Longitudinal Follow-up of Osseointegrated Implants in Patients with Resected Jaws

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Purpose: *To investigate the effects of bone grafting and radiotherapy on implant survival rates.* ***Materials and Methods:*** *This follow-up study involved 36 patients with 180 implants who were treated between January 1989 and December 2000 by prosthodontic rehabilitation using osseointegrated implants following jaw resection. They comprised 20 patients with malignant tumors, 12 with benign tumors, and 2 patients each with osteomyelitis and cysts.* ***Results:*** *A total of 15 implants (11 in the maxilla and 4 in the mandible) were removed for various reasons during the follow-up study. Implant survival rates were calculated using the Kaplan-Meier method; the overall survival rate for the 180 implants was 88.6%. Specific implant survival rates were as follows: in residual bone, 73.8% for the maxilla and 95.2% for the mandible; in grafted bone, 80% for the maxilla and 94.1% for the mandible; in irradiated bone, 79.7%; and in nonirradiated bone, 93.5%.* ***Discussion:*** *Radiotherapy, a dose of 30 Gy, was performed in patients with malignant tumors but not in patients with benign tumors, cysts, or osteomyelitis. No differences were found in the results for implants placed due to jaw resection for malignant tumors and those for implants placed due to benign tumors, cysts, or osteomyelitis. Implants lost varied in length from 7 to 18 mm. Among these, loss was more frequent with shorter implants (lengths to 10 mm).* ***Conclusion:*** *The clinical results obtained in the present study compare favorably with those obtained by others. However, jaw reconstruction and rehabilitation should not be performed by the oral surgeon alone; oral and maxillofacial function should be restored using a team approach in close cooperation with specialists in prosthodontics and periodontics to improve the result of implant treatment.* (Int J Oral Maxillofac Implants 2002;17:225–230)

Key words: *dental implants, resected jaw*

Prosthodontic treatment using titanium dental implants directly connected to jawbone became widely accepted in Japan during the 1980s because of reliable clinical and basic research results. Success rates of 90% or higher have been reported for partial and completely edentulous patients in routine situations, based on follow-up data for 20 years or more after treatment.[1,2] Osseointegrated implants have also been employed for rehabilitation to maximize postoperative function in patients with oral and maxillofacial diseases.[3]

For the assessment of implants in patients with resected jaws, it is necessary to consider whether grafted bone was used, whether radiotherapy was performed, and whether sufficient coverage by soft tissues was achieved.[4–7] In the present study, the clinical outcomes of osseointegrated implants in resected jaw patients treated at the Department of Oral and Maxillofacial Surgery of Saga Medical School, Japan, over a 12-year period were evaluated to investigate the effects of bone grafting and radiotherapy on implant survival rates.

MATERIALS AND METHODS

Rehabilitation of masticatory function was provided using endosseous implants in 86 patients in the 12-year period from January 1989 to December 2000. Oral and maxillofacial diseases involving these patients are shown in Fig 1. In the present study, 36 patients were selected from 86 patients according to jaw resection and/or bone grafting. The resected-jaw group comprised 20 patients with malignant tumors, 12 with benign tumors, and 2 patients each

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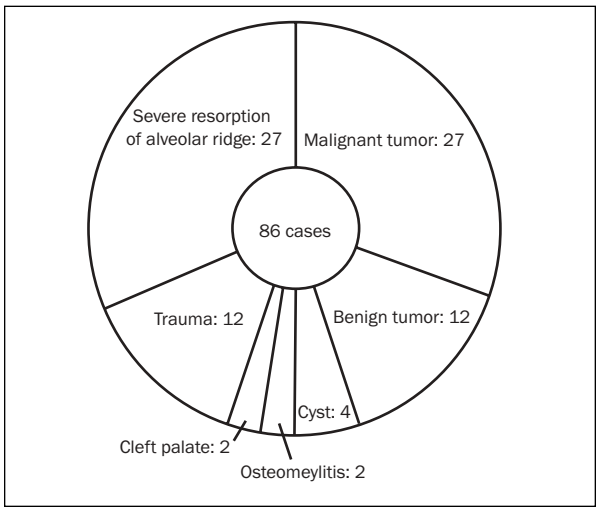

Fig 1 Implant cases from the Department of Oral and Maxillofacial Surgery, Saga Medical School (1989 to 2000) .

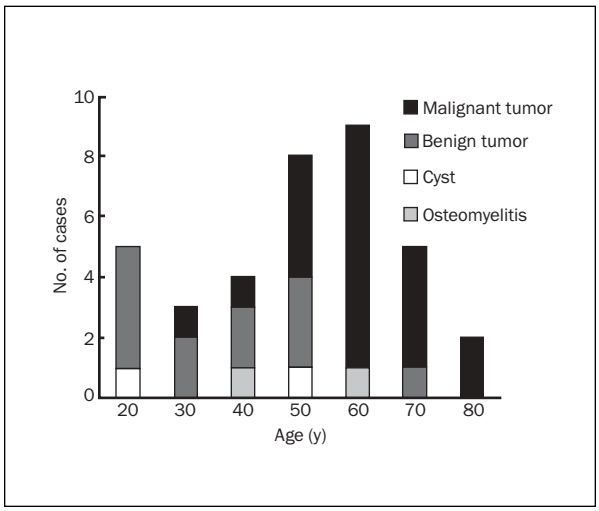

Fig 2 Distribution of age and diagnosis in the study group.

with osteomyelitis and cysts. The subjects included 26 men and 10 women ranging in age from 20 to 83 years, with a mean age of 52.9 years. The patients' ages and oral diseases are shown in Fig 2. Twenty-four patients were 50 years of age or older, accounting for 66% of the study group, and underwent jaw resection for malignant tumors. Patients in the 20- to 30-year-old age group underwent jaw resection for benign tumors or cysts.

The jaw-resection procedures performed for the mandible, to include peripheral resection and segmental resection, were accomplished in 16 and 12 patients, respectively. For the maxilla, partial resection was done in 8 patients. Bone grafting was performed in 19 patients undergoing mandibular resection and in 2 patients undergoing maxillary resection. Fresh autogenous iliac bone was used for grafting, and anastomosis was not performed.

Evaluation Methods

The Kaplan-Meier method was used to evaluate the clinical outcomes of the implants by providing comparisons between residual and grafted bone, the maxilla and mandible, and irradiated and nonirradiated patients. Implants were classified as successful when the patient did not complain of pain or discomfort, no mobility was observed in each implant, no marked resorption was noted in surrounding bone, no inflammation was found in surrounding soft tissues, and the implants properly supported the prosthesis in function. These criteria for successful implantation are in conformity with those for ITI implants advocated by Buser and associates.[8]

The radiographs used for reference were mainly panoramic films. For the quantitative evaluation of bone resorption, periapical dental films obtained by standardized imaging techniques are required. However, in resected-jaw patients, it was sometimes difficult to obtain standardized x-ray films because of limitations in mouth opening or deformity of the oral soft tissues.

RESULTS

The locations of the 180 implants in the 36 resected-jaw patients are shown in Fig 3. In all patients who underwent bone grafting, the implants were placed in the grafted bone. In 13 patients, the implants were placed in residual bone following peripheral mandibular resection or partial maxillary resection. In total, 112 implants were placed in residual bone and 68 were placed in grafted bone. With regard to the implants placed in residual bone, 47 were in the maxilla and 65 in the mandible. Of the implants in grafted bone, 5 were placed in the maxilla and 63 in the mandible.

The clinical courses of the 180 implants were followed for a minimum of 72 days and a maximum of 3,901 days, with a mean follow-up period of 1,811 days. The overall cumulative survival rate for the 180 implants was 88.6% as determined by the Kaplan-Meier method (Fig 4). In addition, the cumulative survival rates for the implants at 10 years in residual and grafted bone were 85.9% and 93.1%, respectively (Fig 5). Moreover, cumulative

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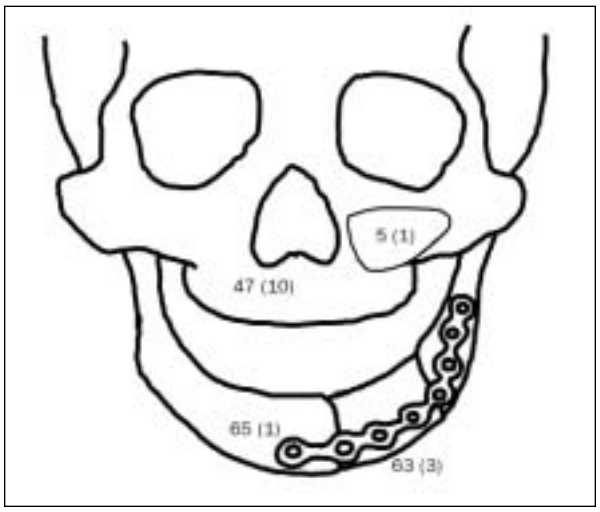

Fig 3 Location of implants. The number of implant loss in each location is provided in parentheses.

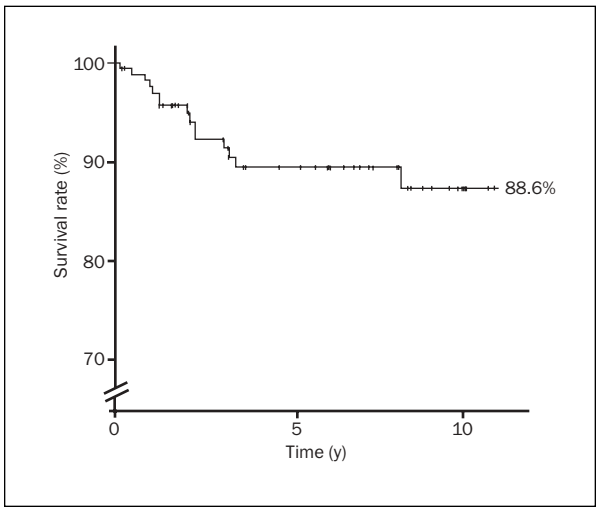

Fig 4 Kaplan-Meier survival analysis for all implants (n = 180).

survival rates for the mandible and maxilla were 95.2% and 73.8%, respectively, for implants in residual bone (Fig 6). However, for grafted bone, the results were 94.1% for the mandible and 80% for the maxilla (Fig 6). Comparison of irradiated and nonirradiated bone showed survival rates of 79.7% and 93.5%, respectively (Fig 7).

Regarding the 180 placed in resected jaws, and the 15 lost implants, relationships between length, diameter of implants, and location are shown in Table 1. In the maxilla, mandible, and residual grafted bone, implants of 13 mm length or more were used in the majority of cases. Implants with diameters of 4 or 5 mm were used less frequently.

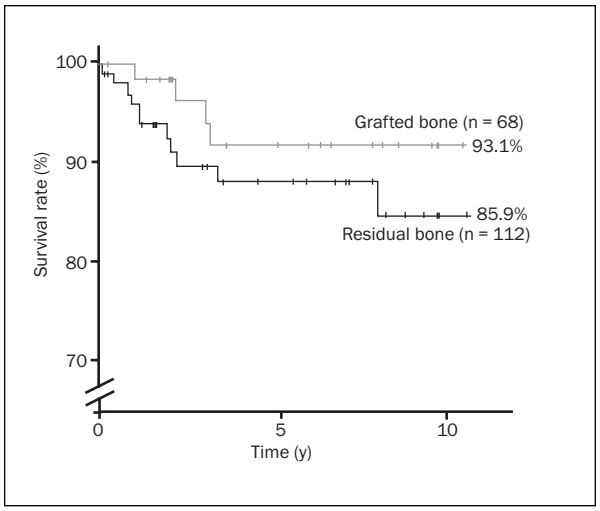

Fig 5 Kaplan-Meier survival analysis for comparison of implants in grafted and residual bone.

DISCUSSION

Changes in Methods Used to Evaluate Implants

Since the NIH-Harvard Consensus Development Conference in 1979, a number of workshops have been held to develop new criteria for evaluating the clinical outcomes of osseointegrated implants.[9] For the clinical evaluation of such implants, new standards have been proposed based on the degree of mobility of the implant, radiographic findings, the degree of bone resorption, the condition of soft tissues surrounding the implant, and success rates in a long-term follow-up.[8–11] At the NIH-Harvard Consensus Development Conference, the acceptable degree of mobility of osseointegrated implants was determined to be 1 mm or less; however, Albrektsson and associates[10] suggested in 1986 that successful implants should be immobile. Therefore, at the European Workshop on Periodontology held in 1993,[11] it was decided that implants showing even a small degree of mobility should be considered as failures. In terms of radiographic findings and bone resorption, even more rigorous evaluation criteria have been adopted. With regard to success rates in long-term follow-up cases, in 1979 implants were considered as successes when 75% were functional at 5 years. However, in 1986, it was determined that the criteria for successful implants should include

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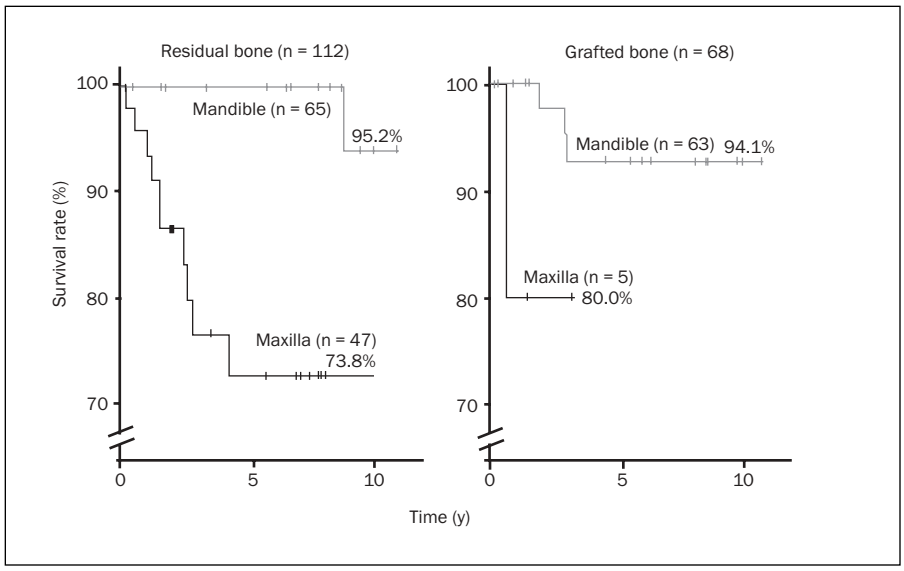

Fig 6 Kaplan-Meier survival analysis for comparison of implants in the maxilla and mandible.

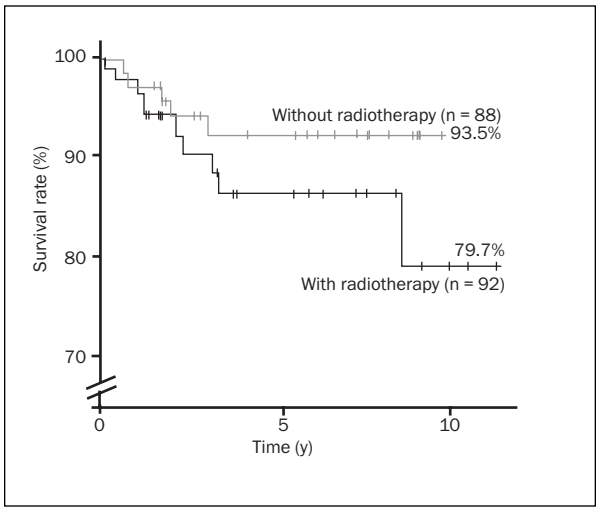

Fig 7 Kaplan-Meier survival analysis cumulative survival rates with and without radiotherapy.

Table 1 Distribution of Implant Lengths, Diameters, and Locations

Implant length (mm)	Placed (lost) implants			
	Maxilla		Mandible	
	Residual bone	Grafted bone	Residual bone	Grafted bone
7	2 (2)		3	
10	9 (3)	1 (1)	6 (1)	2
12	1† (1)			4†
13	9 (2)	1	8 + 1*	6
15	10	1	14	17 (3)
18	11 (2)		12 + 1*	24
20	4	2	20	10
50	1*			
Total	47 (10)	5 (1)	65 (1)	63 (3)

*Diameter = 4 mm, †diameter = 5 mm; all others of standard diameter (3.75 mm).

rates of 85% at 5 years and 80% at 10 years.[10] At the European Workshop on Periodontology in 1993, it was determined that the rate should be 80% or higher at 5 years.[11]

Clinical Course of Implants

The cumulative survival rate of the 180 implants in 36 patients over a 12-year period was 87.8%, which satisfies the criteria for success determined at the European workshop in 1993.[11]

With regard to the placement of implants in resected-jaw patients, implants may be placed in grafted bone or in residual bone without bone grafting.[3] The cumulative survival rate was higher for grafted bone. Comparison between the maxilla and mandible with regard to residual and grafted bone revealed that better results were obtained in the mandible than in the maxilla for residual bone. Accordingly, the clinical courses of implants may not be affected by the presence of grafted bone once the graft has succeeded. In the 12-year follow-up study of implants placed in resected-jaw patients by Keller and colleagues,[6] the survival rate of the implants was reported to be 95.5%. In the report of Mericske-Stern and coworkers,[7] the cumulative survival rate in the mandible at 5 years was 90.5%. In the present

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study, the cumulative survival rate in both the maxilla and mandible over 12 years was 87.8%. However, in the mandible, the rates were 94.1% for residual bone and 92.9% for grafted bone, showing results comparable to those reported by other researchers. Implants placed in residual bone were lost more frequently in the maxilla than in the mandible; also, implants placed in grafted bone were likely to be lost more frequently in the maxilla than in the mandible. In these clinical cases, only 5 implants were placed in grafted bone in the maxillary sinus. The greater the number of implants placed in the grafted bone involving the maxillary sinus, the more the number of implants lost may increase.

At the authors' institution, patients with squamous cell carcinoma generally undergo radiation therapy (approximately 30 Gy) prior to surgery. Preoperative irradiation was performed for the patients with malignant tumors in the present study, except for a single patient with adenocarcinoma. The cumulative survival rate for implants in patients who received radiotherapy was 79.3%, and that in patients who did not receive radiotherapy was 92.8%. Radiotherapy was performed in patients with malignant tumors, but was not performed in patients with benign tumors, cysts, osteomyelitis, etc. Accordingly, no differences were found in the results for implants placed as the result of jaw resection for malignant tumors and those for implants placed because of benign tumors, cysts, or osteomyelitis.

A number of studies have reported the effects of radiotherapy on implants. In both animal[12,13] and clinical studies,[14,15] researchers have reported that hyperbaric oxygen therapy is effective for promoting osseointegration. On the other hand, some researchers have reported that survival rates in the mandible are as high as 95% without hyperbaric oxygen therapy.[16,17] In addition, with regard to the radiation dose, Nguyen and coworkers[18] have asserted that bone necrosis is a common complication when a dose of 65 Gy or more is administered. Accordingly, the clinical courses of implants at the authors' clinic were not affected by preoperative radiation therapy at a dose of approximately 30 Gy, and hyperbaric oxygen therapy is not required. However, it cannot be predicted that the clinical outcome of implants will not be affected by a dose of 30 Gy, since the influences of radiation therapy can exist for an extended period. Furthermore, the results for implants in patients after malignant tumor resection may be poorer because of factors other than radiotherapy, such as a large resection area and the presence of insufficient soft tissues for coverage.

Implants lost varied in length from 7 mm to 18 mm. Among these, loss was more frequent with shorter implants (ie, lengths of up to 10 mm). Of the 15 implants lost, 11 were in the maxilla; implant longer than 13 mm placed in the maxilla were also lost.

CONCLUSION

Clinical results for osseointegrated implants in resected-jaw patients over a 12-year period were analyzed by the Kaplan-Meier method. The clinical results obtained in the present study compare favorably with those obtained in other institutions. In the future, comprehensive continuous treatment by a team approach is important for improving the clinical results of implants. It is important that jaw reconstruction and rehabilitation should not be performed by the oral surgeon alone, but that oral and maxillofacial function should be restored using a team approach in close cooperation with specialists in prosthodontics and periodontics to improve the result of implant treatment.

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