

Immediate Loading of Dental Implants Inserted in Edentulous Maxillas and Mandibles: 5-Year Results of a Clinical Study

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The aim of the present study was to evaluate the long-term outcome of immediately loaded full-arch, fixed, one-piece prostheses supported by dental implants inserted in completely edentulous maxillae and mandibles. Twenty-eight completely edentulous jaws in 27 patients were treated with screw-fixed provisional prostheses on the same day as implant insertion. A total of 189 implants were inserted into the jaws of the patients. All provisional prostheses were the one-piece bridge type and were made with acrylic resin. Final restoration was performed more than 2 months after surgery. Implant survival rate, prosthesis success rate, and complications during the follow-up period were evaluated. Implant size (diameter and length) and bone quality (Hounsfield units) of the region of the implant were also analyzed. Mean follow-up time was 77.9 months. The cumulative survival rate of the implants was 100%, and the success rate of the prostheses was also 100% during the observation time. Although 3 types of minor complications occurred in 10 jaws (10/28; 35.7%), no major complications were found. Immediate loading of dental implants produces an equivalent outcome as that reported in previous studies using conventional loading. We believe this study not only adds to the immediate loading data but also confirms that the immediate loading technique may be most advantageous strategy for edentulous patients.

Key Words: *immediate loading, completely edentulous jaw, survival rate*

INTRODUCTION

Immediate loading has been defined as a “provisional restoration [that] is performed within 48 hours after implantation.”¹ Immediately loaded dental implants have recently gained popularity because of such beneficial factors as decreases in the psychological and physiological burdens of patients and a shorter treatment time. Conventional treatment requires an undisturbed healing period, usually 3 to 6 months, after implant insertion. This imposes difficulties not only on patients, especially completely edentulous patients, but also on clinicians. In conventional treatment, patients may be required to not use their dentures during the healing period or

may need to have frequent adjustment or realignment of their dentures.² Immediate loading implant treatment allows prompt restoration and should help avoid these problems that are inherent in conventional implant treatment.

Immediate loading of completely edentulous mandibles is well documented,^{3–5} and studies seem to have reached consensus that immediately loaded implants are effective for treating completely edentulous mandibles.³ In general, the success rate of immediate loading in the maxilla is slightly lower than that in the mandible. The aim of the current study was to evaluate the efficacy of immediately loaded, fixed, one-piece prostheses supported by dental implants inserted in completely edentulous maxillae and mandibles to add to the current data and to present a prospective protocol for completely edentulous patients.

MATERIALS AND METHODS

Patients

This clinical study for oral rehabilitation of completely edentulous jaws was carried out at 2 institutions, Shonan Dental Care Implant Clinic and Takanashi Dental Clinic, from January 2004 to April 2008, according to the clinical protocol described later. All patients had consecutive treatments with a

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fixed prosthesis with screws immediately after insertion of the implant. Retrospectively gathered data from each institution were evaluated. All patients lost their teeth because of severe periodontal disease or caries, and they wanted to rehabilitate with fixed prostheses. No one lost teeth because of accidents or congenital disease.

Implants

Straumann implants (Institute Straumann AG, Basel, Switzerland) were inserted in all cases because implants with an SLA (sand-blasted, large-grit, acid-etched) surface are known to be safe and predictable for the immediate loading procedure.⁶ Straumann Standard/Plus or Tapered Effect (TE) implants were chosen, depending on bone quality. Type, length, and width of inserted implants were recorded, and the cumulative survival rate of the implants and success rate of the prostheses were analyzed. Moreover, complications and symptoms during the follow-up period were recorded and analyzed.

Computed tomography images

We used SimPlant Pro 11.03 software (Materialise, Leuven, Belgium) to analyze the DICOM (digital imaging and communications in medicine) data from computed tomography and evaluated bone quality around the implants using the mean Hounsfield units (HU) in the area of the implantation site.

Clinical Protocol

Patients were admitted for consultation and discussion before the consecutive treatments, which were performed according to the following protocol.

1. Diagnosis and design
 - a) At least 6 implants were inserted in the maxilla and 5 implants in the mandible (Figure 1).
 - b) No implant was inserted with low bone quality (HU <150) or insufficient bone quantity (D5 based on Misch's classification⁷). TE implants were chosen for low-bone-quality sites (D4 based on Misch's classification⁷).
 - c) The implants were aligned to form an arch and not a straight line to disperse the occlusal force. The distal implant was inserted as far posterior as possible to acquire a long anterior-posterior distance.
2. Surgical procedure
 - a) Implant placement was performed under local anesthesia.
 - b) Implants with insufficient primary stability (insertion torque <35 Ncm) were not included in the immediate loading study but instead underwent conventional loading.
 - c) Bone particles, which were removed during drilling for the implantation, were transplanted to the dehiscence around the implants if necessary.
3. Prosthetic procedure (provisional restoration)
 - a) The screw-fixed provisional restoration was affixed on the same day as the implantation and remained in place during the healing process (Figure 2).

- b) The one-piece prosthesis was made with acrylic resin without additional reinforcement materials such as metal frames.
 - c) An occlusal screw-fixed prosthesis was chosen because of its good conformity.
 - d) Prostheses were designed without distal cantilevers.
 - e) The first and second molars did not have occlusal contacts.
4. Follow-up
 - a) Eating solid foods was prohibited for 6 weeks after surgery.
 - b) The prosthesis was not removed during the healing period (approximately 2 months following the manufacturer's guidelines for the Straumann implant) until impressions were taken for the final restoration.
 - c) Mobility of the prosthesis, loosening of screws, and cracks/breakage of the provisional restoration were checked.
 5. Final restoration
 - a) Impressions and bite for the final restoration were taken more than 2 months after surgery based on the manufacturer's protocol.
 - b) A distal cantilever was avoided in all maxilla cases.
 - c) A 1-tooth distal cantilever was made when implants were inserted between the mental foramen in the mandible.
 - d) The occlusal pattern was chosen depending on the opposing dentition. Canine induction was created for the Angle Class I occlusion type, and group-function or full-balanced occlusion was selected for Class II.

RESULTS

Patients

Twenty-seven completely edentulous patients with a mean age of 61.8 years participated in this study: 15 men (mean age, 61 years) and 12 women (mean age, 68 years). Implantation was performed in 18 maxillae and 10 mandibles (Table 1). Only 1 patient underwent total implant rehabilitation of both jaws. The mean follow-up period was 77.9 months (range, 64–110 months).

Implants

Straumann implants (189) were included in this study, and all implants had a rough SLA surface. The average number of inserted implants per patient was 7 in the maxilla and 5.6 in the mandible. Of the implants, 146 (77%) were Standard and Standard Plus, and 43 (23%) were TE. The TE implants were mainly used in the maxilla (40/43; 93%). The diameter of most implants was 4.1 mm (132/189; 69.8%). With TE implants, 3.3-mm diameter was mainly used (34/43; 79%) (Table 2). The lengths of the implants were mainly 12 mm (72%) and 10 mm (20%) (Table 3).

Computed tomography values

Average bone density at the site of implantation was 612.3 HU in the maxilla and 911.2 HU in the mandible (Figure 3). To

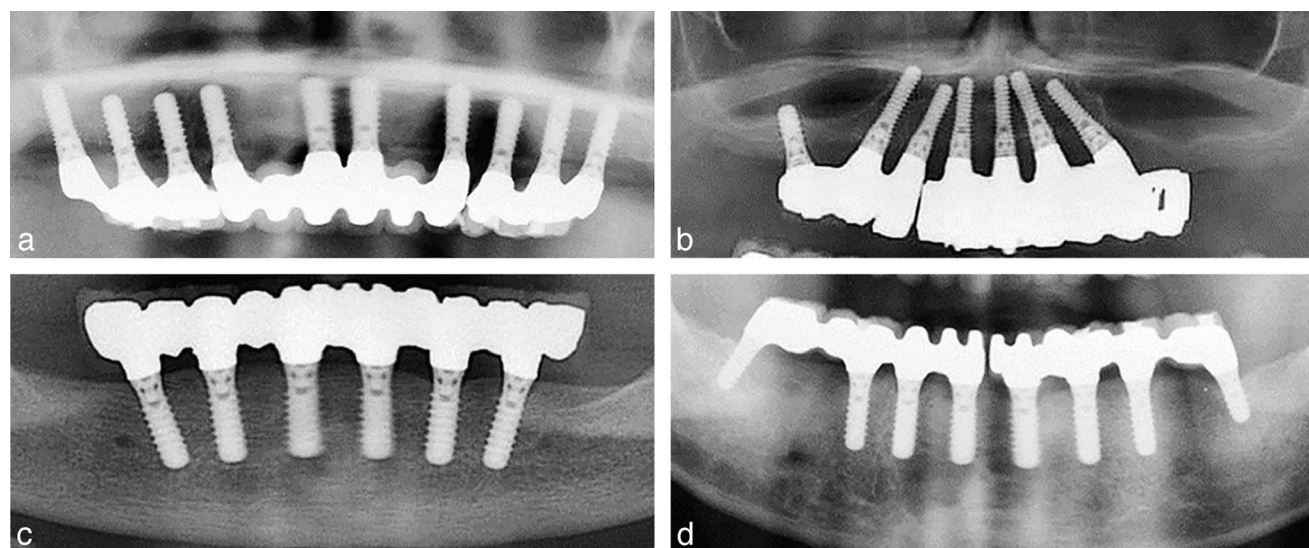


FIGURE 1. Four typical cases of edentulousness are shown. Two (a and b) are maxilla and others (c and d) are mandible cases. (a) A 66-year-old man. Ten implants were inserted symmetrically in the maxilla because bone condition was good at each side of maxilla. (b) A 58-year-old woman. Six implants were inserted with tilting to avoid perforating the maxillary sinuses. One implant was added at right first molar region to avoid a long cantilever. (c and d) A common strategy in our procedure was to place 4 or 6 implants between foramina in the mandible. (c) A 67-year-old woman. Six implants were inserted between foramina. (d) A 55-year-old man. Six implants were inserted between foramina, in the same way as for (c), and 2 short implants were added to avoid injuring the inferior alveolar nerves.

compensate for the inferior bone quality of the maxilla relative to the mandible, more implants were inserted into the maxilla than the mandible. All implants were inserted into good-quality bone because bone quality is one of the most important factors for successful implant therapy.⁸

Survival rate

The survival rate of immediately loaded implants and the success rate of final prostheses were 100% in the maxilla and the mandible (Table 4).

Complications

Three types of minor complications emerged (Table 5). First, 2 implants resulted in formation of sequestrums of 2 to 3 mm at the alveolar bone edge of the tooth extraction sites. These 2 implants were inserted at the site of the extraction socket right after tooth removal. After sequestrectomy, slight bone resorption and soft-tissue regression appeared around the implant in both cases, but osseointegration of these implants was maintained. Second, 8 complications occurred that may have been caused by stress from the polymerized acrylic resin, which was used to synthesize the provisional prosthesis; 4 of 8 provisional restorations broke (Figure 4). In these cases, acrylic resin was placed between the broken surfaces like brazing of

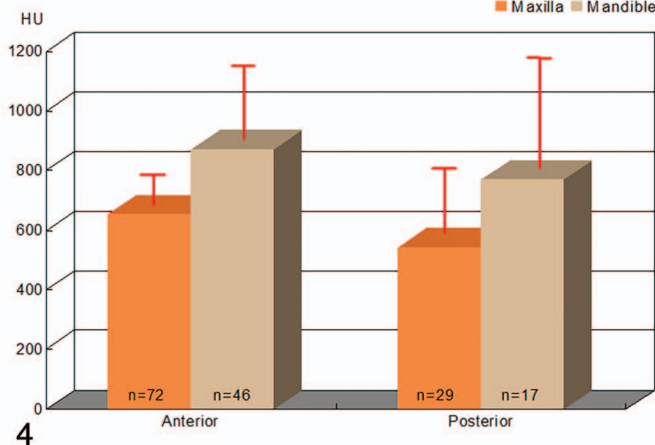
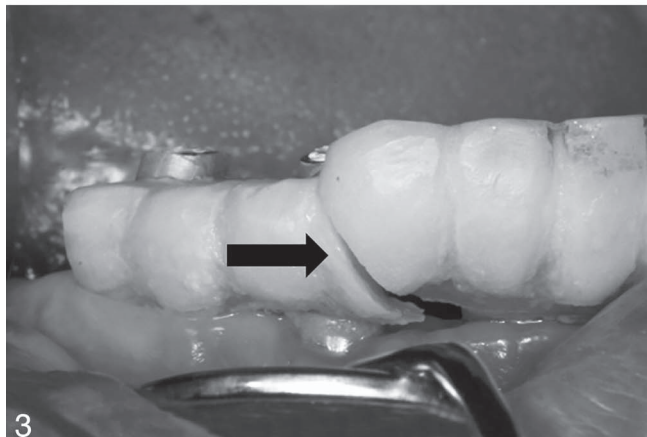
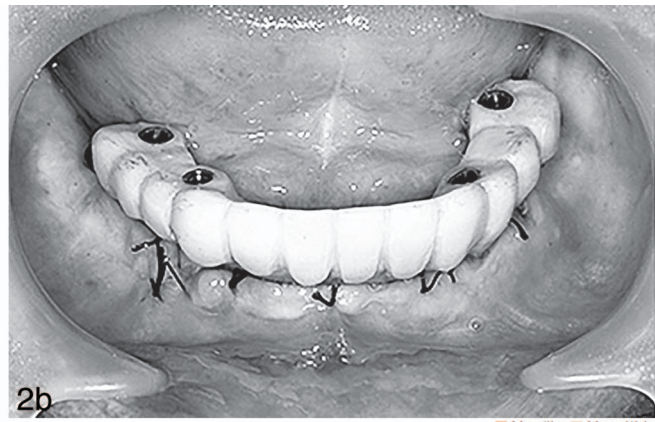
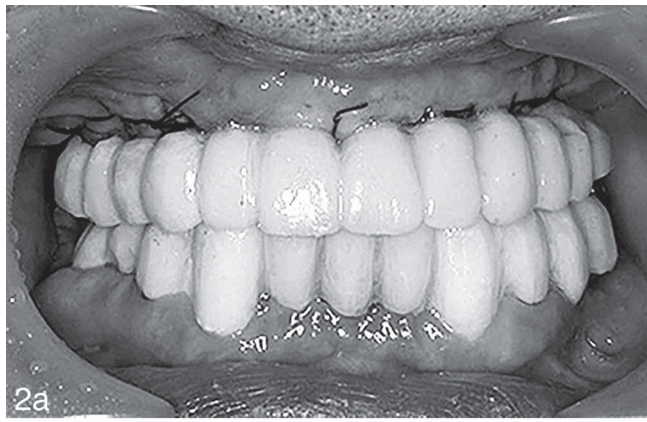
metal. Third, 4 patients complained of discomfort, including headaches and feelings of pressure within several days of the provisional restoration. These symptoms were relieved immediately after cutting the acrylic resin of the provisional prosthesis. Then, the prostheses were repaired with acrylic resin.

DISCUSSION

In the present study, we performed immediate loading treatment with Straumann implants in completely edentulous patients, and both the survival rate of implants and the success rate of prostheses were 100%. No computed tomography scans were performed during follow-up, and no gingival recession was observed in all cases, which indicates clinically that the bone particles used for covering unexpected bone dehiscences were retained at the site and healed, even if the volume was reduced. These results showed equivalent success rates as other recent reports, which described 92.8%–100% survival rates for several types of implants,^{5,6,9–12} and 100% prosthetic success rate^{10,11,13} in cases of immediate loading implants with fixed prostheses. We also analyzed the survival rate of conventionally loaded implants inserted in completely edentulous jaws with Straumann implants using a very similar protocol from 1992 to 2001

Jaw	Men	Women	Total
Maxilla	10	8	18
Mandible	6	4	10
Total	16	12	28

Diameter (mm)	Standard and Standard Plus			Tapered Effect		
	3.3	4.1	4.8	3.3	4.1	Total
Maxilla	17	65	3	31	9	125
Mandible	3	58	0	3	0	64
Total	20	123	3	34	9	189



FIGURES 2–4. **FIGURE 2.** A bridge-type provisional restoration was immediately set after implantation in the maxilla (a) and mandible (b). **FIGURE 3.** Mean Hounsfield units (HUs) corresponding to the implant position (immediately loaded cases). The highest HU was in the anterior mandible, and the lowest was in the posterior maxilla. Each lesion had a sufficient HU to acquire primary stability after implantation. **FIGURE 4.** Breakage of the provisional prosthesis. The arrow indicates the crack in the provisional prosthesis. Fortunately, this had no effect on the implants. The temporary prosthesis was repaired and reset.

(data not shown). A total of 231 implants were inserted in 34 patients, and 6 implants were lost (survival data; 97.4%). The success rate of prostheses was 100%. This outcome was almost equivalent to that in previous reports, which described conventionally loaded implants with fixed prostheses for completely edentulous patients. The survival rate of several types of implants was 96.6%–98.7% in 8 reports, and the success rate of prostheses was 100% in 7 of 8 reports.^{14–18} In another report, the success rate of prostheses was 96%, and 2 of 55 failed in the maxilla.¹⁶ Our current outcome of immediately loaded implant treatment was either equal to or surpassed outcomes for conventionally loaded implant treatment for completely edentulous patients.

Several factors affect the success of immediate loading

Length (mm)	%
6	2
8	6
10	20
12	72

treatment for completely edentulous jaws. The number of implants used is one of the most critical issues for successful immediate loading. In the mandible, 4 to 6 implants are considered to be sufficient between the mental foramen.^{3,13} On the other hand, the number needed remains controversial in the maxilla.^{9–11} More than 6 implants were inserted in each maxilla in our protocol, and we avoided inserting implants where bone quality and quantity were insufficient. According to our protocol, it was sometimes difficult to insert implants because of a low sinus floor or insufficient bone quality and quantity in the maxilla. Maló et al³ proposed an all-on-four concept to

	Number	Patients	Lost (%)	Lost Patients (%)
Immediately loaded implants	189	28	0 (0)	0 (0)
Final prosthesis		28	0 (0)	100 (100)

TABLE 5

Complications in patients undergoing immediate loading	
Complication	No. of Patients
Sequestrum formation	2
Discomfort	4
Headache	2
Feeling of pressure	2
Prosthesis breakage	4

resolve this anatomical problem. They placed implants at an angle close to the anterior wall of the sinus floor so as to not perforate it and applied provisional restoration the same day. This concept does not require additional surgical intervention, such as alveolar ridge augmentation or sinus floor elevation, and hence, this technique is popular. However, it should be taken into account that a failure of 1 implant could lead to a failure of the prosthesis, which then requires oral rehabilitation. Therefore, we believe at least 5 implants in the mandible and 6 in the maxilla are required for successful immediate loading, although fewer implants would be required for the all-on-four concept.

We proposed lack of occlusion in first and second molars for the prosthesis installed, and it promoted good results for the temporary restorations. We observed minor complications in 10 patients during the provisional restoration. In these cases, 4 prostheses broke, and 4 patients complained of discomfort, including headaches and opposing pressure. These symptoms were released after the provisional bridges were cut. Provisional restoration was made with thick acrylic resin to avoid fracture and micromovement of the prosthesis, which seems to cause disintegration of the implant. We believe shrinkage of the acrylic resin due to polymerization caused the breakage of the provisional restoration and the discomfort. It is important to consider shrinkage when planning a provisional restoration. When patients report discomfort, the choice of treatment is to cut the resin immediately.

CONCLUSION

We believe immediate loading is a prodigious technique and may be most advantageous strategy for edentulous jaws because of its many benefits such as the minimizing cost and treatment time, removing physical and mental stress early, and immediate functional and esthetic restoration. Immediate loading procedures require training, planning, preparation of the patient, and work and organization of the treatment plan. We add our data to the current data regarding immediate loading. We believe this study will contribute to the development of the immediate loading strategy for completely edentulous jaws.

ABBREVIATIONS

SLA: sand-blasted, large-grit, acid-etched
TE: tapered effect

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