Immediate Loading of Dental Implants Placed in Revascularized Fibula Free Flaps: A Clinical Report on 2 Consecutive Patients

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Purpose: *The objective of this study was to report the clinical outcome of dental implants placed in revascularized fibula flaps for the reconstruction of severely atrophied edentulous maxillae and immediately loaded with full-arch implant-supported prostheses.* ***Materials and Methods:*** *Two patients, a 55-year-old woman and a 59-year-old woman, who presented with severely atrophied edentulous maxillae and local anatomy incompatible with rehabilitation with conventional complete removable dentures and insufficient bone volume for placement of implants of adequate dimensions were selected for reconstruction with revascularized fibula free flaps. Three months after the reconstructive procedure, Brånemark System dental implants (8 in the 55-year-old patient, 7 in the 59-year-old patient) were placed in the reconstructed areas and immediately loaded with implant-supported full-arch prostheses. The mean follow-up period of implants after the start of prosthetic loading was 24 months. Radiographic peri-implant bone level changes and peri-implant clinical parameters (Plaque Index, Bleeding Index, and probing depth) were evaluated.* ***Results:*** *No implants were lost during the follow-up period. Implant survival and success rates were 100% and 93.3%, respectively. Peri-implant clinical parameters presented values consistent with those obtained for implants placed in native nonreconstructed bone and allowed to heal before loading.* ***Discussion:*** *To the authors' knowledge, this is the first time that the successful immediate loading of implants placed in fibula free flaps for the rehabilitation of totally edentulous patients with severely resorbed maxillae or mandibles has been described.* ***Conclusion:*** *Despite the limited number of patients and the short follow-up period, immediate loading of implants placed in revascularized fibula free flaps appears to be a reliable method for the dental rehabilitation of these patients.* INT J ORAL MAXILLOFAC IMPLANTS 2004;19:906–912

Key words: *atrophy, bone transplants, dental implants, fibula free flaps*

One of the fundamental principles for obtaining safe and predictable long-term survival of submerged and nonsubmerged dental implants has been a load-free period lasting from 3 to 6 months.[1–3] Long-term results of implants placed according to this protocol have demonstrated a high success rate; no significant differences between implant systems have been found.[4–11] However, the waiting period between implant placement and definitive dental restoration, which has been deemed necessary for osseointegration, may include discomfort and inconvenience for the patient. During this period, patients often must use removable provisional prostheses, which may be unstable, especially in cases of total edentulism. Therefore, there is increasing interest among clinicians and researchers in shortening the waiting period between the placement and loading of implants.

In recent years, a relevant number of studies have demonstrated that in selected clinical situations, immediate loading of dental implants is a predictable method for the restoration of missing dentition. This principle has been successfully applied to single-tooth restorations,[12–15] partial edentulism,[15,16] and total edentulism. In the case of total edentulism, implants

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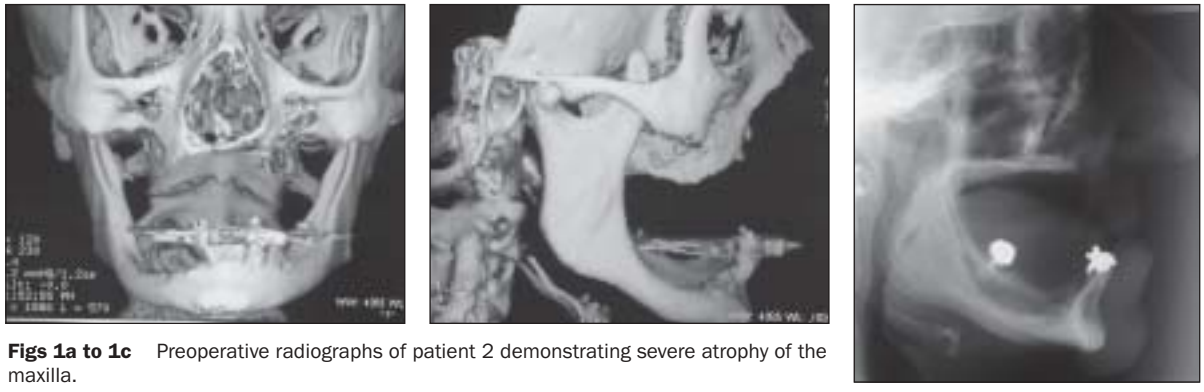

Figs 1a to 1c Preoperative radiographs of patient 2 demonstrating severe atrophy of the maxilla.

may be immediately loaded with either implant-supported overdentures[17–21] or implant-supported fixed prostheses with success.[22–26] However, the patients in these studies had sufficient residual bone volume to receive implants of adequate dimensions.

To the authors' knowledge, there is a paucity of experience concerning immediate loading of implants placed in areas reconstructed with autogenous bone transplants because of severe atrophy. In particular, no data concerning success rates of immediately loaded implants placed in revascularized fibula free flaps are available to date. The aim of this study was to report the clinical outcomes of dental implants placed in revascularized fibula flaps used for the reconstruction of severely atrophied edentulous maxillae and immediately loaded with implant-supported full-arch prostheses.

MATERIAL AND METHODS

In 2001, 2 patients, a 55-year-old woman (patient 1) and a 59-year-old woman (patient 2), with such severe resorption of the edentulous maxillae (class VI according to Cawood and Howell classification[27]) that neither implant placement nor acceptable conventional denture rehabilitation were possible were referred for evaluation for possible surgical reconstruction of the atrophied maxillae with autogenous bone transplants. Patient 1 presented sequelae of previous attempts at dental rehabilitation with subperiosteal implants, which had to be removed because of chronic infection, persistent pain, and mobility. Patient 2 presented sequelae of previous attempts at bone reconstruction with autogenous onlay bone grafts harvested from the anterior iliac crest. After a 4-year period of loading with a removable conventional complete denture, however, the grafted bone had been almost completely resorbed.

Because of the bad quality and quantity of the hard and soft tissues of the maxillae, including the presence of scarred and hypovascular soft tissues, as well as areas with no residual bone beneath the floor of the nose and/or maxillary sinus, further reconstruction with autogenous bone grafts was not considered possible. Instead, it was decided to rehabilitate these patients with revascularized fibula free flaps and immediately loaded implant-supported dental prostheses. Both patients were clinically healthy at the time of surgery. In patient 1, the opposing dentition was a full-arch tooth-supported prosthesis, while in patient 2, the opposing dentition was a tooth-supported mandibular overdenture. Neither patient exhibited signs or symptoms of active periodontal disease involving the residual dentition at the time of the reconstructive procedure. Preoperative documentation consisted of intraoral radiographs of the residual mandibular dentition, a panoramic radiograph, a profile radiograph, and computerized tomography of the maxilla to evaluate the morphology of the residual bone and the maxillomandibular relationship (Figs 1a to 1c).

The reconstructive procedures were performed under general anesthesia at the Unit of Maxillo-Facial Surgery, Department of Medicine, Surgery and Dentistry, San Paolo Hospital, University of Milan, Italy. In both patients the bone transplant was bent into 3 segments to obtain an arch shape that followed the local anatomy of the residual maxillary bone and to recreate favorable morphologic conditions for the prosthetic rehabilitation. The fibular vessels of the free transplants were anastomosed in both cases to the facial artery and vein through an extraoral cervical incision. The fibula was then fixed with titanium miniscrews to the residual bone (Figs 2a to 2c).

After a waiting period of approximately 3 months for the consolidation of the connection between the transplant and the recipient bed, alginate impressions

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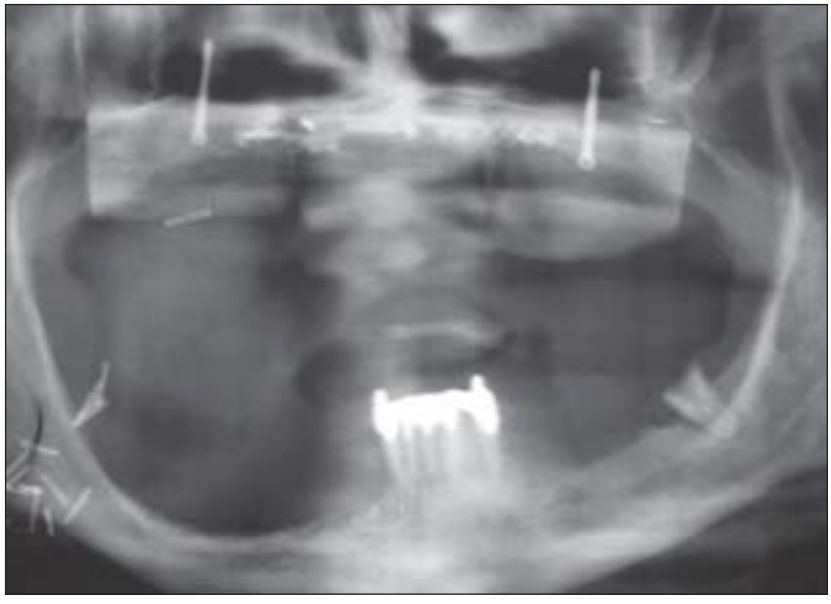
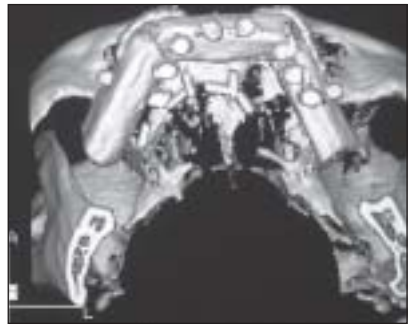
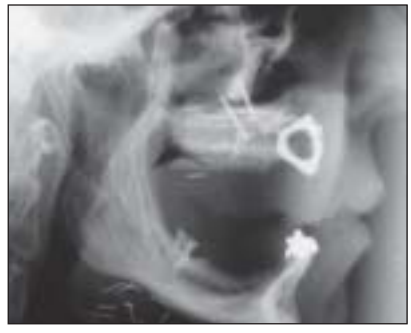
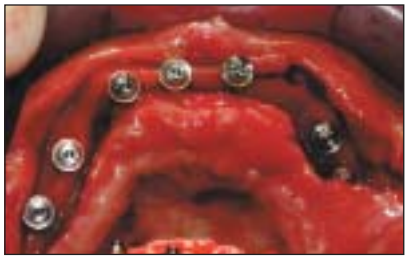






Figs 2a to 2c Postoperative imaging of patient 2 taken 3 months after reconstruction with a revascularized fibula free flap.



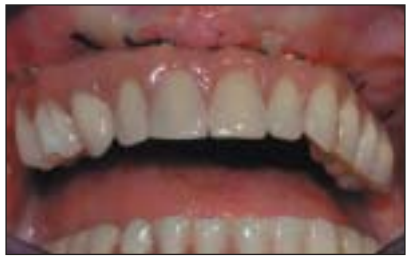


Fig 3a *(Left)* Placement of 7 endosseous implants in the transplanted fibula flap (patient 2).

Fig 3b *(Right)* Loading of implants with an implant-supported prosthesis 24 hours after placement (patient 2).

of both arches were made and prosthetic waxing of the maxillary dentition was completed on the casts obtained. After the waxing procedure, resin templates were fabricated to optimize implant placement.

Under general anesthesia with nasotracheal intubation, a full-thickness incision was made and the soft tissues overlying the reconstructed maxilla were elevated. The fixation screws used for stabilization of the bone transplant were removed and dental implants were placed according to the prefabricated resin template (Fig 3a). Ti-Unite MK III Brånemark System implants (3.75 mm in diameter and 13 or 15 mm long; Nobel Biocare, Göteborg, Sweden) were placed in the reconstructed maxilla. Patient 1 received 8 implants; patient 2 received 7. The lengths of implants were selected so as to engage the cortical bone of the more cranial part of the fibula to optimize primary stability of the implants. Care was taken during incision, flap elevation, and implant site preparation to avoid damaging the vascular pedicle of the fibula flap. Immediately after implant placement, appropriate multiunit abutments (Nobel Biocare) were connected to the implants, and the flaps were sutured tightly around the abutments.

Transfer copings were mounted on the abutments and impressions were made immediately with a polyether material (Impregum F; ESPE Dental, Seefeld, Germany). The impressions incorporating the transfer copings were sent to the dental laboratory for immediate fabrication of the prosthetic suprastructure, while the multiunit abutments were covered with prefabricated plastic caps. On the master casts, which incorporated implant and multiunit abutment analogs, prefabricated titanium caps were mounted and connected with titanium bar segments. The fit of the mesiostructure was tested on the master cast using the Sheffield test. A provisional full-arch resin restoration was fabricated on the mesiostructure within 24 hours of implant placement (Fig 3b).

The day after implant placement, the prosthetic suprastructure was connected to the abutments, after verification of fit by means of the Sheffield test. Patients were allowed to chew immediately after loading; they were instructed to follow a soft

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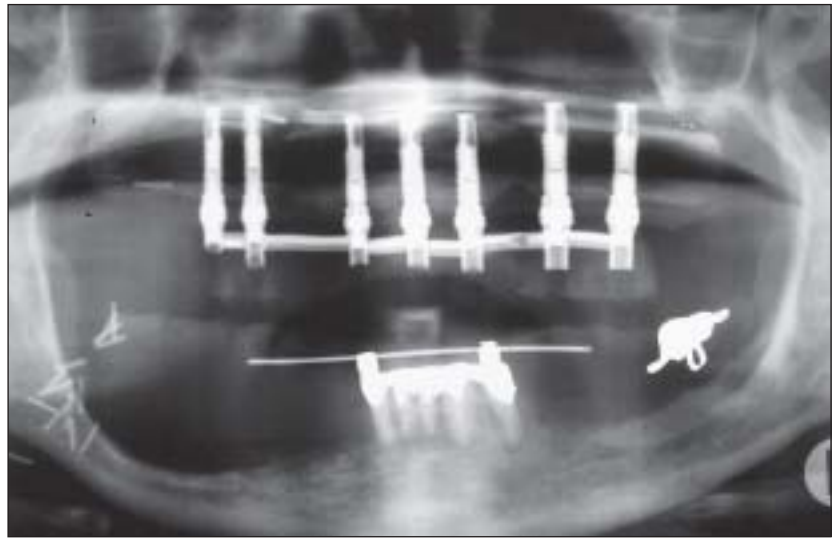

Fig 4 Radiographic examination of patient 2 immediately after the rehabilitation with a provisional prosthesis.

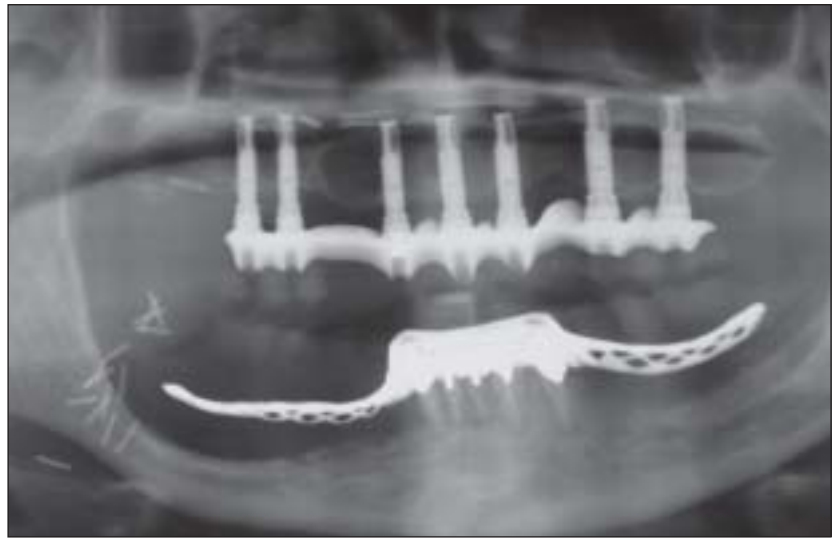

Fig 5 Radiographic examination of patient 2 at 2 years after the start of prosthetic loading.

diet for 4 weeks. Antibiotic therapy was continued until the seventh postoperative day, and the use of 0.2% chlorhexidine mouth rinse was continued for 2 weeks after surgery. Standard oral hygiene practices were restarted after suture removal, 7 days after implant placement.

Patients were then followed with clinical examinations at 1, 3, 6, and 12 months after the start of prosthetic loading and annually thereafter. Radiographic examinations were performed immediately after the completion of prosthetic rehabilitation, and then annually (Fig 4). After a waiting period of approximately 12 months, the provisional prostheses were replaced with definitive prostheses (Fig 5). The following parameters were evaluated: *(1)* radiographic assessment of peri-implant bone resorption after the start of prosthetic loading, *(2)* peri-implant clinical parameters, and *(3)* implant success and survival rates.

Radiographic Assessment of Peri-implant Bone Level Changes

Peri-implant bone level changes were recorded by comparing standardized periapical radiographs made perpendicular to the long axis of the implants using conventional film holders in which the platform and threads were clearly visible. Radiographs were obtained immediately after implant placement, at the time of prosthetic loading, and annually thereafter. Measurements of bone level changes were made mesial and distal to each implant using a transparent millimeter ruler. The distance between the top of the implant shoulder and the most coronal level of direct bone-to-implant contact was measured. The bone level measured on periapical radiographs obtained immediately after implant placement was considered the baseline for further measurements. Measurements were recorded to the

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Table 1 Peri-implant Bone Resorption in mm 1 and 2 Years After the Start of Prosthetic Loading

Time elapsed since prosthetic loading (y)	Mean	SD	Median	First quartile	Third quartile	Range
1	1.1	0.2	1.0	1.0	1.0	1.0 to 1.5
2	1.5	0.3	1.5	1.5	1.5	1.0 to 2.0

Table 2 Life Table Analysis of Implants with Cumulative Survival and Success Rates

Time elapsed since prosthetic loading (y)	No. of implants at start of interval	No. of implants withdrawn	No. of implants failed	Implants at risk at end of interval	Cumulative survival rate (%)	Cumulative success rate (%)
1	15	0	0	15	100.0	100.0
2	15	0	1	15	100.0	93.3

The failed implant had 2 mm bone resorption in the second year but fulfilled the other criteria of Albrektsson and coworkers.[4]

nearest 0.5 mm. Mean values and standard deviations (SDs) were reported. Because of the small number of implants, medians and quartile ranges were also reported.

Peri-implant Clinical Parameters

Plaque Index (PI) and Bleeding Index (BI) scores were recorded after the removal of the implant-supported prosthesis at 4 sites for every implant (ie, mesial, distal, buccal, palatal) according to the modifications described for implants by Mombelli and colleagues.[28] Probing depth (PD) measurements were performed at 4 sites for each implant (mesial, distal, buccal, palatal) to the nearest millimeter using a calibrated plastic probe (TPS Probe; Ivoclar Vivadent, Schaan, Liechtenstein). Measurements were recorded every 12 months after the initial prosthetic loading.

Implant Success and Survival Rates

Implants were considered to have survived if they were characterized by the following criteria: *(1)* absence of persistent pain, *(2)* absence of peri-implant infection with suppuration, *(3)* absence of mobility, and *(4)* absence of continuous peri-implant radiolucency.

Implants that met these criteria and had less than 1.5 mm peri-implant bone resorption in the first year of function and less than 0.2 mm in subsequent years were considered successful.[4]

RESULTS

Postoperative recovery from the reconstructive phase with fibula free flaps was uneventful in both patients. Hospitalization lasted 7 days for patient 1 and 9 days for patient 2.

Postoperative recovery from implant placement and immediate loading of implants was uneventful in both patients. Transient discomfort was reported by both patients in the first weeks postoperatively during standard oral hygiene procedures.

The mean follow-up of implants after the start of prosthetic loading was 24 months (patient 1 for 22 months; patient 2 for 26 months). None of the implants were lost during the follow-up period, and no other adverse event was recorded during this period.

Mean peri-implant bone resorption was 1.1 mm (SD = 0.2) 1 year after the start of prosthetic loading and 1.5 mm (SD = 0.3) after 2 years. Means, SDs, medians, and quartile ranges are reported in Table 1. Only 1 implant did not fulfill the success criteria, because of peri-implant bone resorption of 2 mm 2 years after the start of prosthetic loading. The cumulative survival and success rates were 100% and 93.3%, respectively (Table 2).

The mean PI values were 0.4 (SD = 0.5) at 1 year after the start of prosthetic loading and 0.4 (SD = 0.4) after 2 years. The mean BI values were 0.2 (SD = 0.3) after 1 year and 0.3 (SD = 0.4) after 2 years. The mean PD values were 2.3 mm (SD = 0.6) after 1 year and 2.2 mm (SD = 0.5) after 2 years.

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DISCUSSION

The fibula free flap in association with dental implants has been previously described for the rehabilitation of patients affected by the sequelae of maxillary or mandibular tumor resection.[29–35] There is ample documentation of the reliability of the procedure as a reconstructive method and of the placement of dental implants in grafted tissue relative to bone quality and volume.[29–35] More recently, the fibula free flap has also been employed for reconstruction of the extremely atrophied maxilla or mandible.[36,37] To the authors' knowledge, immediate loading of implants placed in fibula free flaps for the rehabilitation of totally edentulous patients with severely resorbed maxillae or mandibles has not yet been described.

Primary stability and a healing period during which the implants are not loaded have long been considered *conditio sine qua non* to allow osseointegration of dental implants. However, the necessity of an unloaded healing period was empirically based and not experimentally ascertained.[1–3] It is therefore justifiable to question whether this healing period is an absolute prerequisite to obtaining osseointegration or whether under certain circumstances this period can be shortened without jeopardizing osseointegration and long-term results.

There is documentation in both the experimental[38–43] and the clinical literature[12–26] to demonstrate that implants that are immediately loaded can become successfully osseointegrated; this has been demonstrated in the treatment of both partial and total edentulism. However, these clinical studies are related to the immediate loading of implants placed in native, nonreconstructed bone.

The results of this study, despite the limited number of patients, the short follow-up, and the absence of histologic support concerning the quality of osseointegration obtained, seem to demonstrate that immediate loading of implants placed in fibula free flaps with full-arch implant-supported dental prostheses does not jeopardize osseointegration or implant survival rates. The rich cortical component of the fibula apparently can offer adequate primary stability to the implants and withstand the biomechanical demands of immediate loading.

Survival rates obtained in this limited patient population not only compare favorably with those reported in the literature for implants placed in revascularized flaps and loaded after a healing period,[29–36] but also with those for implants placed in nonreconstructed edentulous arches and loaded either immediately[12–26] or after a healing period.[4–11] Only 1 implant did not fulfill the success criterion concerned with marginal bone loss 2 years after the start of prosthetic loading. Finally, results concerning other clinical peri-implant parameters were consistent with those reported for cases of implants placed in nonreconstructed edentulous jaws.[10,44–46]

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