Immediate Loading of Brånemark System Implants Following Placement in Edentulous Patients: A Clinical Report

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The purpose of this study was to evaluate the immediate loading of Brånemark System implants following placement with a screw-retained provisional prosthesis in edentulous patients. Twelve mandibular and 5 maxillary arches were treated from December 1997, including 3 bimaxillary patients. The provisional prosthesis, made of heat-polymerizing resin, had an inner casting of cobalt-chromium alloy to provide rigidity. The implants whose placement torque was more than 40 Ncm were immediately loaded. Implants that were placed with placement torque of less than 40 Ncm or that were associated with bone grafting were submerged. Following abutment connection, temporary cylinders were incorporated into the provisional prosthesis intraorally with autopolymerizing resin. After the provisional prosthesis was completed extraorally, it was screw-retained. After a 4- to 6-month healing period, a definitive prosthesis was fabricated and placed. Of the 140 immediately loaded implants, 136 osseointegrated during an 8- to 24-month follow-up period (97.2%). All 17 submerged implants osseointegrated. The results suggest that immediate loading of Brånemark System implants at the time of placement in edentulous patients can be a valuable adjunct to therapy and as predictable as delayed loading, in both mandibular and maxillary arches. (INT J ORAL MAXILLOFAC IMPLANTS 2000;15: 824–830)

Key words: *Brånemark System implant, complete edentulism, endosseous dental implantation, immediate loading, temporary dental restoration*

The immediate loading of endosteal blade implants that predated the introduction of the principles of osseointegration resulted in a high incidence of complication and failure.[1] The development of osseointegration in endosseous implant therapy is generally predicated on a stress-free healing period achieved by submerging the implant below the soft tissue and allowing the surgical site to heal without any direct load on the implant.[2] In edentulous patients who undergo implant therapy with a delayed loading protocol, the need to be without conventional denture prostheses for 2 weeks after implant placement and to wear a conventional denture until stage 2 surgery must be tolerated as a necessary inconvenience. Moreover, postoperative changes in the soft tissues during the healing period can result in discomfort and often necessitate frequent prosthesis adjustments.

Schnitman and colleagues[3] reported on immediate fixed interim prostheses supported by Brånemark System implants (Nobel Biocare, Göteborg, Sweden) in a number of different configurations in mandibles only. According to their report[4] on 10-year follow-up results, 5 implants placed anterior to the mental foramina were used. The midline implant and 2 posterior implants served as immediate abutments in creating a broad-based triangle of support. The submerged implants in the lateral incisor sites provided predictable backup. Life table analysis demonstrated an overall 10-year survival

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Table 1 Patient Summary

Patient	Age	Sex	Placement site	Opposing dentition	Medical history
Maxillary implants					
1*	40	M	Between second molars	PD→FPI	Hepatitis C
2†	50	M	Between second molars	PD→FPI	Gagging reflex
3	59	F	R second molar to L second premolar	PD	Hypertension
4	51	F	Between third molars	FPI	—
5‡	62	M	Between second molars	FPI	—
Mandibular implants					
6	64	M	Between mental foramina	FD	Hepatoma
7	62	F	Between second molars	PD	—
8	72	M	Between mental foramina	PD	Syphilis
9*	40	M	Between second molars	FPI	Hepatitis C
10†	50	M	Between second molars	FPI	Gagging reflex
11‡	62	M	Between second molars	FD→FPI	—
12	75	M	Between second molars	FD	Myocardial infarction
13	53	M	Between third molars	PD	—
14	83	F	Between mental foramina	FD	—
15	76	F	Between second molars	ND	—
16	53	M	Between second molars	ND	Hypertension
17	56	M	Between second molars	PD	Insomnia

*Patients 1 and 9, †Patients 2 and 10, and ‡Patients 5 and 11 were bimaxillary patients.
PD = partial denture; FPI = fixed prosthesis supported by implants; FD = complete denture; ND = natural dentition.

rate of 93.4% for 63 implants (84.7% for 28 immediately loaded implants and 100% for 35 submerged implants), and the authors found that there was a statistically significant degradation in the survival rates of immediately loaded implants versus submerged implants. Moreover, the authors cautioned that their results should not be extrapolated to the maxilla, especially to the posterior region, where bone quality and quantity differ dramatically.

Salama and coworkers[5] reported on 2 patients in whom all titanium root-form implants, loaded immediately with provisional restorations, osseointegrated and were restored with fixed prostheses in the maxilla and the mandible using IMZ implants (Friatec AG, Mannheim, Germany) and Brånemark System implants, respectively. Tarnow and coworkers[6] reported on the immediate loading of threaded implants at stage 1 surgery in 10 edentulous arches (6 mandibles and 4 maxillae) with 1- and 5-year follow-up data. They used Brånemark System implants in 6 patients, Astra TiOblast implants (Astra Tech, Mölndal, Sweden) in 2 patients, ITI Bonefit implants (Straumann, Waldenburg, Switzerland) in 1 patient, and 3i implants (Implant Innovations, West Palm Beach, FL) in 1 patient. Sixty-seven of 69 immediately loaded implants and 37 of 38 submerged implants integrated. Their results indicate that immediate loading of multiple implants that are rigidly splinted around a completely edentulous arch can be a viable treatment modality.

The purpose of this study was to evaluate the immediate loading of Brånemark System implants with a screw-retained provisional prosthesis in edentulous patients, including the maxilla and the posterior mandible.

MATERIALS AND METHODS

Patient Selection

Fourteen patients, 5 females and 9 males ranging in age from 40 to 83 years, were treated between December 1997 and December 1999. Twelve mandibular and 5 maxillary arches were treated, including 3 bimaxillary patients (Table 1). Patient selection was as follows. In maxillary arches, including bilateral posterior regions, there was adequate bone to allow placement of a minimum of 8 implants at least 10 mm in length. In mandibular arches, there was adequate bone between the mental foramina to allow placement of 5 to 6 implants with a minimum length of 10 mm. Moreover, when the amount of bone allowed the placement of at least 7-mm-long implants distal to the mental foramina, 2 implants were placed in each side. If possible, 12 and 10 implants were placed in the maxilla and the mandible, respectively.

Preoperative Preparation

A diagnostic wax-up for a provisional fixed prosthesis was completed. This wax-up, or a previous removable denture, was duplicated, and a diagnostic template was fabricated in which 5-mm-long columns of temporary stopping were placed in the planned implant sites. A panoramic radiograph was taken with the diagnostic template. In all maxillary cases and some severely atrophic mandibular cases, DentaScans were taken for further quantitative and qualitative analyses.

The provisional prosthesis, made of heat-polymerizing resin, had a lingual or palatal casting fabricated of cobalt-chromium alloy to provide reinforcement and was divided into 2 portions: an outer facing portion and an inner one with a casting reinforcement (Fig 1).

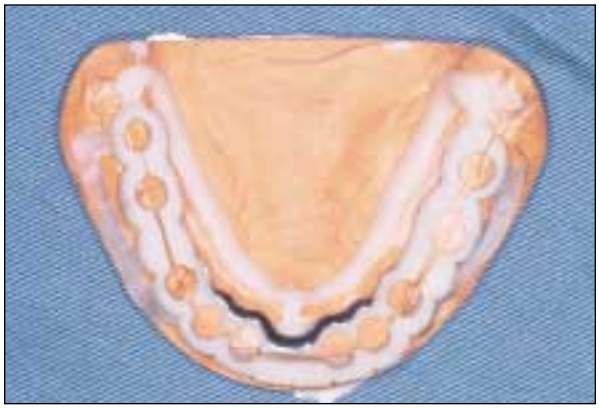

Fig 1 The provisional prosthesis, made of heat-polymerizing resin, was divided into 2 portions: an outer facing portion and an inner one with a casting reinforcement.

Surgical and Prosthetic Procedures

All patients underwent surgery under local anesthesia with intravenous sedation using Midazolam (Yamanouchi Pharmaceutical Co, Ltd, Tokyo, Japan) and were treated with Brånemark System implants. A mucosal incision was made 2 to 3 mm lingual or palatal to the alveolar crest, because abutment connection had to be performed simultaneously. The implants whose placement torque was more than 40 Ncm were immediately loaded. The implants with placement torque of less than 40 Ncm or with bone grafting were submerged and allowed to heal without any loading. The abutments were then connected in the usual fashion. When there was an intervention between the abutment and marginal bone, excessive bone was removed with a bone mill. The temporary cylinders were connected with the abutments using guide pins or gold screws to fabricate the screw-retained provisional prosthesis. The temporary cylinders were incorporated into the inner portion of the provisional prosthesis intraorally with autopolymerizing resin (Fig 2a), followed by extraoral connection of the outer portion (Fig 2b). After the provisional prosthesis was detached from the abutments, healing caps were connected to the abutments, and the wound was closed with 5-0 Vicryl sutures, reconstructing gingival papillae. After the provisional prosthesis was completed extraorally, it was placed and retained with gold screws. Occlusal adjustment was performed intraorally.

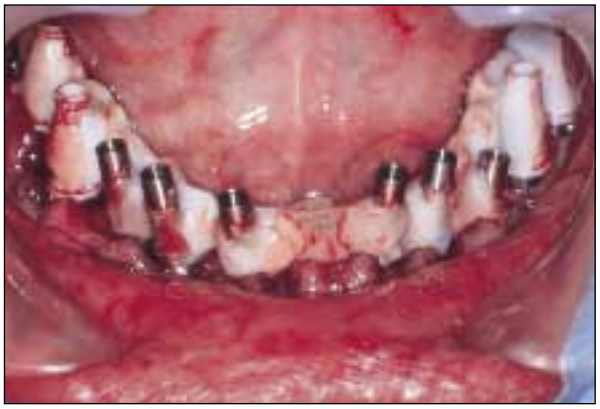

Fig 2a Temporary cylinders were incorporated into the inner portion of the provisional prosthesis intraorally with autopolymerizing resin.

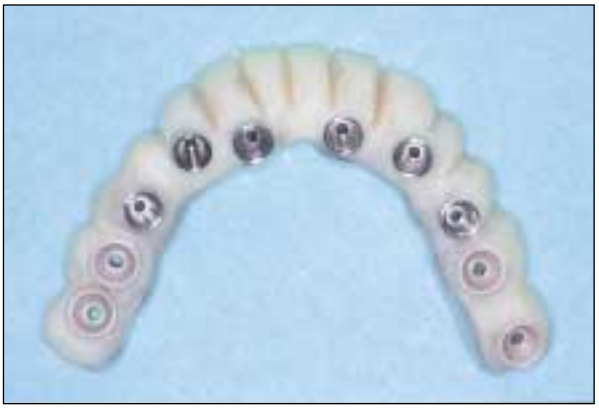

Fig 2b The provisional prosthesis was completed extraorally.

Table 2 Characteristics of Immediately Loaded and Submerged Maxillary Implants

		Implant length (mm)						
		Regular platform			Wide platform			
Patient	Date loaded (mo/y)	13	15	18	10	11.5	13	Total
1	2/98	2	4	2	0	2	0 (2)	10 (2)
2	2/98	2	3	5	0	0	0	10 (0)
3	5/98	1	2	5	0 (1)	0	0	8 (1)
4	8/98	2 (2)	4	2 (1)	0	0	0	8 (3)
5	11/98	0	0 (2)	4	0	1	3	8 (2)
Total, each length		7 (2)	13 (2)	18 (1)	0 (1)	3 (0)	3 (2)	
Total, each platform			38 (5)			6 (3)		44 (8)

Regular platform = 3.75 mm or 4 mm diameter; wide platform = 5 mm diameter.
Parentheses indicate submerged implants.

In patients with submerged implants, abutments were connected 4 and 6 months after implant placement in mandibular and maxillary situations, respectively. The provisional prosthesis was not removed during the healing period, except for when sutures were removed 1 month after stage 1 surgery. A definitive prosthesis was fabricated and placed after 4 and 6 months of the healing period in mandibular and maxillary cases, respectively. Manual testing of implant mobility and radiographs were employed to clinically evaluate the state of osseointegration.

Table 3 Life Table Analysis of Immediately Loaded and Submerged Maxillary Implants

	Months loaded				
	0 to 3	4 to 6	7 to 12	13 to 18	19 to 24
Immediately loaded					
Success	44	44	42	42	20
Failure	0	0	2	0	0
Submerged					
Success	8	8	8	6	2
Failure	0	0	0	0	0
Total	52	52	52	48	22

RESULTS

In maxillary arches, 44 of 52 implants placed were immediately loaded, and 8 implants were submerged (Table 2). Five of 8 submerged implants were placed in conjunction with bone grafting. For the remaining 3, placement torque was less than 40 Ncm. Forty-two of 44 immediately loaded implants (95.5%) and all of 8 submerged implants osseointegrated (Table 3). Two 13-mm-long, immediately loaded implants in the posterior region failed in 1 patient (patient no. 5). The failure was discovered at the time of final impression making, although the implants in question supported the provisional prosthesis uneventfully in the healing period. The failed implants were replaced 3 months after the original implants were removed.

In mandibular arches, 96 of 105 implants placed were immediately loaded, and 9 implants were submerged (Table 4). Six of 9 submerged implants were associated with bone grafting and the remaining 3 were 7 mm long. Ninety-four of 96 immediately loaded implants (97.9%) and all 9 submerged implants osseointegrated (Table 5). Two 18-mm-long immediately loaded implants mesial to the mental foramen were lost in 1 patient (patient no. 15) at the time of final impression making. The failed implants were removed and replacement was performed 4 months later. The provisional prosthesis was transferred to the submerged implants distal to the mental foramina. All patients noted an improvement in masticatory function soon after immediate loading without any complications.

DISCUSSION

In most studies[3,4,7,8] of immediate loading of threaded implants, mandibular arches were treated and posterior placement was avoided, because poor bone quality in this region was expected to result in a high failure rate. Schnitman and coworkers[7] reported that factors associated with the survival of immediately loaded implants include intimacy of

Table 4 Characteristics of Immediately Loaded and Submerged Mandibular Implants

Patient	Date loaded (mo/y)	Implant length (mm)									Total
		Regular platform					Wide platform				
		7	8.5	11.5	13	18	8.5	10	11.5	13	
6	12/97	0	0	0	0	5	0	0	0	0	5
7	3/98	0	0	0	0	6	0	0	1	3	10
8	5/98	0	0	0	0	7	0	0	0	0	7
9	5/98	0	0	0	0	6	1	1	2	0	10
10	6/98	0	0	0	0	6	1	1	1	1	10
11	8/98	0	0	0	0	5 (1)	0	0	2	2	9 (1)
12	10/98	2	1	0	0	6	1	0	0	0	10
13	12/98	0	0	0 (1)	1 (1)	7	0	0	0	0	8 (2)
14	12/98	0	0	0	0	6	0	0	0	0	6
15	3/99	0 (2)	0	0	0	6	0	0	0	0	6 (2)
16	4/99	0	0	0	0	6	0	1	2	1	10
17	4/99	0 (1)	0	0 (1)	0	5	0	0 (2)	0	0	5 (4)
Total, each length		2 (3)	1	0 (2)	1 (1)	71 (1)	3	3 (2)	8	7	
Total, each platform				75 (7)					21 (2)		96 (9)

Regular platform = 3.75 mm or 4 mm; wide platform = 5 mm diameter.
Parentheses indicate submerged implants.

Table 5 Life Table Analysis of Immediately Loaded and Submerged Mandibular Implants

	Months loaded				
	0 to 3	4 to 6	7 to 12	13 to 18	19 to 24
Immediately loaded					
Success	96	94	94	61	32
Failure	0	2	0	0	0
Submerged					
Success	9	9	9	1	0
Failure	0	0	0	0	0
Total	105	105	103	62	32

initial fit, percentage of implants in contact with cortical bone, density of the cortical bone, and elimination of micromovement during the bone remodeling period. They recommended[4] that only 3 of 5 implants placed anterior to the mental foramina (1 in the symphysis and 2 in the posterior region) be immediately loaded with the screw-retained fixed provisional prosthesis in the mandible only, a treatment strategy that he contended maximizes a successful outcome and reduces complexity and cost. On the other hand, 3 failures of the 28 immediately loaded implants occurred distal to the mental foramina, which correlates with the increased failure rate for submerged implants in the posterior region, where failures may be the result of the porous nature of the bone and the implant's lack of contact with the opposing cortex. In addition, since 2 of the immediately loaded implants that failed were 7 mm long, implant length could also be a factor in survival. Moreover, they cautioned that the good results in mandibular arches were not to be extrapolated to the maxilla, especially the posterior region, where bone quality and quantity differ dramatically.

With respect to the concern regarding poor bone quality, there have been few reports on immediate loading in maxillary arches, except one case reported by Salama and colleagues[5] and 5 cases reported by Tarnow and coworkers.[6] In the present study, 136 of 140 immediately loaded implants (97.2%) osseointegrated, including implants in the posterior mandible and the maxilla. These favorable results could be attributed to the following modified surgical techniques. Threaded implants are suitable for immediate loading, because they permit immediate mechanical engagement of bone, compared with cylindric implants. In soft bone, the use of a smaller-diameter twist drill (2.85 mm) and a 4-mm-diameter standard implant without tapping provides additional immediate stabilization. In addition, to maximize bicortical primary stabilization, the thin cortical bone of the nasal and antral floors can be engaged when placing implants in the maxilla.

Sagara and associates[9] observed evidence of osseointegration when titanium screw implants were immediately loaded with a unilateral prosthesis. Their findings showed that osseointegration did

occur, although the immediately loaded implants exhibited less direct bone contact than did the control implants. However, there is a significant difference in biomechanics between their study, which examined a unilateral prosthesis, and the present study, in which almost all patients used bilateral prostheses.

Micromotion or motion of the implant surface relative to the bone can result from functional overloading immediately after implantation. Micromotion can also disturb the early remodeling phase. A critical degree of micromotion caused by overload can result in fibrous repair at the interface rather than osseous regeneration and osseointegration. Brunski[10] theorized that 100 μm of micromovement may be a critical level above which healing would undergo fibrous repair rather than the desired osseous regeneration. Others have suggested that movement of 28 μm or less has no adverse effect on integration, while movement of 150 μm or more results in fibrous connective apposition to the implant.[11]

Bilateral splinting action among several implants that are themselves stable at placement, along with other stabilizing factors, such as optimal distribution of implants and a protective occlusal scheme, may resist this theoretically critical degree of micromovement at the bone-implant interface. In the present study, the potential for micromovement may have been minimized by the screw-retained provisional prosthesis, which rigidly splinted implants together.

In this study, 2 consecutive immediately loaded distal implants failed in 2 patients. The overload resulting from an ill-fitting provisional prosthesis seems to have led to the failures. Therefore, it is hypothesized that elimination of micromovement during the bone remodeling period may be the most important factor for osseointegration, as reported by Brunski.[10] Based upon the results of this report and clinical observations, guidelines for immediate loading are suggested as follows.

1. Immediate loading may be attempted in selected patients to create bilateral splinting action among at least 5 (mandibular) and 8 (maxillary) implants distributed optimally.
2. The length of immediately loaded implants probably should be at least 8.5 mm (wide platform) or 10 mm (regular platform).
3. Implants with good primary stabilization (placement torque of more than 40 Ncm) can be immediately loaded.
4. Implants with placement torque < 40 Ncm, length < 8.5 mm (wide platform) or 10 mm (regular platform), or associated with bone grafting probably should be submerged.
5. A screw-retained, passively fitting provisional prosthesis with a rigid metal casting will likely be more successful.
6. Cantilevers should be avoided in the provisional prosthesis.
7. The provisional prosthesis should not be removed during the healing period (4 months in the mandible and 6 months in the maxilla).

Some clinical studies[12,13] have reported increased failure rates in areas with low bone density or reduced bone height, such as in the posterior maxilla, for threaded implants with a machined surface such as a Brånemark System implant. Therefore, many attempts to facilitate osseointegration of implants have been made over the past 2 decades. Thomas and Cook[14] reported that only the implant surface had a significant effect on bone integration. A removal torque study by Buser and coworkers[15] in the maxillae of miniature pigs confirmed that a machined surface had 8 to 10 times lower removal torque values when compared with 2 rough surfaces, in this case a titanium plasma-sprayed surface and a sandblasted and acid-etched surface. Therefore, the rough surface was considered to be more suitable than the machined surface from an osseointegration viewpoint, and it has been recently recommended for early or immediate loading.

When significant marginal bone resorption occurs and leads to exposure of the rough implant surface during functional loading, subsequent periimplantitis may result in implant failure. In contrast, Lekholm and colleagues[16] reported that exposed threads on Brånemark System implants with a machined surface do not necessarily lead to soft tissue complications and marginal bone resorption during a 5-year period, at least not in patients with good oral hygiene. In addition, Schnitman and coworkers[4] reported that there was no difference in bone level changes over a 7-year period between immediately loaded and originally submerged adjacent implants.

CONCLUSIONS

1. Brånemark System implants were successfully placed into immediate function to support a screw-retained provisional prosthesis in 5 maxillary and 12 mandibular arches.
2. One hundred thirty-six of 140 immediately loaded implants (97.2%) osseointegrated during an 8- to 24-month follow-up period.

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