Full-Arch Restoration of the Jaw with Fixed Ceramometal Prosthesis

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Between 1990 and 1995, 214 implants were placed in 29 maxillae and mandibles of 22 patients following extraction of all residual teeth as a consequence of severe periodontal disease. All patients were discharged wearing immediate dentures. The implants were analyzed with regard to the number per arch, location, length, and diameter. The 5-year cumulative survival rate was 98.5%. The mean number of implants per arch was 7.5 for the maxilla and 7.2 for the mandible. The preferred implant locations were canines, central incisors, lateral incisors, and second premolars in the maxilla; and lateral incisors, first molars, and canines in the mandible. The mean implant length was 14.7 mm in the mandible and 14.5 mm in the maxilla. The mean implant diameter was 3.8 mm in the maxilla and 3.8 mm in the mandible. The results of the present study indicate that immediate implantation for fixed full-arch reconstruction can be considered a viable treatment alternative in patients with severe periodontal disease.
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Key words: immediate implantation, residual teeth extraction

Little is known about the major factors that influence bone resorption. Anatomically, bone resorption affects the maxilla and mandible, both buccolingually and apicocoronally. The first 6 months postextraction are critical, since it is at that time that the highest rate of bone resorption in both directions occurs.[1–7]

Several clinical reports have demonstrated that early implant placement may preserve the width and height of arches.[8,9] Implantation should not be considered only as a final treatment option but should be performed early to prevent initial bone loss. For example, in refractory periodontal disease, the dilemma is whether to continue prolonged periodontal treatment, or to extract the involved teeth to maintain bone volume.

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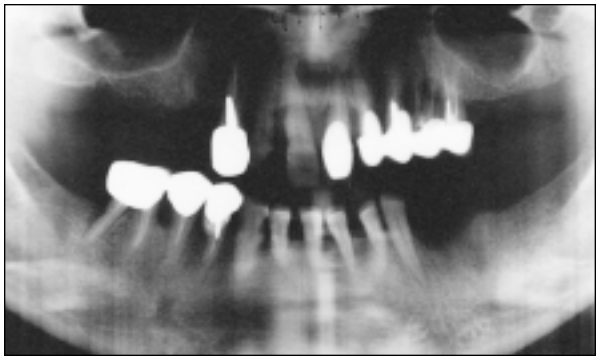
In the present study, the 5-year implant cumulative survival rate was evaluated for full-arch restoration of the jaw with a fixed ceramometal prosthesis immediately following extraction of all residual teeth.

Materials and Methods

From 1990 to 1995, 22 patients (6 male and 16 female) ranging in age from 36 to 66 years (mean 53.5 years) underwent immediate implantation in the private clinic of the senior surgeon (DSA). A total of 214 implants (128 in the maxilla, 86 in the mandible) were placed in 29 jaws (17 maxillae and 12 mandibles) immediately following the extraction of 207 teeth with severe periodontal disease (117 in the maxilla, 90 in the mandible (Figs 1a and 1b). Screw-type titanium implants were used. A potential site for immediate implant placement needed to demonstrate 3 to 5 mm of bone beyond the root apex.

Oral examination included an assessment of the intra-arch relationship, buccolingual width, and intermaxillary relationship. Panoramic radiographs and computerized tomography (CT) images were evaluated for bone quantity (mesiodistal width, residual bone beyond the apex, socket width, and distance from vital structures such as the maxillary sinus, nasal cavity, and mandibular canal) and tooth angulation.



Figs 1a and 1b Preoperative view of a typical patient with moderate to severe adult periodontitis. *(Left)* Intraoral photograph; *(right)* panoramic radiograph.

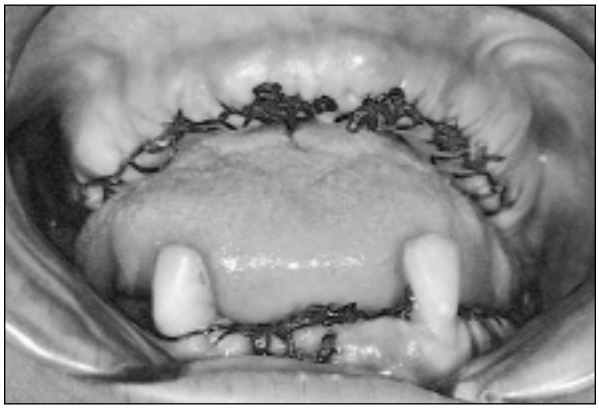


Fig 2 Intraoral clinical view of the same patient 1 week post-extraction and immediate implant placement (16 implants, 8 in each arch). All residual teeth were extracted in the maxilla; the mandibular canines were temporarily left for retention of a temporary removable denture. Notice the minimal initial hematoma in both arches resulting from the use of immediate dentures.

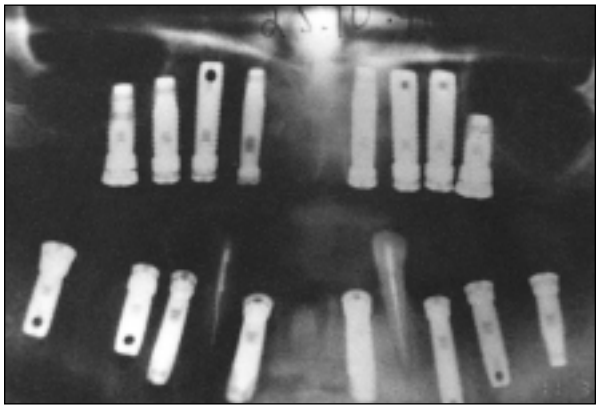
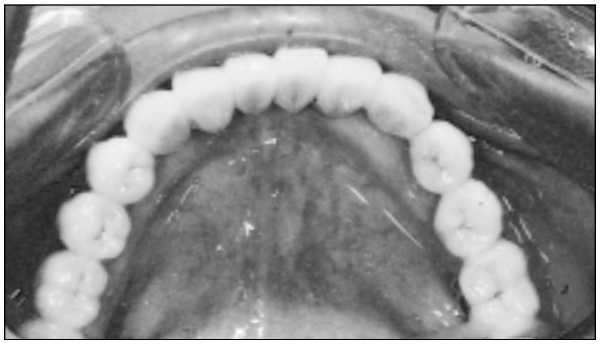


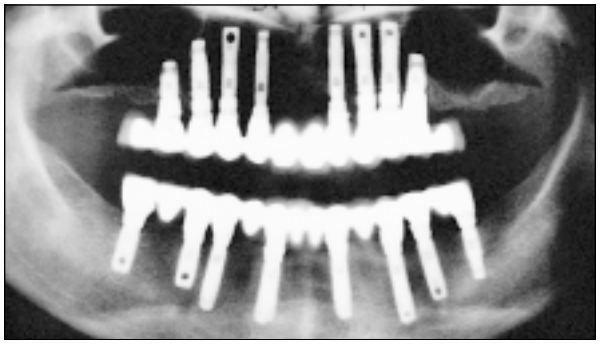
Fig 3 Panoramic radiograph at stage 1 after tooth extraction and immediate implant placement.

One hour preoperatively, 1 g amoxicillin and 8 mg dexamethasone were administered and intraoral 0.5% chlorhexidine rinses were used for 2 minutes. For patients allergic to penicillin, 0.5 mg erythromycin was administered. Amoxicillin or erythromycin was continued for 5 to 7 days postsurgery, and 4 mg dexamethasone per day was administered for 2 additional days. Teeth were carefully extracted and the sockets debrided. Implant placement was performed using a surgical template. Implant location was dictated by the planned prosthetic reconstruction. When the locations were compatible with that of an extracted tooth, sockets were prepared with standard drills using the bony walls as guides, with maximum use of bone apical to the extraction sockets. When appropriate, nonimmediate implant sites were also prepared according to standard guidelines. The longest and widest possible implants were placed at the crestal ridge to achieve a normal emergence profile and maximum preservation of vertical bone. The implants were then determined to be clinically stable. Small autogenous bone chips (from bone adjacent to the implant site or bur debris) were grafted into the defect between the implant and socket walls when needed. Primary flap closure was achieved in all patients.

Removable complete dentures were adjusted with a soft lining and placed immediately postsurgery. Patients were instructed to wear the immediate prosthesis only for esthetics or necessary function to minimize the total wearing time. The prosthesis was not worn at night, except for the first 24 hours following placement. The average daily use was 10 to 12 hours (Fig 2). Patients were recalled at least once a month before second-stage surgery. The mean number of recalls was 8.55 for maxillary restorations and 6 for mandibular. At second-stage surgery (a mean of 6.9 months in the maxilla and 3.8 months in the

Figs 4a and 4b Clinical photographs 1 month post-second-stage surgery. *(Left)* View of mandible before the canines were extracted; *(right)* view of maxilla.





Figs 5a to 5d Postoperative look with fixed ceramometal prosthesis. Notice the reduction of cantilever area to the first molar in the maxilla and the lack of cantilever in the mandible.

mandible after implantation), panoramic radiographs of the implant sites were taken (Fig 3). Healing caps were placed and the temporary denture was adjusted (Figs 4a and 4b). After varying intervals, implants were restored with fixed ceramometal prostheses by 11 prosthodontists (Figs 5a to 5d).

The influence of the following parameters on the 5-year cumulative survival rate was assessed: the number of implants per jaw, implant location, implant length, and implant diameter.

Results

The main cause of tooth loss in the patient population examined in the present study was extensive untreatable periodontal disease. Of 214 implants, 15 (in 2 arches) were placed in 1990, 16 (in 2 arches) in 1991, 14 (in 2 arches) in 1992, 39 (in 5 arches) in 1993, 36 (in 5 arches) in 1994, and 94 (in 13 arches) in 1995. Follow-up was from the time of implant placement to 1996.

Table 1 Extracted Teeth and Their Location

	Location						
	First molar	Second premolar	First premolar	Canine	Lateral incisor	Central incisor	Total
Maxillary							
No. extracted	7	16	15	24	26	29	117
%	21	47	44	71	76	85	
Mandibular							
No. extracted	6	10	18	18	19	19	90
%	25	40	72	72	79	79	

% = No. of extracted teeth/no. of the maxillary or mandibular quadrants

Table 2 Maxillary Implant Characteristics and Location

	Location					
	Central incisor	Lateral incisor	Canine	First premolar	Second premolar	First molar
No. of implants	28	21	31	20	21	7
%	82	62	91	59	62	21
Mean length (mm)	14	15.1	15.3	14.9	13.4	13.4
Mean diameter (mm)	3.8	3.6	3.9	3.75	3.9	3.8

% = No. of implants/no. of the maxillary quadrants

Table 3 Mandibular Implant Characteristics and Location

	Location					
	Central incisor	Lateral incisor	Canine	First premolar	Second premolar	First molar
No. of implants	1	22	18	13	12	20
%	4	92	75	54	50	83
Mean length (mm)	16	16	16	15.8	13	12.5
Mean diameter (mm)	3.75	3.75	3.8	3.8	3.9	3.9

% = No. of extracted teeth/no. of the mandibular quadrants

Table 1 shows the extracted teeth by arch and tooth location. Of the extracted maxillary teeth, 67% (79 of 117) were in the premaxilla (between the canines), and of the extracted mandibular teeth, 82% (74 of 90) were in the anterior mandible (between the first premolars).

Table 2 shows the characteristics of the maxillary implants (length and diameter) and their location. The mean implant diameter was 3.8 mm and the mean implant length was 14.5 mm. The preferred locations were canines (91%), central incisors (82%), lateral incisors (62%), and first premolars (62%).

Table 3 shows the characteristics of the mandibular implants (length and diameter) and their location. The mean implant diameter was 3.8 mm and the mean implant length was 14.7 mm. The preferred locations were lateral incisors (92%), canines (75%), and first molars (83%).

Table 4 shows the location of immediate implants (69%) placed in the maxilla. The main locations were in the central, lateral incisor, canine, and second premolar areas. The distribution of immediate implants (63%) placed in the mandible is shown in Table 5. Implants were placed mainly in the lateral, canine, and first premolar areas.

Minor complications were defined as implant exposures requiring the use of chlorhexidine rinses and oral antibiotics without surgical intervention. Major complications were defined as implant exposures requiring surgical intervention for curettage and primary closure. There were 17 minor (7.9%) and 5 major (2.3%) complications. Three implants were lost (1.5%) for a cumulative implant survival rate of 98.5% (Table 6). One implant was lost after loading during the follow-up period.

Table 4 Implants Immediately Placed in the Maxilla

	Location						
	Central incisor	Lateral incisor	Canine	First premolar	Second premolar	First molar	Total
No. of implants	24	19	23	10	12	0	88
Total	28	21	31	20	21	7	128
%	86	90	74	50	57	0	69

% = No. of immediate implants/no. of the maxillary quadrants

Table 5 Implants Immediately Placed in the Mandible

	Location						
	Central incisor	Lateral incisor	Canine	First premolar	Second premolar	First molar	Total
Immediate	0	18	15	9	6	6	54
Total	1	22	18	13	12	20	86
%	0	82	83	69	50	30	63

% = No. of implants/no. of the mandibular quadrants

Table 6 Cumulative Survival Rate

Time since surgery	Number of surviving implants	Number of failed implants	Cumulative survival rate (%)
Implantation	214		
Exposure	212	2	99.0
3 mo	211	1	98.5
6 mo	211		98.5
1 y	211		98.5
2 y	117		98.5
3 y	81		98.5
4 y	42		98.5
5 y	28		98.5

Discussion

The use of osseointegrated implants in dentistry has increased. Although the traditional use of osseointegrated implants in the edentulous mandible was to support a fixed prosthesis with resin restorations, typically with 4 to 6 implants, the use of multiple implant-supported fixed ceramometal restorations is becoming more widespread. In the present study, barrier membranes were not used and the only graft material used was autogenous bone chips.

Adell et al[10] reported a 99% success rate using osseointegrated implants to support fixed dental prostheses in the mandible. The international popularity of this type of treatment plan does not mean that it is free of clinical or biomechanical complications. The transfer of occlusal load through the distal cantilever of the prosthesis may lead to screw loosening, fracture of the superstructure, or implant failure.[11]

When compared to the anterior mandible, the maxilla presents complex variables that influence the final result. In the resorbed maxilla, the bony arch will constrict palatally. If sufficient bone remains for implant placement, its position will likely be too far palatal. The discrepancy between tooth and implant position complicates prosthesis design and may compromise the esthetic result, hinder access for oral hygiene beneath the prosthesis and around the implants, or encroach upon tongue space, creating problems with speech and patient comfort.[12]

Implant therapy may preserve bone height and width.[8,9,13,14] Denissen and Kalk[8] evaluated submerged hydroxyapatite implants placed immediately into fresh extraction sites. They concluded that alveolar ridge volume was maintained as a result of the physical presence of the implants. Von Wowern et al[13] proved that less bone volume was lost at implant sites by studying the mineral content of the implant

sites. Patients treated with implant-supported prostheses show a delayed resorption pattern compared to those treated with mucosa-supported dentures.[14]

Most of the patients in this clinical study were relatively young and almost two-thirds were women. Patients who seek implant reconstruction today are likely to be more demanding and have higher expectations. They want their prosthesis to resemble the natural dentition as much as possible (it should be fixed, esthetic, functional, and comfortable), and to minimize time away from work, and they desire surgery that will provide a postoperative outcome with minimal discomfort.

The use of immediate implantation in edentulous patients for complete restoration of arches with fixed ceramometal prostheses satisfies most of these desires. The need for a cantilever design is minimized and the emergence profile of the teeth is more natural, eliminating the large space beneath the prosthesis.

In this study, most of the extracted mandibular teeth were in the area between the first premolars; whereas the extracted maxillary teeth were in the area between the canines. This enabled immediate implantation in the mandibular second premolar (50%) and first premolar (30%) areas. In the maxilla, 44 to 47% of arches still had healthy teeth in the premolar areas, which enabled immediate implantation in the second premolar area (57%) because of preserved bone height and width near the existing teeth.

A mean of 7.2 implants per arch were placed in the mandible, resulting in a mean total arch length of 105.8 mm and a mean total arch diameter of 27.4 mm. Compare this to the traditional prosthesis supported by six implants: 6 implants with a mean length of 16 mm result in a total arch length of 96 mm and 6 implants with a mean diameter of 3.75 mm result in a total arch diameter of 22.5 mm. The expanded arch has several advantages, including better implant positioning, which minimizes the need for a cantilever, and a higher bone-implant contact for the entire restoration. These assumptions need further study and exploration before general acceptance.

The preferred locations in the mandible were the lateral incisor, canine, and first molar areas. In the maxilla, a seventh implant was added in the premolar area along with the central incisor, canine, lateral and first premolar sites. Approximately 80% of the mandibles and 60% of the maxillae (Tables 2 and 3) received this implant positioning. The mandibular central incisors were avoided because of their mesiodistal width, thus allowing more freedom in creating the final esthetic restoration. In the maxilla, implants were placed where possible in any location between the canines to enable the best emergence profile (better than a pontic) and maximum future bone preservation. Maintenance of bone height resulted in short crowns, leading to long-term esthetics and function with the best attainable crown-root ratio.

Implant-supported prostheses may involve cantilever prostheses. In the mandible, cantilever extension can be 18 to 20 mm to enable restoration of 1 premolar and 1 molar.[14] However, in the maxilla, the maximum cantilever length should be no greater than 10 to 12 mm[15,16] to provide space for placing 1 premolar distal to the most posterior implant. Esthetics and function are thus compromised. By using the treatment plan proposed in this study, the cantilever area was minimized to the first molar, enabling both function and esthetics (Figs 5a to 5d).

The placement level of the implant into the alveolar bone is crucial. All implants in this study were placed at the alveolar crest level. The 5-year cumulative implant survival rate was 98.5%. This demonstrates that alveoloplasty 2 mm or more below the level of the alveolar crest performed prior to immediate implantation or implant placement is not essential for osseointegration. Thus, more bone volume can be preserved, resulting in more esthetic restorations with improved crown-root ratios.

Complications are inevitable but do not necessarily result in implant failure. In previous studies,[17–22] the use of temporary dentures only 2 weeks after immediate implant placement has been demonstrated. In only 1 study were patients allowed to use temporary dentures immediately after stage I surgery.[23] Patients in the present study were also permitted to wear their dentures immediately after implantation. This did not result in higher complication ratios or implant failures, which may be attributed to the close follow-up. The mean number of recalls between the 2 surgical stages was 8.55 for maxillary restorations and 6 for mandibular restorations. Temporary dentures that caused soreness were adjusted as soon as possible. The immediate placement of prostheses may reduce the dead space between soft tissue coverage and bone following implant placement, reduce initial hematoma, minimize chances of infection, and enhance the healing process (Fig 2). The social, functional, and economic advantages are obvious.

Conclusion

High patient expectations can be met by immediate implant-supported full-arch fixed ceramometal reconstruction. Immediate implantation shortens the total treatment time and has the potential to preserve bone volume, thus enabling better function and

esthetics. The use of temporary dentures at the end of surgery restores the patient's social confidence and oral function as soon as possible. The use of ceramometal restorations may be the most comfortable way to rehabilitate a patient because of its durability and resemblance to the natural dentition.

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