Immediate Function of Brånemark Implants in the Esthetic Zone: A Retrospective Clinical Study with 6 Months to 4 Years of Follow-up

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ABSTRACT

Background: Immediate implant function is a psychological benefit for the patient and makes a substantial reduction in treatment cost possible. Currently, immediate function using Brånemark implants has become an accepted alternative for complete-arch fixed restorations in mandibles and for overdenture support for some other screw-shaped implants. Clinical documentation is lacking for other applications.

Purpose: The purpose of this study was to investigate a concept for immediate function of Brånemark implants supporting fixed prosthesis in the esthetic regions of the jaws.

Materials and Methods: This retrospective clinical study included 49 consecutively treated patients with 94 implants supporting 54 fixed prostheses, all in esthetically critical regions: 23 of the prostheses were bridges, 14 in maxillae and 9 in mandibles; 31 of the prostheses were crowns, 22 in maxillae and 9 in mandibles. At surgery, the implant platform was positioned above the surrounding bone level and bicortical anchorage was the goal whenever possible. The minimum insertion torque for accepting the implant for immediate function was 32 Ncm. Provisional implant-supported prostheses without occlusal contacts were delivered at time of surgery, and final prostheses with normal occlusion were delivered 5 months later.

Results: Eighty-five of the implants (90%) have passed the 1-year and 40 (43%) the 2-year follow-ups, respectively. Two implants failed in one patient before the 6-month follow-up, and another two implants between the 6-month and the 1-year follow-up, in two other patients, giving a cumulative survival rate of 96%. The average bone resorption was 0.8 mm after the first year as evaluated from 35 patients with readable radiographs. The failed implants were replaced after 3 to 4 months with immediate function; these were successful in all cases (not included in this study). The number of complications was small and did not differ in character from those normally encountered at implant treatment using a conventional protocol.

Conclusions: The cumulative survival rate of 96% at 1 and 2 years indicates that immediate function of Brånemark implants used in the esthetic zone in both jaws can be a viable concept. All failures occurred in fresh extraction sites, and extra care is recommended to avoid situations with ongoing inflammation in these situations.

KEY WORDS: bone anchorage, Brånemark implants, esthetic zone, extraction sites, immediate function, occlusion, partial prostheses, retrospective study, single tooth

The first scientifically documented concept for dental implant treatment, the Brånemark System,[1] included a two-stage surgical technique with intermediate healing periods. However, this screw-shaped implant has demonstrated an initial stability similar to that after healing, when used in dense bone,[2] and, therefore, a healing period may not be needed before loading the implant in that situation. Currently, immediate loading of Brånemark implants has become an accepted alternative for complete-arch fixed restorations in mandibles,[3–5] and the use of other screw-shaped implants has been demonstrated for implant-supported dentures in mandibles.[6,7]

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Immediate implant function provides an evident psychological benefit for the patient as well as a potential cost reduction and, therefore, increases the attractiveness of implant treatment. This study addresses its potential in the esthetic regions, where published clinical documentation currently is limited to one pilot study of 14 patients with single-tooth losses in the region anterior to the molars.[5]

Load transfer between implant and bone is essentially based on mechanical interlocking,[8] and implant anchorage is the effect of the initial anchorage and any subsequent bone formation and remodeling.[9] Implant anchorage (stability) measurements with the resonance frequency analysis technique have revealed that in dense bone this anchorage most often does not increase during healing, but rather slightly decreases, owing to marginal bone resorption.[2] Soft bone sites, on the other hand, often develop an increased anchorage over time, owing to new bone formation,[10] but the more dense bone structure incorporated at surgery, the less critical this formation is. Therefore, in many situations, osseointegration can be viewed as a process maintaining primary anchorage rather than creating increased stability, and immediate function should be a viable option.

The prerequisites for immediate function still are to be specified in detail. However, clinical results indicate that, provided that a certain primary implant anchorage and a controlled load situation is established, bone remodeling will take place without deterioration of this anchorage.[3–5,11] Therefore, if an atraumatic surgical technique is used, the primary anchorage may be maintained, even when loaded during the healing phase.

The purpose of this study was to investigate the concept of immediate function of Brånemark implants in oral locations where an immediate prosthesis placement was important to the patient. Provisional implant-supported prostheses without occlusal contacts were delivered at time of surgery and final prostheses in normal occlusion were delivered 5 months later. The goal of this article is to present a preliminary report of the clinical outcome of this approach.

MATERIALS AND METHODS

This retrospective clinical study was performed in a private clinic, Clinica Maló, in Lisbon, Portugal, and included 49 consecutively treated patients, 18 males and 31 females, with 94 implants supporting 54 prostheses in esthetically critical regions (first premolar to first premolar in either jaw). Twenty-three of the prostheses were bridges: 14 in maxillae and 9 in mandibles; 31 of the prostheses were crowns: 22 in maxillae and 9 in mandibles. Surgery and prosthetic placement were performed by one clinician. The first implant was placed in April 1995 and the last in April 1999, and the patients were followed between 6 months and 4 years. The patients' ages ranged from 16 to 64 years (mean, 42 yr) (Table 1).

The patients were included in the study provided that they had good general health and excellent oral hygiene; had sufficient bone height to place at minimum a 10-mm-long implant; were highly motivated; were in need of single-tooth or short-span implant-supported restorations in esthetically critical areas; and considered immediate function of the prosthesis an important psychological factor.

As exclusion criteria, those generally used when performing implant treatment were followed.[12] Further, patients with the following conditions were excluded: need of bone grafting procedures; diabetes; immunodeficiency pathology; smoker (more than 10 cigarettes/day); bruxism; stress situation (socially or professionally); emotional instability; unrealistic esthetic demands; infection at adjacent teeth; and infection or inflammation in general in the mouth.

Implant positions and implant site status per jaw are presented in Table 2. In maxillae, 43 implants were placed in healed sites and 14 in fresh extraction sites. In mandibles, 24 implants were in healed sites and 13 in fresh extraction sites. Bone quality distribution, according to Lekholm and Zarb,[13] is outlined in Table 3. Of the 94 implants, 94% were placed in bone quality 2 (n = 70) or 3 (n = 18). Implant sizes per type and jaw are presented in Table 4. The majority (90%) of the implants were either 13 or 15 mm long.

Periapical radiographs were taken at implant insertion, at 6 months, 1 year, and thereafter each year. The

TABLE 1. Distribution of Patient Age at Time of Surgery

Patient Age (yr)	Number of Patients
14–20	5
21–30	6
31–40	10
41–50	10
51–60	17
61–70	1

TABLE 2. Distribution of Implant Position and Implant Site Status per Jaw

Implant Position	Immediate Prosthesis Placement	Extraction and Immediate Prosthesis Placement*
Maxillary (n = 57)		
Premolars	9	—
Incisors or cuspids	34	14 (3)
Total	43	14 (3)
Mandibular (n = 37)		
Premolars	8	—
Incisors or cuspids	16	13 (1)
Total	24	13 (1)

*Number of failed implants in parentheses.

reference point for the reading was the implant platform (the horizontal interface between the implant and the abutment), and marginal bone loss was defined as the difference in marginal bone level relative to the bone level at time of surgery. The radiographs were grouped as follows: implant insertion, 1-year follow-up, and 2 years and longer follow-up.

Surgical Protocol

Prophylactic presurgery and 15 days postsurgery antibiotics (Oraminax®, 1g, Wyeth Laboratories, Azevedos, Algés, Portugal), anti-inflammatory medication (Nimed®, Rhône-Poulenc Rorer, Lda, Mem Martins, Portugal), and analgesics (Clonix®, Barcarena, Portugal, Janssen-Cilag, Brussels, Belgium) were used. Some patients were sedated (Valium®, 10 mg, Roche, Anadora, Portugal) before surgery, which was performed under local anesthesia (Rapicaine®, 2% ep, lidocaine HCl 2% with epinephrine 1:100,000, Unipharm, Vera Crus, Mexico). Postsurgically, a chlorhexidine gel (Elugel®, Pierre Fabre Dermo Cosmetique, Lda, Lisboa, Portugal) was placed over the area around the tooth. The patient was instructed to rinse with chlorhexidine solution (Eludril®, Pierre Fabre Dermo Cosmetique, Lda, Lisboa, Portugal) daily for 15 days.

TABLE 3. Distribution of Bone Quality

Bone Quality*	Placed (n = 94)	Failed (n = 4)
1	6	—
2	70	3
3	18	1
4	—	—

* According to Lekholm and Zarb.[13]

TABLE 4. Distribution of Implant Type and Size per Jaw

	Maxillary		Mandibular	
Implant, Diameter Length (mm)	Placed (n = 57)	Failed (n = 3)	Placed (n = 37)	Failed (n = 1)
MkII RP, 3.75 mm	n = 33	n = 2	n = 26	n = 0
11.5	1	1	3	—
13	16	1	13	—
15	16	—	9	—
18	—	—	1	—
MkII RP, 4.00 mm	n = 10	n = 0	n = 1	n = 0
11.5	—	—	1	—
13	4	—	—	—
15	6	—	—	—
MkII NP, 3.3 mm	n = 14	n = 1	n = 10	n = 1
10	2	—	—	0
11.5	1	1	—	—
13	6	—	1	—
15	5	—	9	1

The insertion of the implants (Brånemark System®, MkII, Nobel Biocare AB, Gothenburg, Sweden) followed the standard procedures,[14] with the following modifications: incision was performed on the palate side of the crest for maximum tissue repositioning of the papilla, and the flaps were kept as small as possible, to maximize the blood supply to the implant site after surgery. In case of immediate extraction, the sockets were made free from soft-tissue remnants and cleaned as much as possible to keep infection to a minimum.

A surgical guide was used for optimal implant positioning. The drilling sequence was modified in order to achieve maximum apical compression and anchorage. For 3.3-mm-diameter implants, sites were prepared using the 2.0-mm twist drill. For 3.75-mm implants, sites were initially prepared with 2.0-mm twist drills. The coronal one half of these sites was then enlarged with 2.8-mm twist drills. For 4.0-mm implants, the sites were prepared with 2.8-mm twist drills. The coronal one half of these sites was enlarged with 3.15-mm twist drills. Countersinking was eliminated in order to preserve marginal bone.[15]

The implant platform was aimed to be 0.8 mm above bone level, corresponding to the lower corner of

the cylindrical part of the implant flange, and bicortical anchorage was established whenever possible. The minimum insertion torque for accepting the implant for immediate function was 32 Ncm. The soft tissues were readapted and sutured back into position with 4-0 nonresorbable suture.

Prosthetic Protocol

For single teeth, a prefabricated acrylic prosthesis was adjusted to fit the single-tooth replacement abutment (Nobel Biocare AB) immediately after implant insertion.[16] In the case of the CeraOne abutment (Nobel Biocare AB), a prefabricated acrylic prosthesis using a temporary cap (DCA 161 Nobel Biocare AB) was adjusted.[17] The abutment height was established at the gingival level, to avoid any subgingival location of the crown margin, and the prosthesis was cemented with zinc oxide cement before suturing to ensure complete removal of excess cement. A single-tooth case is presented in Figure 1.

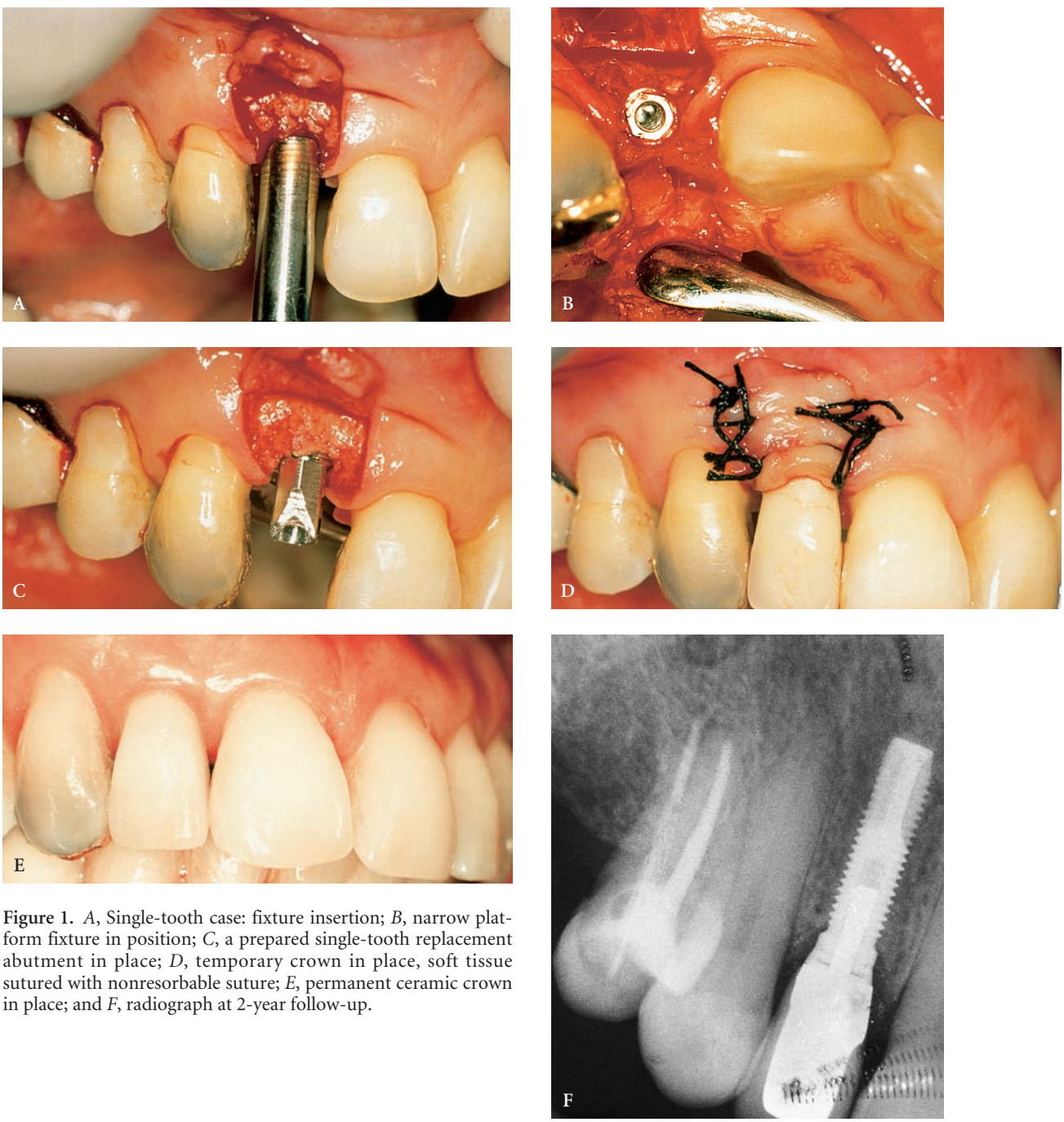


Figure 1. *A*, Single-tooth case: fixture insertion; *B*, narrow platform fixture in position; *C*, a prepared single-tooth replacement abutment in place; *D*, temporary crown in place, soft tissue sutured with nonresorbable suture; *E*, permanent ceramic crown in place; and *F*, radiograph at 2-year follow-up.

In the case of short-span bridges, MirusCone and EsthetiCone abutments (Nobel Biocare AB) were used.[18] Temporary cylinders (DCA 468 and DCA 157, Nobel Biocare AB) were screwed to the abutments and a prefabricated acrylic bridge was adjusted to fit over the cylinders. The bridges were screw-retained, and there were no cantilevers. A short-span bridge case is presented in Figure 2.

All crowns and prostheses were adjusted to eliminate any contact with antagonist teeth in occlusal, lateral, or forward movements or in any plausible parafunctional direction.

Postoperative Protocol

The patients were instructed to avoid chewing on the prostheses for 3 months. Fifteen days after surgery, the sutures were removed, and hygiene and implant stability were checked (in case of bridges, these were unscrewed). The occlusion was rechecked, according to the initial protocol, a procedure that was repeated once a month until a stable situation was envisioned.

The crowns and bridges were checked for stability each month, without removing the prostheses. At 3 months, the prostheses were again removed, jet-cleaned, and disinfected; the implants were checked for anchorage; and the prostheses were recemented or refastened by the screws. At each evaluation, the healing process was monitored by applying finger pressure to the soft tissues around the implants and evaluating for pain, bleeding, or suppuration. After 5 months, the final crowns were fabricated for the single implants and placed according to the standard procedures.[18]

Dropout

Two years after implant placement, one patient with two implants died due to unrelated causes; consequently, data related to this case were withdrawn from the study.

Study Parameters

All patients were followed with regard to implant survival; marginal bone loss; and mechanic, biologic, and esthetic complications.

Implant Survival Criteria

Survival is related to the implant function at the time of evaluation, whereas success, in addition, includes the probability that the implant will remain stable, as judged by the annual bone loss.[19,20] As the majority of the patients in the present study were followed for only 1 year, and there was limited information about the annual bone loss, the success classification could not be met. Therefore, the implants were classified as survivals when they were clinically stable and fulfilled their purported function without any discomfort to the patient.

Marginal Bone Loss

The marginal bone level was read from periapical radiographs taken at surgery and at each evaluation. A conventional radiograph holder was used, and its position was manually adjusted for an estimated orthognathic position of the film.

Mechanic, Biologic, and Esthetic Complications

The following complication parameters were assessed: fracture or loosening of mechanical and prosthetic components (mechanic complications); fistula formation, pain or infection, soft-tissue inflammation (biologic complications); and esthetic complaints from the patient or the dentist (esthetic complications).

RESULTS

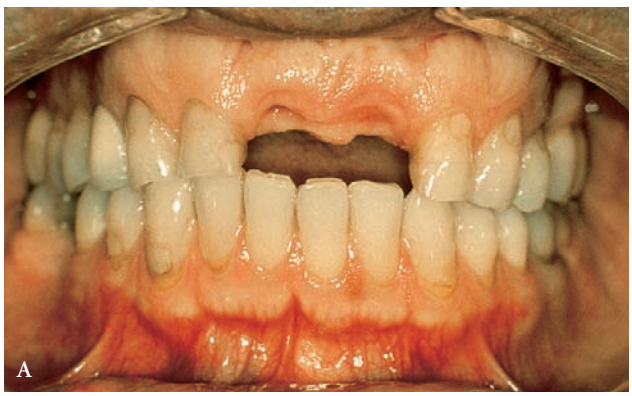
All implants were successfully inserted into desired positions, achieving good primary stability.

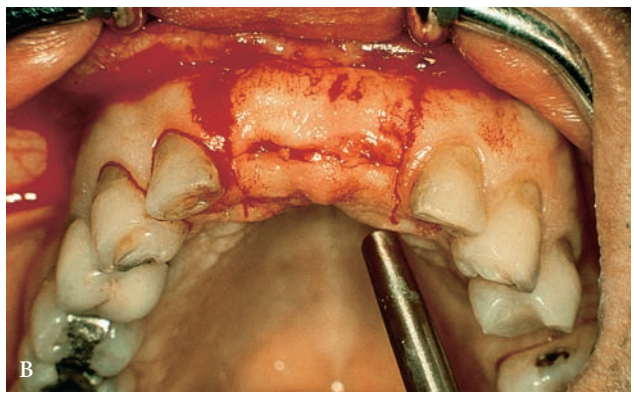
Cumulative Implant Survival

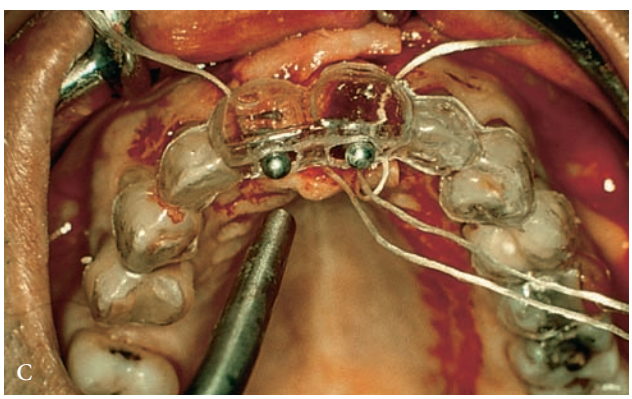
Eighty-five of the implants (90%) have passed the 1-year follow-up, and 40 (43%) the 2-year follow-up, whereas four implants have failed, all in fresh extraction sites (see Table 2), giving a cumulative survival rate of 95.7% after 1 year and 2 years (Table 5). Two implants failed in one patient before the 6-month follow-up, and another two implants failed between 6-month and 1-year follow-up in two other patients. For the patient with the early losses, the extraction sites showed infection with suppuration at implant insertion, whereas no specific observations were made for the other two patients with failed implants. The failed implants were removed, and after 3 to 4 months, new implants were installed and immediately loaded. These implants have not been included in the present study.

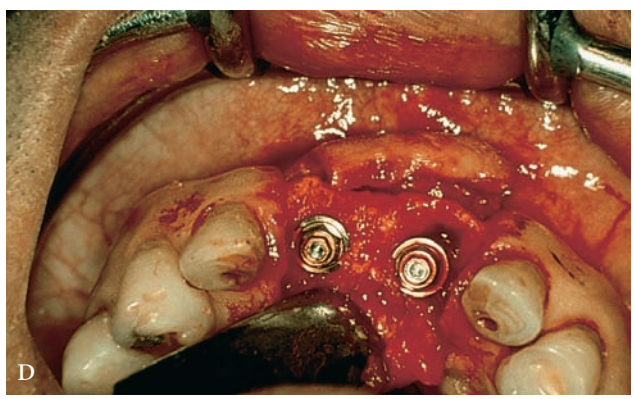
Marginal Bone Loss

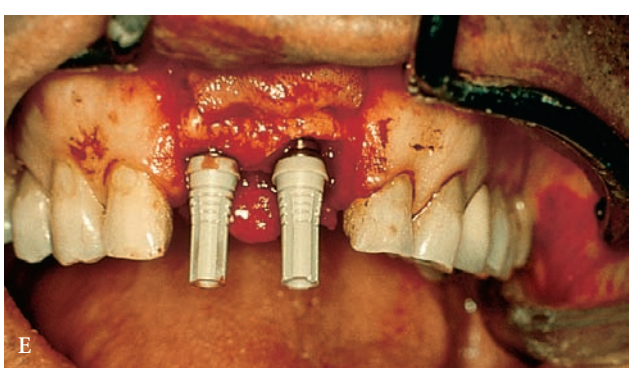
Of the radiographs used for the marginal bone level measurements, 46% were readable. For implants for which the baseline radiographs (time of surgery) was not readable (n = 49), a default value was set to the

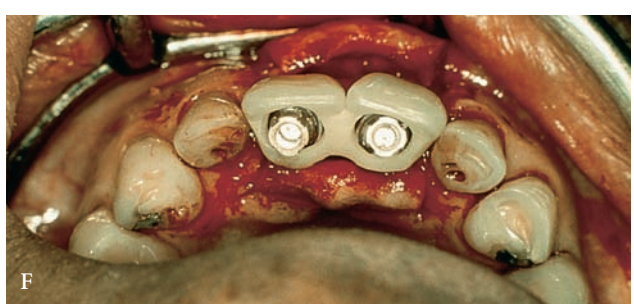


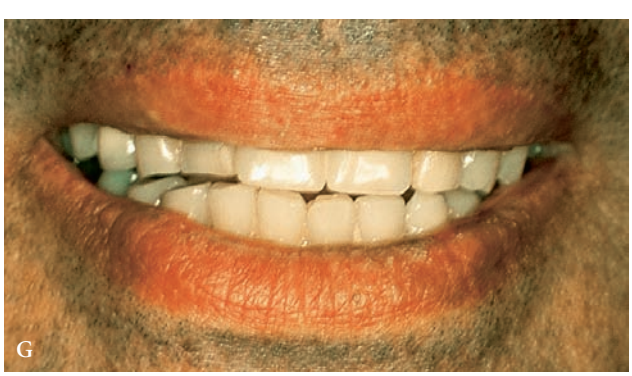












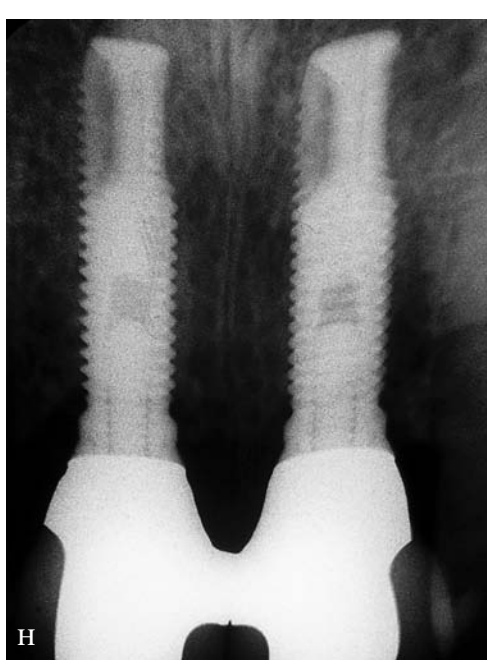


Figure 2. *A*, Partially edentulous case preoperatively; *B*, incisions are made; *C*, for optimal positioning, a surgical guide is used; *D*, abutments are placed; *E*, temporary cylinders were used for a flexible, temporary prosthetic procedure; *F*, temporary bridge in position; *G*, the temporary prosthesis was adjusted to eliminate any supracontacts; and *H*, radiograph at 2 years after loading.

TABLE 5. Life Table Analysis Regarding Implants Survival

Duration	Number of Implants				CSR (%)
	Total	Failed	Withdrawn	Not Yet Due	
Placement–6 mo	94	2	0	0	97.9
6 mo–1 yr	92	2	0	5	95.7
1–2 yr	85	0	0	45	95.7
2–3 yr	40	0	2	26	95.7
3–4 yr	12	0	0	8	95.7
4 yr	4	–	–	–	

CSR = cumulative survival rate.

mean value of the readable radiographs. This value was 0.7 mm for the healed sites, based on the readings on 21 implants (38%), and 1.5 mm for the fresh extraction sites, based on the readings on 20 implants (59%).

Table 6 outlines the distribution of marginal bone resorption. Of the 85 implants followed for 1 year or more, 61 (72%) had a readable radiograph at least one of the follow-up examinations. The latest bone resorption reading for each of these implants is presented in Table 6. The average bone resorption was 0.8 mm after the first year.

All cases with bone resorption more than 2 mm were scrutinized, and no remarkable findings were made. None of the cases showed any sign of inflammation around the implants and the implants were judged stable.

Mechanic, Biologic, and Esthetic Complications

Twelve temporary crowns became loose, and three crowns fractured. No biologic complications were observed besides the failed implants. Eighteen of the abutments were exchanged to provide better esthetics. No other complications were experienced.

DISCUSSION

The 96% cumulative survival rate for this immediate loading protocol at the 1- and 2-year follow-up examinations is comparable to results from clinical studies of both jaws using two-stage procedures.[21]

Two failures occurred in one patient during the use of the provisional prosthesis, and two failures occurred in two other patients after the final prosthesis was placed, but before the 1-year follow-up. As the majority of implant losses with the Brånemark System take place during healing or the first year of function, it is believed that any implant loss related to the procedure would have shown up within the time frame of the study, and that the prognosis for implant success after 1 year of function is equivalent to that for the two-stage technique.

All implant losses occurred at immediate extraction sites. The patient who lost both implants and had infected sites with suppuration should not have been included in the study, according to the exclusion criteria.

Immediate placement of Brånemark implants into fresh extraction sockets with two-stage surgery seems to be a safe and predictable procedure.[22–24] However, when a tooth has been extracted because of an infection, the infection should be eliminated before an implant is placed; otherwise, the prognosis for the implant could be jeopardized.[25]

All patients with bone resorption exceeding 2 mm (n = 6) had healed sites before implant placement,

TABLE 6. Distribution of Marginal Bone Resorption

	Baseline–1 Yr		Baseline–2 Yr		> 1 Yr	
	Mesial	Distal	Mesial	Distal	Mesial	Distal
Number of implants	35	35	18	18	61	61
Mean bone resorption (mm)	0.8	0.8	1.4	1.3	1.2	1.2
Standard deviation	1.1	1.0	1.3	0.8	1.3	1.2

*Implant insertion.

indicating that the extraction procedure did not cause increased bone loss. Since all implants were judged stable at surgery, the apparent cause of implant failures in this study was infection.

Bone resorption was low, on average 0.8 mm during the first year of function, which is within the limits for success classification.[20,27] However, because annual bone loss assessment was not available, owing to a small number of readable radiographs, the implants were classified as survivals. The minimal mean bone resorption, however, supports the assumption that the prognosis should be equivalent to that for the two-stage technique.

Historically, implant success criteria have been applied to two-stage protocols, and the baseline for bone resorption has been the bone level after prosthesis attachment.[26] However, marginal bone loss may take place during the period from surgery to final prosthesis (i.e., before the baseline is defined) and, consequently, not be considered in the above success criteria.[27,28] In case of immediate function, however, such bone resorption is registered, and a value of 1.5 to 2.0 mm, rather than 1 mm, the first year would be more appropriate in this situation.

Some temporary crowns came loose or fractured, although occlusal contacts were virtually eliminated and the patients were instructed not to chew with these teeth. This indicates that even if immediate function without substantial loading was sought, in reality these crowns were loaded during the bone healing period. Therefore, the initial bone anchorage with the present protocol might be sufficient for true immediate loading.

The term "immediate function" is used instead of "immediate loading" because the latter has lost some of its specificity when applied to different procedures. Immediate function is proposed as it relates to the patient's concerns: to have new teeth immediately, both fulfilling esthetic demands and performing mastication. It is then the dentist's responsibility to select and perform the treatment to meet these demands. Thus, implant loading for immediate function may vary significantly from case to case.

CONCLUSIONS

The cumulative survival rate of 96% at 2 years indicates that, within the limits of this study, immediate function of Brånemark implants used in the esthetic zone in both jaws may be a viable concept.

All failed implants were successfully replaced and the number of complications was small and did not differ from that normally encountered during implant treatment; therefore, this study indicates a favorable advantage:risk ratio for the proposed protocol.

The prerequisites for immediate function still are to be specified in detail, but the clinical results of the present study indicate that, provided a certain primary implant anchorage and a controlled load situation, bone remodeling may take place without deterioration of the initial anchorage. The report does not indicate whether all of the prerequisites applied are necessary, and further clinical research is needed to determine the limits for this promising technique.

All failures occurred in fresh extraction sites, and extra care is recommended to avoid situations with persistent inflammation in these situations.

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