Skin as well as mucosa or gingiva are severely damaged by irradiation, and as such have a compromised blood supply. But the risk of structure-threatening infections is elevated in the oral cavity because of the higher pathogenic potential of oral bacteria in comparison to the skin microbiota.

Results from animal experiments, to the authors' knowledge, have never been discussed. Either incomplete osseointegration occurred in the implants in irradiated bone as well as in the controls without statistically significant differences,[12] or complete osseointegration was observed in all cases, independent of being irradiated or nonirradiated.[4]



Fig 2 Section of mandible, right lateral incisor region, in the irradiated bone; osseointegration can be observed (magnification ×100).

In a number of clinical studies, populations of different sizes (1 to 40 patients; sum 96 patients) with follow-up periods up to 6 years after implant placement have been evaluated (Table 1). The clinical success rates varied from 61.1% to 98.5%. These results may be explained by the different study designs and the varying lengths of follow-up periods. Additionally, in long-term evaluations of groups consisting of patients with malignant disease, some patients may die from the malignancy, which complicates the correct determination of the success rate of the implants.[1,2,5,6,13–15]

Table 1 Experiences with Osseointegrated Implants and Irradiation in the Literature

Author	No. of cases	Irradiation	HBO	Outcome
Schweiger 1989[12]	5 beagle dogs, 5 implants (5 controls)	60 Gy fractionated irradiation 9 months before oral implantation	No	No functional load, 50% good bone ingrowth (blood supply of the bone detected by scintigraphy)
Asikainen et al 1991[4]	5 beagle dogs, 10 implants (10 controls)	20 Gy fractionated irradiation 8 weeks before oral implantation	No	6 months functional loading; success rate 100%
Johnsson et al 1993[8]	10 rabbits, 20 implants (20 controls)	Implantation in the leg 1.5 hours after irradiation with 15 Gy	Yes	Success rate 100%; unscrew force for implants with HBO markedly improved
Parel and Tjellström 1991[15]	27 patients, 108 implants	Previously irradiated patients	No	No information given on follow-up; success rate 61.1%
Martin et al 1992[3]	2 patients, 10 implants	6 weeks after oral implantation, partially in forearm flaps, 60 Gy fractionated	No	Up to 24 months, follow-up success rate 90%
Jacobsson et al 1992[14]	17 patients, 81 implants	43 orbital implants in previously irradiated tissue	No	No information given on follow-up; success rate 62.7%
Vassos 1992[6]	1 patient, 5 implants	20 Gy, 6 years before implantation	No	Follow-up 24 months (previously subperiosteal implants)
Wolfaardt et al 1993[5]	7 patients, 36 implants	Previously irradiated patients, 40 to 70 Gy	3 of 7 patients	No information given on follow-up; success rate 94.4%
Granström et al 1993[1]	11 patients, 32 implants	50 to 80 Gy irradiation 4 to 60 months after implantation (27 fixtures extraorally, 5 orally)	No	Mean follow-up 39 months; success rate 87.5%; histology for 1 implant showed osseointegration; abutment deconnection during radiotherapy suggested
Granström et al 1993[2]	40 patients, 200 implants	Previously irradiated patients > 50 Gy	66 of 134 patients	Mean follow-up 56 months; HBO success rate 98.5%; no HBO success rate 64.2%; histology for 1 case showed osseointegration
Ueda et al 1993[9]	4 patients, 21 implants	Previously irradiated patients 40 to 101.5 Gy	Yes	Follow-up 6-15 months; success rate 92.3%
Oechslin et al (present study)	1 patient, 2 implants	72 Gy 4 years before implantation	No	2 months functional loading; success rate 100%

The hyperbaric oxygen therapy (HBO), suggested by Scandinavian researchers, is obviously indicated to improve clinical success rates.[7] Beyond therapy and prevention of osteoradionecrosis, it should be expected that implant stability would be improved, which has been demonstrated clearly in animal experiments. Johnsson and coworkers found that the forces needed to unscrew implants were significantly increased after the application of HBO during healing.[8]

Summary

Apart from the costs, osseointegrated implants are a valuable treatment modality for rehabilitation after ablative tumor surgery in the head and neck region. Patient selection criteria should be applied less rigidly. Insufficient compliance, impaired oral opening, social circumstances, or substance abuse are only minor contraindications, because in these patients, functional oral rehabilitation by other means may not be possible. A minimal but effective daily oral hygiene regimen should be an essential component of the overall treatment.

From this case report it may be concluded that implant therapy with a predictable result is possible even in an irradiated and reconstructed mandible. In this situation, histologic examination confirmed apparent osseointegration.

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Rehabilitation of Patients with Reconstructed Mandibles Using Osseointegrated Implants: Clinical Report

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Experience with 9 patients who underwent mandibular reconstruction with autogenous free bone grafts and subsequent placement of titanium screw-type implants is reported. The interval between bone grafting and implant placement in these patients ranged from 8 to 34 months. A total of 33 implants was placed, followed up for 16 to 53 months, and achieved an 85% survival rate. Analysis of these patients reveals that the type of bone graft used is integral to successful prosthodontic reconstruction to ensure viability and minimal resorption as well as the timing of implant placement.
(Int J Oral Maxillofac Implants 1999;14:118–126)

Key words: mandibular reconstruction, oral cancer, osseointegration, titanium implants

Radical surgical treatment in patients with malignant or benign lesions of the mandible often results in problems with speech, deglutition, and masticatory function. Prosthodontic rehabilitation of these patients poses particular problems for the clinician. These problems include a lack of bony support for the prosthesis, movable soft tissue in the area that must support the prosthesis, and lack of stability. Spread of the tongue into the surgical site also limits the extension of the prosthesis, which may adversely affect its stability and patient acceptance.

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The goal of maxillomandibular reconstruction for patients who require resection of the mandible is to reestablish anatomic form and oral function. A number of techniques have been used for reconstruction of the form, with bone grafting playing a primary role. Different types of bone grafts used may include vascularized grafts, such as radial and fibular, and free grafts, such as autogenous block and particulate cancellous bone marrow (PCBM) from the iliac crest.[1] After successful reconstruction, facial contour, architectural support, and occlusal relationships may be regained. The alterations that result from scar or replacement tissue, sensory changes, lack of sublingual sulcus or vestibular depth, and changes in muscle function often prevent the wearing of even the most skillfully designed and fabricated tissue-supported dentures. As a result, these patients will likely have poor speech, be unable to eat a solid diet, and exhibit cosmetic deformity.

Osseointegrated implants have become generally accepted for prosthodontic management of the dental patient.[2] The application of endosseous implants in combination with bone grafting, which has become more important in jaw reconstruction over the last decade, has allowed for improved results. Different types of osseointegrated implants have been placed, either simultaneously with bone