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
ment have also been reported. Recent studies document the beneficial effect of adjunctive hyperbaric oxygenation therapy (HBO). 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 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.
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. 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. 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, or complete osseointegration was observed in all cases, independent of being irradiated or nonirradiated. 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.
Table 1  Experiences with Osseointegrated Implants and Irradiation in the Literature

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

The hyperbaric oxygen therapy (HBO), suggested by Scandinavian researchers, is obviously indicated to improve clinical success rates. Beyond therapy and prevention of osteoradio necrosis, 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.

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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References


