A Retrospective Study of 1,925 Consecutively Placed Immediate Implants From 1988 to 2004

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Purpose: *The purpose of the present study was to evaluate implant survival rates with immediate implant placement (IIP) into fresh extraction sockets and to determine risk factors for implant failure.* ***Materials and Methods:*** *A retrospective chart review was conducted of all patients in whom IIP was performed between January 1988 and December 31, 2004. Treatment required atraumatic tooth extraction, IIP, and mineralized freeze-dried bone allograft with an absorbable barrier to cover exposed implant threads. Implant failure was documented along with time of failure, age, gender, medical history, medications taken, postsurgical antibiotic usage, site of implant placement, and reason for implant failure. Statistical analysis was performed using chi-square and logistic regression analysis methods.* ***Results:*** *A total of 1,925 IIPs (1,398 machined-surface and 527 rough-surface implants) occurred in 891 patients. Seventy-one implants failed to achieve integration; a total of 77 implants were lost in 68 patients. The overall implant survival rate was 96.0% with a failure rate of 3.7% prerestoration and 0.3% postrestoration. Machined-surface implants were twice as likely to fail as rough-surface implants (4.6% versus 2.3%). Men were 1.65 times more likely to experience implant failure. Implants placed in sites where teeth were removed for periodontal reasons were 2.3 times more likely to fail than implants placed in other sites. Patients unable to utilize postsurgical amoxicillin were 3.34 times as likely to experience implant failure as patients who received amoxicillin.* ***Conclusions:*** *With a 1- to 16-year survival rate of 96%, IIP following tooth extraction may be considered to be a predictable procedure. Factors such as the ability to use postsurgical amoxicillin and reason for tooth extraction should be considered when treatment planning for IIP.* Int J Oral Maxillofac Implants 2006;21:71–80

Key words: *age factors, dental implants, gender, implant surfaces, implant survival, penicillin allergy, smoking*

A high level of predictability for implants placed into fully and partially edentulous patients has been demonstrated in many long-term studies.[1–9] The procedure used in most of these studies includes a 6- to 12-month healing period following tooth extraction to allow implant placement into mature bone.[1,10] Albrektsson and associates stated that this protocol resulted in 5- to 8-year implant success rates of 99.1% in the mandible and 84.9% in the maxilla.[2] Unfortunately, during this extended postextraction healing phase, resorption of the residual bone occurs.

Studies have demonstrated that approximately 45% of the residual alveolar ridge may be resorbed after tooth extraction, with the majority of resorption occurring during the first 6 months after extraction.[11,12] Without treatment, resorption is observed in all dimensions of the residual alveolar ridge following tooth extraction.[13–15] Left uncontrolled, this resorption could prevent routine implant placement.

Immediate implant placement (IIP) into an extraction socket has been proposed as a method to preserve bone at the surgical site.[16–18] Other advantages of IIP are a reduction in treatment time and the ability to place the implants in positions that are favorable for the final prosthesis.[19] In addition, patient acceptance from the reduced number of surgeries and reduced treatment time is an advantage of this method.[20]

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Two literature reviews found similar implant survival rates for immediate and delayed implant placement. [19,21] Likewise, bone fill occurred with submerged and nonsubmerged implant placement.[22] Studies describe a variety of techniques resulting in survival rates of immediate implants ranging from 89% (for molar replacement only) to 100%, with study durations ranging from 1 to 11 years.[23–33]

Comparison of success rates and analysis of the factors important for implant survival is difficult with the many variables included in the aforementioned studies (ie, implant surface, use of bone graft and/or membrane barrier, primary closure of wound, reason for tooth extraction). In the present retrospective study, protocol variation was controlled; the same techniques (bone grafting and membrane use) were utilized for placement of all implants. The purpose of the present study was to evaluate survival rates of implants placed immediately into fresh extraction sockets and restored for a minimum of 1 year. An additional purpose was to correlate implant failure rates with the age and gender of the patients, implant position, smoking habits, medications taken, penicillin allergy, and reason for tooth failure.

MATERIALS AND METHODS

A retrospective chart review was conducted on all patients treated with implants placed immediately into tooth extraction sites by a single periodontist. Patients were identified through analysis of the office database and through evaluation of data recorded in an implant tracking software program (Implant Tracker, West Hartford, CT). Once patients were identified, individual charts and radiographs were evaluated, and the following data were recorded: age at implant placement, date of implant placement, gender, medical history, smoking history, medication usage, medical allergies, reasons for initial tooth failure, location of implant placement, additional surgical procedures (eg, sinus lift), implant dimensions, implant manufacturer, date of abutment connection, date of final restoration seating, and, when applicable, date of and reasons for implant failure. Restorative clinicians were contacted via telephone survey to confirm the dates of restoration and determine whether there were any unreported complications or failures of the immediately placed implants. Up-to-date monitoring with recall visits to the surgeon and restorative clinicians was performed for all patients and all implants placed through December 2004.

Implants included in this review met the following inclusion criteria:

1. Apical or lateral stabilization. Upon surgical placement, the implants achieved stability in host bone. Dehiscence with thread exposure at the time of implant placement did not prevent inclusion in the study if initial stability was obtained.
2. Lack of residual infection. The extraction socket was examined after a thorough curettage removing all residual fibers from the apical area and the lateral walls.
3. Continuous function for a period of 1 year postrestoration. If an implant failed prior to restoration placement this implant was included in the statistical analysis and considered as a failure prior to final restoration.

A consistent surgical protocol was followed. Local anesthesia was achieved through infiltration techniques (no regional block anesthesia) using lidocaine with 1:50,000 epinephrine (Abbott Laboratories) unless medically contraindicated. In patients where epinephrine was contraindicated, mepivacaine 3% (Abbott Laboratories, North Chicago, IL) was used. Full-thickness flaps were elevated with minimal palatal elevation in the maxilla. Vertical incisions were utilized as necessary. The teeth to be removed were extracted atraumatically whenever possible. Molars were sectioned and roots removed separately. Using a bur, a trough was made around the circumference of the root through the ligament. The roots were removed with an elevator using minimum pressure. Sockets were thoroughly degranulated with curettes or burs and inspected. All remnants of fibers and soft tissue were removed from the sockets.

Standard protocol and the manufacturer's recommendations were followed for drilling. Implant placement varied by area and position of the remaining bone. Implants in the esthetic zone were placed slightly to the palatal, especially between the maxillary right and left canines. Implants in the premolar area in the maxilla were placed to the palatal, but apically, through the remaining septum. In the mandibular premolar area implants were placed into the center of the socket. In the maxillary and mandibular molar areas implants were placed slightly to the mesial of the interradicular bone (most often utilizing a wide implant, but not necessarily in contact with the buccal and lingual plates of bone). When sinus lifts were performed, either lateral windows were opened or osteotomes were utilized to complete the implant preparation. An appropriate-length implant was placed, leaving the platform 1 to 2 mm apical to the most coronal height of the remaining crest.

Mineralized freeze dried bone allograft (FDBA) (Miami Tissue Bank, University of Miami; Miami, FL) was tightly packed into the residual spaces around

the implant. A periodontal probe was utilized to push the bone into narrow spaces. Bone grafts were utilized in all cases in which there was a residual space around the implant. A Vicryl membrane (Ethicon/Johnson & Johnson, Somerville, NJ) was custom cut, extended 5 to 7 mm beyond the margins of the defects and tucked under the flaps both labially and palatally (lingually) without suturing. The flaps were closed using chromic 4-0 gut sutures. No attempt was made to advance the flaps and cover the membrane (Figs 1a to 1g). Patients were premedicated with amoxicillin (500 mg 4 times daily; TEVA Pharmaceuticals USA, Sellersville, PA) starting 2 days prior to the procedure and continuing for 10 days postsurgery. Penicillin-sensitive patients were premedicated with clindamycin (300 mg 4 times daily; Watson Laboratories, Corona, CA) prior to surgery and continuing for 10 days. The patients utilized .12% chlorhexidine gluconate (Peridex, Vila Pharmaceutical, Phoenix, AZ) on a cotton tip to lightly clean any exposed membrane area 3 times daily until the membrane was absorbed.

Most implants were allowed to heal for 3 months in the mandible and 6 months in the maxilla prior to second-stage surgery. In most cases final restoration began within 3 weeks of second-stage surgery. Of the implants that were immediately restored with provisional restorations, the same IIP protocol was followed as to position of placement, use of graft and membrane, and flap closure.

Implant failure was recorded as "before final restoration" or "after final restoration." Whenever possible the reason for implant failure was recorded. Implant survival was checked at the abutment connection stage and at various intervals after placement of the final restoration. Implant survival was defined by the criteria proposed by Albrektsson and colleagues.[34]

Data analysis methods included chi-square analysis for the evaluation of statistical significance and logistic regression analysis for the evaluation of impact of demographic and clinical variables on implant survival. Data analysis software used was JMP 5.0.1.2 (SAS Institute, Cary, NC). The level (alpha) of statistical significance was .05.

RESULTS

Eight hundred ninety-one consecutively treated patients (381 men and 510 women) in whom immediate implant surgery was performed between January 1988 and December 31, 2004 were evaluated through the study. All patients were treated with implants made by 2 manufacturers (Nobel Biocare, Göteborg, Sweden, and Implant Innovations/3i, Palm Beach Gardens, FL). The mean patient age at the time of surgery was 57.9 years, with a range of 14 to 94 years. A total of 1,925 implants were placed in fresh extraction sockets immediately following tooth extraction. As of December 31, 2004, a total of 1,854 implants had been restored for at least 1 year. A total of 1,398 machined-surface and 527 rough-surface implants were placed. Thirteen implants in 10 patients were placed in conjunction with lateral-window sinus lifts, and 148 implants in 111 patients were placed using an osteotome internal sinus augmentation procedure. Nineteen implants in 7 patients were immediately loaded following placement. Forty-five implants in 40 patients received immediate nonocclusally loaded provisional restorations following placement. The follow-up period varied between 12 and 193 months after delivery of the final prosthesis, with a mean follow-up period of 71 months. Failure to achieve or maintain osseointegration was seen in 68 patients, some of whom experienced more than 1 failure. A total of 77 implants were lost (42 in male patients; 35 in female patients). Of these failed implants, 71 (92%) failed to achieve osseointegration and 6 (8%) failed to meet success criteria after final restorations were placed.[34] Nine patients experienced multiple failures—1 patient lost 2 implants to progressive bone loss, 3 patients lost 2 implants each to nonintegration, 4 patients lost 2 implants each to infection, and in 1 patient, 2 implants were removed because of paresthesia. The reasons for implant failure as well as the reasons for the tooth loss that precipitated the need for implant placement were documented (Table 1). The overall implant survival rate was 96.0%, with implant failure rates of 3.7% prior to restoration and 0.3% after restoration (Table 2).

Of the 1,398 machined-surface implants placed, 65 failed (4.6%). Of the 527 rough-surface implants placed, 12 failed (2.3%). There was a statistically significant difference in implant failure rate between rough- and smooth-surface implants ($P = .02$). A total of 1,602 implants were placed in nonsmokers, 1,162 with machined surfaces and 440 with rough surfaces. A statistically significant difference between the failure rates of smooth- and rough-surface (4.5% versus 1.8%) implants was documented ($P = .01$) in nonsmokers.

A total number of 323 implants were placed in patients with a self-described smoking habit. Of these, 18 failed (5.6%). Nonsmokers received a total of 1,602 implants of which 59 (3.7%) failed. The difference in implant failure rate between smokers and nonsmokers was not statistically significant ($P = .342$). There was no difference in the failure rate of rough-surface implants and that of smooth-surface implants in

Table 1 Reasons for Tooth and Implant Loss

Implant no.	Patient gender	Tooth no.	Reason for tooth loss	Reason for implant loss
1	F	23 (32)	DEC	NI-VHS
2	M	14 (26)	DEC	NI-ISL
3	F	19M	PDD	RAB: NI
4	F	28 (44)	PDD	ATI
5	F	24 (31)	PDD	ATI
6	M	19 (36)	AB-PDD	ATI
7	M	28 (44)	AB-PDD	ATI
8	F	12 (24)	DEC	ATI
9	M	29 (45)	PAP	FBG
10	M	21 (34)	PAP	I
11	M	23 (32)	PDD	I
12	M	31 (47)	PAP	I
13	M	7 (12)	PDD	I
14	M	26 (42)	PAP	I
15	F	30 (46)	PDD	I
16	F	24 (31)	PAP	I
17	F	26 (42)	PDD	I
18	F	5 (14)	PAP	I
19	M	14D (26)	PDD	I
20	M	18M (37)	RF	I
21	M	18D (37)	RF	I
22	M	28 (44)	PDD	I
23	F	24 (31)	PDD	I
24	F	26 (42)	PDD	I
25	F	21 (34)	PAP	I
26	M	12 (24)	PDD	I
27	M	20 (35)	PDD	I
28	M	30 (46)	PDD	I
29	F	20 (35)	PDD	I
30	M	21 (34)	PDD	I
31	M	25 (41)	PDD	I
32	M	12 (24)	RF	I
33	F	13 (25)	PDD	I-ISL
34	M	14 (26)	DEC	I-ISL
35	F	23 (32)	PDD	I-VHS
36	M	10 (23)	DEC	I-VHS
37	F	27 (43)	RF	I-VHS
38	M	13 (25)	RF	I-ITR
39	F	24 (31)	PDD	I-ITR
40	M	9 (21)	PDD	NI-ITR
41	F	26 (42)	PAP	NI-ITR
42	F	13 (25)	PDD	NI
43	M	7 (12)	PDD	NI
44	M	7 (12)	PAP	NI
45	M	10 (22)	PDD	NI
46	F	5 (14)	RF	NI
47	M	19M (36)	RF	NI
48	F	22 (33)	PDD	NI
49	F	23 (32)	PDD	NI
50	F	11 (23)	PAP	NI
51	M	3 (16)	AB-PDD	NI
52	M	7 (12)	PDD	NI
53	F	30 (46)	PDD	NI
54	F	11 (23)	RF	NI
55	M	30 (46)	RF	NI
56	M	19 (36)	RF	NI
57	F	7 (12)	PAP	NI
58	M	15 (27)	PDD	NI
59	M	24 (31)	PDD	NI
60	F	29 (45)	PDD	NI
61	M	4 (15)	PAP	IL-NI
62	M	14 (26)	RF	IL-NI
63	F	3M (16)	PDD	ISL-NI
64	F	13 (25)	PDD	ISL-NI
65	F	14D (26)	PDD	ISL-NI
66	M	2 (17)	PDD	ISL-NI
67	M	2 (17)	PAP	ISL-NI
68	F	14 (26)	PDD	WSL-NI
69	M	3 (16)	PDD	WSL-NI
70	F	20 (35)	PAP	P
71	M	30 (46)	RF	P
72	M	30 I (46)	P	P
73	F	11 (23)	PAP	O-O*
74	M	3 (16)	PAP	PBL-VHS
75	M	5 (14)	PAP	PBL-VHS
76	F	7 (12)	PDD	T-EP
77	M	12 (24)	PAP	TLC†

smokers ($P = .6492$). Fifty-one immediate implants were utilized to replace failed implants. Two of these failed, for a 3.9% failure rate, which was not significantly different than the failure rate in the general survey population ($P > .05$).

Of the 1,094 implants placed in women, 34 failed for a 3.1% failure rate. Forty-three of the 831 implants placed in men failed, for a 5.2% failure rate. The relative risk of implant failure in men was 1.65 times that for women ($P = .0314$, CI [1.04, 2.61]).

Two of 51 immediate implants placed to replace a failing implant failed, for a failure rate of 3.92%.

The mean age of women in this study was 57 years. The mean age of men was 59 years. This represents a statistically significant difference in age in the study population ($P < .001$) No correlation was found between implant failure and age of the patient ($P > .06$).

There was no statistically significant correlation between implant failure and any single medication or combination of medications taken by patients in this study in whom implant failure occurred ($P = .895$). A significantly greater implant failure rate was linked to the high infection rate in patients who were unable to use postsurgical penicillin due to allergy, with penicillin-allergic patients demonstrating a relative risk of 3.3 when compared to patients who were able to utilize penicillin ($P < .01$). Patients with an allergy to penicillin were 5.7 times more likely to experience implant failures due to infection than patients without allergy to penicillin (Table 3). There was no significant difference in implant failure rate associated with any medical condition of patients included in this study ($P = .967$).

A total of 383 implants were used to support single crowns. The remaining 1,471 implants were used

Table 2 Failure Rate of Implants Before and After Loading

	n	%
Total implants placed	1,925	
Total implants failed	77	4.0
Postrestoration failures	6	0.3
Failures prerestoration	71	3.7

Table 1 notes: Universal (FDI) tooth numbers shown. AB-PD = abscess periodontal disease; AB-PDD = periodontal abscess; ATI = adjacent tooth infection; D = distal; DEC = decay; FBG = failed block graft; I = infection; IL = immediate load; ISL = internal sinus lift; ITR = immediate tooth replacement; M = mesial; NI = nonintegration; O-O = occlusal overload; P = parasthesia; PAP = periapical pathology; PBL = progressive bone loss; PDD = periodontal disease; RAB = refused antibiotic; RF = root fracture; TEP = trauma–epileptic patient; TLC = trauma from a loose crown; VHS = very heavy smoker; WSL = window sinus lift.
*After 9 y.
†After 5 y.

in restorations supported by multiple implants, with 2 or more implants splinted to support the definitive prosthesis. There were no failures in the single-unit group, while 16 implant failures were seen in the splinted group. This difference was not significant ($P = .356$).

A significant difference in implant failure rate by area of implant placement was seen ($P = .001$) (Table 4). The area with the highest percentage of failures was the mandibular anterior area, while the lowest percentage of failure occurred in the maxillary canine area.

One hundred twenty-two teeth were lost because of periodontal disease, while 1,803 teeth were lost for other reasons. The difference in implant failure between implants placed at the sites of periodontally diseased teeth and those placed in nondiseased sites was statistically significant ($P = .02$). Implants placed after tooth extraction because of periodontal causes were 2.3 times more likely to fail than implants placed after tooth extraction for nonperiodontal reasons (Table 5).

Table 3 Implant Failure in Patients with Penicillin Allergy

	Number placed	Number failed	% failed
No penicillin allergy	1,561	46	2.95
Penicillin allergy	364	31	8.52
Total	1,925	77	

Table 4 Implant Failure by Location

	No. of implants	No. of failures	Failure rate (%)
Maxillary			
Molars	202	13	6.44
Premolars	427	12	2.81
Canines	145	3	2.07
Incisors	422	9	2.13
Mandibular			
Molars	261	13	4.98
Premolars	226	11	4.87
Canines	60	2	3.33
Incisors	182	14	7.69

DISCUSSION

The 96.0% survival rate of the 1,925 implants placed in the present study is similar to reports for implants placed in healed bone.[35] This study reports on restorations that were in place at least 1 year postloading, with a follow-up from 1 to 16 years, which also compares favorably with the time of follow-up in other studies. Using 2 electronic databases and having 1 individual enter all of the data minimized the possibility of undetected failures.

The current study demonstrates a statistically significant difference in favor of rough surface implants, but both surfaces demonstrated survival rates in excess of 95%. When considering implant placement in healed bone, no significant differences were seen relative to implant surface.[36] With the reported advantage of roughened surfaces being improved clot formation and increased bone-to-implant contact,[37] it is possible that these factors play a role in IIP. In addition, during the early phases of IIP, only machine-surfaced implants were used; consequently, a "learning curve" may have influenced implant failure in that study group.

Although some studies have reported decreased implant survival in smokers,[38–45] only 1 immediate implant study reported the effect of smoking and implant survival.[46] In contrast to other reports, the results in the present study show no significant difference in implant failure rate between smokers and nonsmokers. Likewise, while some studies have shown that rough-surface implants can partially compensate for the negative healing response in smokers,[46–48] the current study demonstrated no significant difference in implant failure in smokers, regardless of the type of implant surface. A number of factors may explain this lack of difference in implant failure rate in smokers compared to nonsmokers. In the present study, patients were categorized as smokers if they reported smoking more than 10 cigarettes per day. There was no calculation made of how many of these patients smoked no more than 10 cigarettes. This may be an important issue, as the findings of a meta-analysis indicated that "light smoking" (average of 12 cigarettes per day) did not affect the success rate of either machined or dual-acid-etched surface implants.[47] In the current study, absorbable membranes were placed over FDBA and were often left exposed. Although smoking has been reported to have a detrimental effect on periodontal regenerative procedures utilizing bioresorbable barriers in cases of

Table 5 Implant Failure and Etiology of Tooth Loss

	Survived		Failed		
	n	%	n	%	Total
Nonperiodontal	1,736	96.3	67	3.7	1,803
Periodontal	112	91.8	10	8.2	122
Total	1,848		77		1,925

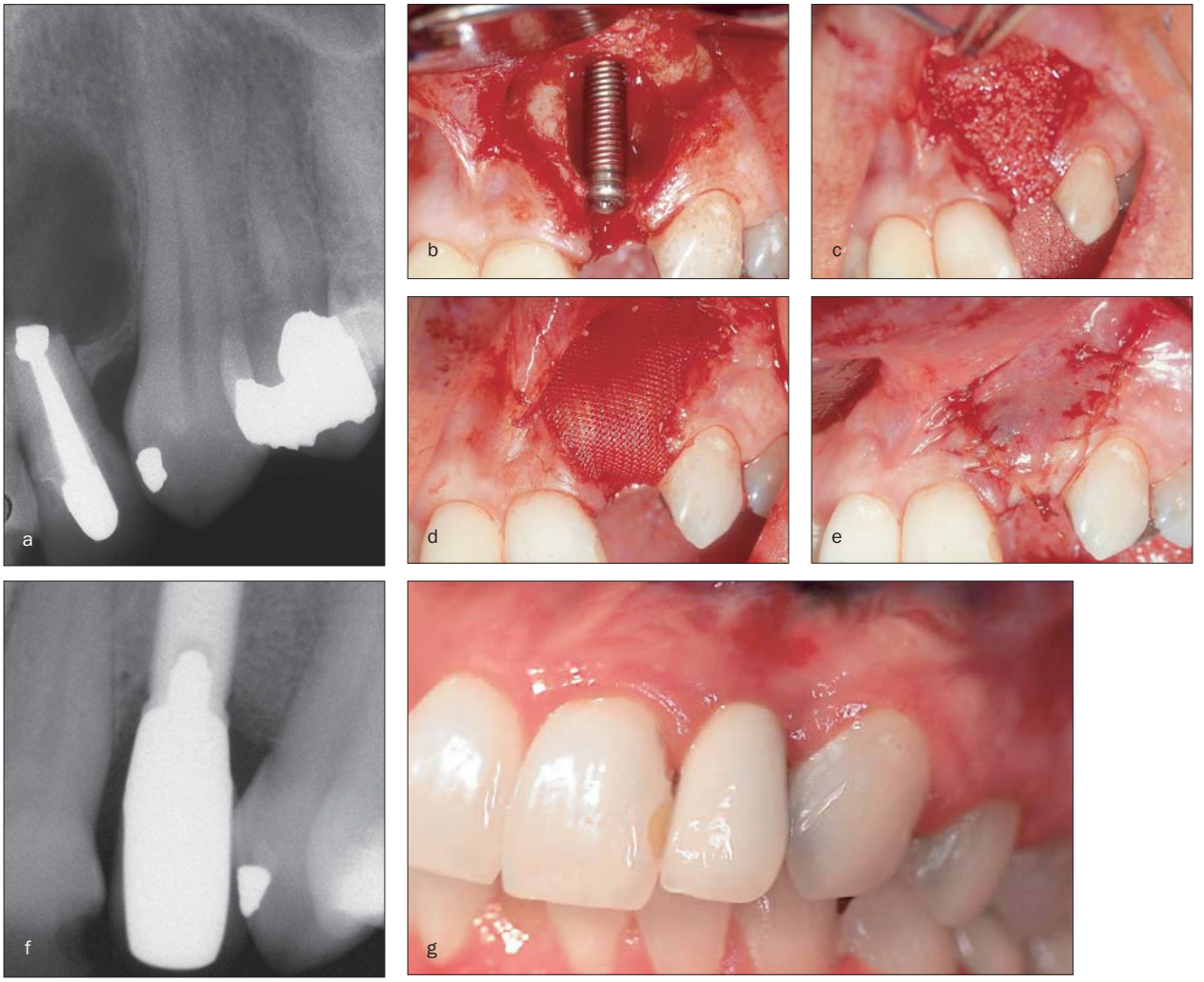

Fig 1a Radiograph of maxillary left lateral incisor with a large periapical area.
Fig 1b Clinical photograph following extraction, debridement of the socket, and placement of the immediate implant.
Fig 1c Placement of mineralized FDBA to fill the defect.
Fig 1d Placement of an absorbable membrane barrier over the graft and implant.
Fig 1e Closure with absorbable sutures.
Fig 1f Radiograph of the implant 5 years postloading.
Fig 1g Clinical photograph of the implant restoration 5 years postloading.

molar furcations, the healing process may differ following immediate implant placement as performed in the present study.[49] Oral hygiene in the current study included localized applications of chlorhexidine 3 times a day until the membrane was absorbed. This combined with the use of systemic antibiotics may have prevented the negative impact of bacterial colonization in the healing site. The fact that all patients included in this study were treated for their periodontal disease prior to or in conjunction with their implant treatment would present a population with a reduced risk for bacterial contamination from ongoing disease. The results of the present study are in agreement with previous findings that rate of implant failure was not correlated with age.[50,51]

Gender was seen as a significant risk factor for implant failure ($P = .0207$) as the relative risk for failure in men showed a 5.05% failure rate compared to a 3.2% failure rate of IIP in women. The results of the present study are in agreement with a previously published report by Schwartz-Arad and coworkers[28] of increased failure rate for IIP in men compared to women, although that study evaluated a small number of implants and showed a much higher overall failure rate than the current article.

The findings that there was no significant difference in failure rate associated with any single medication or combination of medications taken by patients who received IIP and that no medical condition was associated with a statistically significant dif-

ference in implant failure are of interest. Some have questioned the effect of osteoporosis and medications used to treat osteoporosis on implant survival.[52–55] The present study demonstrated no difference in immediate implant survival related to the taking of bisphosphonates or a reported condition of osteoporosis. In fact, only 2 of the 75 implants placed patients with a history of osteoporosis failed (n = 34). The 24 patients that were taking Fosamax (Merck, West Point, PA) experienced no implant failures.

An important part of the technique used in the present study was the use of a bioabsorbable membrane barrier over which no attempt was made to achieve primary closure. The use of penicillin as a postsurgical antibiotic with these bioabsorbable barriers may have decreased bacterial colonization, thus reducing infection postsurgery. There was a significant relationship between implant failure caused by infection and an inability to use postsurgical penicillin ($P < .001$). Dahlin[56] reported better membrane tolerance and less infection in patients able to take penicillin as opposed to 1 patient that had to be placed on erythromycin. All patients in the present study who described no penicillin allergy were prescribed amoxicillin starting 2 days prior to the procedure, and continued on the antibiotic for 10 days postsurgery. Although some controversy[57–59] exists relative to the use of postsurgical antibiotics, the protocol applied in this study used antibiotics for all patients following IIP. In the present study 30 implant failures were attributed to infection. Sixteen of the 30 patients who had implant failure due to infection were penicillin sensitive. Five additional "infection" failures were caused by infection of an adjacent tooth. Three of 5 of these patients were penicillin sensitive. It is doubtful that the difference in implant success seen in penicillin-allergic patients was caused by a biologic difference in these patients that led to a greater implant failure rate. It is more likely that penicillin is a more effective antibiotic for implant survival than the alternative antibiotics given to these patients.

In the present study, a statistically significant difference in failure rates was associated with placement in different locations in the maxilla and mandible. Failure rates were lowest in the maxillary premolars, canines, and incisors (2.81%, 2.07%, and 2.13%, respectively). Failure rates were highest in the mandibular incisor and maxillary molar areas (7.69% and 6.44%, respectively). The higher failure rates in the mandibular anterior area may be related to overheating of the bone when long implants, 15 to 18 mm, were placed (type 1). Ten of the 14 failures occurred before 2000, when longer implants were routinely used. Nine of the 14 failed implants were lost because of infection, and 2 other failures occurred because of implants that were immediately restored with nonoccluding provisional restorations.

Ten of the 13 implant failures that occurred in the maxillary molar area were due to nonintegration. Nine of these were placed into bone augmented with 2 lateral window and 7 internal sinus lift procedures. In a study by Schwartz-Arad and colleagues[27] the cumulative survival rate (CSR) of all implants in the study was 92%. The 5-year CSR was 90% in all areas of the maxilla but only 72% in the posterior maxilla.[27] In the present study the high survival rate of immediately placed implants in the maxillary anterior area may have been related to the easier access in this area for bone graft and membrane placement, along with more effective oral hygiene for the patient.

Several studies have documented high survival rates for conventionally placed implants in patients with different types of periodontal disease.[60–62] In the present study implants replacing teeth that were extracted for periodontal reasons were 2.3 times more likely to fail than implants replacing teeth extracted for nonperiodontal reasons. These results are in agreement with a previous study and demonstrate significantly lower survival of implants when placed in sites from which periodontally involved teeth were removed.[63] In patients in whom teeth were lost for periodontal reasons, the disease may have decreased the available bone following tooth extraction or resulted in the necessity to place the implant with a more exposed surface to achieve ideal prosthetic position. Both of these situations may have resulted in a greater implant failure rate. This question warrants further research.

The flap closure technique used in the present study, with no attempt at primary closure, did not compromise the location of the vestibule and preserved the keratinized tissue at the site of the implant. However, this approach was frequently associated with membranes that were exposed to the oral environment. Although other authors describe the need for primary flap closure, a literature review concluded that survival of implants was not dependent on primary closure.[21] In the present study the antimicrobial regimen may have avoided the reported detrimental effects of membrane exposure.

Considering the high clinical survival rates observed in this and other studies, the immediately placed implant should be considered a predictable protocol. The fact that the survival rate in the present study showed significant differences with regard to gender, implant location, and implant surfaces should be viewed in the context of clinical significance, as survival was high even in the higher-risk

groups. Patient selection, esthetic considerations, and inability to use penicillin, as well as the reason for tooth loss, should be considered in deciding whether or not to utilize an immediate or delayed implant approach.

CONCLUSIONS

Based upon a retrospective chart review of patients receiving 1,925 endosseous implants placed on the day of natural tooth extraction:

- Overall implant survival rate was 96%, with 71 implants failing to achieve osseointegration and 6 implants failing to maintain integration.
- Rough-surface implants survived at a significantly higher rate (97.7%) than did machined implants (95.4%) ($P = .02$).
- There was no significant difference in implant failure rate between smokers and nonsmokers ($P = .342$).
- Men were 1.65 times more likely to develop implant failures than women ($P = .0314$).
- Patients unable to take postsurgical penicillin were 3.34 times more likely to have implant failure than those who used postsurgical penicillin ($P < .001$).
- Implants placed after tooth extraction due to periodontal disease were 2.3 times more likely to experience failure than implants placed after tooth extraction unrelated to periodontal disease ($P < .001$).
- No significant change in implant failure rate was associated with any medical condition of patients included in this study.

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