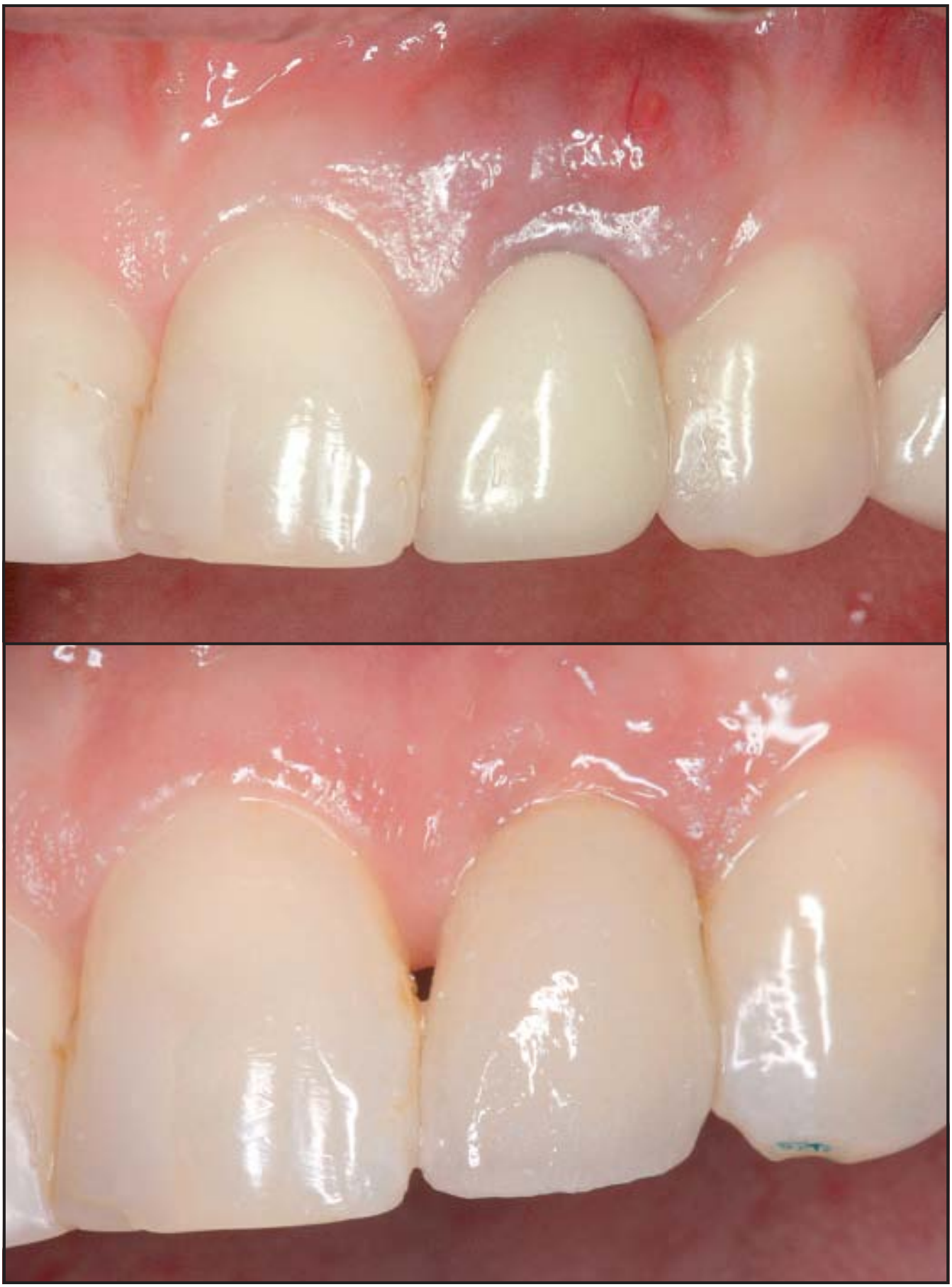
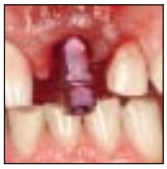


Immediate Placement and Provisionalization of Implant-Supported, Single-Tooth Restorations: A Retrospective Study



*Edgard S. El-Chaar, DDS, MS**

Immediate implant placement into extraction sockets has been widely reported in the dental literature, but few studies have evaluated immediate loading of such implants. This retrospective study evaluated 206 implants placed into fresh extraction sites using a flapless technique, followed by immediate provisionalization with nonoccluding single-tooth restorations and definitive restoration within 2 weeks. Cumulative survival and success rates were 98.77% (mean follow-up, 23.1 months). Periodontitis did not influence the outcome adversely. Within the limitations of this study, immediate implant placement and restoration, followed by definitive loading within 2 weeks, achieved outcomes comparable to those historically reported for delayed implants. (Int J Periodontics Restorative Dent 2011;31:409–419.)

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After tooth extraction, vertical and horizontal compromise of the surrounding alveolar bone is rapid, conspicuous, and inevitable (Table 1).[1] On average, an estimated 23% of bone mass is lost within the first 6 months following extraction,[2] and another 11% is lost within the next 2 years. In both arches, the buccal plates tend to exhibit greater resorption than their corresponding lingual or palatal plates, which shifts the center of the edentulous ridge inward and reduces the total length of the arches.[1] Resorption also tends to be greater in the molar area than in the incisor and premolar regions[1] and in periodontal biotypes that are thin and scalloped as opposed to thick and flat.[2,3]

Attempts to ameliorate or prevent postextraction alveolar bone changes have included socket augmentation using various graft materials, immediate implant placement into fresh extraction sockets, or a combination of both procedures.[4] Nevins et al[5] compared buccal plate resorption in grafted and ungrafted anterior maxillary sockets following the extraction of teeth

Table 1 **Mean ridge resorption (mm) after tooth extraction reported[1] in the dental literature***

	Buccal surface	Lingual/palatal surface	Difference
Mandible			
Central incisor	2.08	0.91	1.17
Lateral incisor	3.54	1.41	2.13
Canine	3.25	1.59	1.66
First premolar	3.45	1.40	2.05
Second premolar	3.28	0.75	2.53
First molar	4.69	2.79	1.90
Second molar	4.30	3.00	1.30
Maxilla			
Central incisor	3.03	1.46	1.57
Lateral incisor	3.47	0.86	2.61
Canine	3.33	1.91	1.42
First premolar	3.33	2.04	1.29
Second premolar	2.58	1.62	0.96
First molar	5.25	3.12	2.13
Second molar	4.10	2.93	1.07

*Based on measurements of 6 to 13 plaster human jaw casts per site.

with prominent roots. Buccal plate resorption was generally less than 20% in grafted sockets and greater than 20% in ungrafted sites.[5] Clinical interest in immediate implant placement with or without simultaneous grafting has also been spurred by the desires of some clinicians to shorten implant treatment time.[6]

Some clinicians have reported that immediate implant placement into fresh extraction sockets may help to limit or avoid postextraction resorption,[7,8] preserve the scalloped soft tissue architecture,[6,9,10] and provide an optimal prosthetic and esthetic result.[6,10] Several short-[11] and long-term[12,13] studies have also suggested the ability of immediately placed implants to achieve survival rates comparable to those generally reported for implants placed conventionally into healed edentulous sites (ie, ≥ 90%).[14]

In contrast to these findings, however, other researchers have documented that outcomes for immediate implant placement can be adversely affected by a variety of variables. In a canine model, Araújo et al[15] reported that implant placement into a fresh extraction site failed to prevent remodeling of the socket walls, and marked dimensional alterations of the ridge became evident after 3 months of healing. Vertical bone loss was also more pronounced at the buccal than at the lingual aspect of the ridge.[15] The authors cautioned that the socket wall resorption that routinely occurs after tooth removal must be considered in conjunction with implant placement in fresh extraction sockets.[15] The same researchers[16] later reported that bone-to-implant contact established during the early phase of postimplantation socket healing in dogs was partially lost from continued resorption of the buccal plate.

Buccal plate thickness can also directly influence the ability of the buccal plate to withstand resorption after implantation,[17] especially in the anterior maxilla where prominent tooth roots may be present[5] and in posterior locations[1] where multiple tooth roots may limit the presence of available bone. These findings, coupled with a present dearth of published long-term clinical data on immediate implant placement to adequately support evidence-based treatment planning, have led some clinicians to call for more long-term prospective data before definitive conclusions can be drawn on the efficacy of immediate implant placement.[18]

Published data on the immediate loading of single-tooth restorations tend to be short-term, but with generally favorable implant success rates. One study[12] found no statistically significant differences between single-tooth restorations subjected to immediate or delayed loading. Another long-term prospective study[9] reported a 99% implant success rate with no measurable crestal bone loss after 5 years of function for 100 tapered, multithreaded implants with fully occluding single-tooth restorations.

This article reports on the outcome of a retrospective, private practice study undertaken to determine the clinical efficacy of immediate implant placement and nonoccluding provisionalization of single-tooth implants placed into fresh extraction sockets, followed by definitive, full occlusal loading within 2 weeks after placement.

Method and materials

The present study was a nonrandomized, uncontrolled, retrospective clinical evaluation conducted in the author's single private practice setting. Patient charts were reviewed and sorted to identify all patients who presented with untreatable caries lesions, endodontic treatment failure, periodontitis, or other factors that rendered a hopeless prognosis for at least one tooth bounded mesially and distally by an intact, healthy dentition and was scheduled for extraction and immediate replacement with an implant. The study hypothesis was that implants placed immediately into fresh extraction sockets and loaded with nonoccluding, provisional, single-tooth restorations followed by definitive restoration within 2 weeks would achieve implant survival rates of at least 95% after 36 months of loading, which is comparable to implants placed in healed edentulous sites and subjected to delayed loading with single-tooth restorations after clinical confirmation of osseointegration.[13] An alternate hypothesis was that failure rates would be slightly higher for immediately loaded implants placed into fresh extraction sockets, but that implant survival would not be less than 90% after 36 months of loading.

All previously treated patients had been subjected to a preliminary evaluation that included careful review of their medical and dental histories, detailed clinical and radiographic examinations, evaluation of oral hygiene, and ability to commit to a long-term treatment plan. Those patients who met the general inclusion criteria for implant treatment (Table 2) and who were deemed by the clinician as acceptable treatment candidates were scheduled for surgery after informed consent was obtained (Figs 1 and 2).

Reviewing of the patients' charts indicated that a diagnostic work-up was performed for each patient to evaluate the volume and location of available bone and the esthetic

Table 2 Patient selection criteria for implant treatment

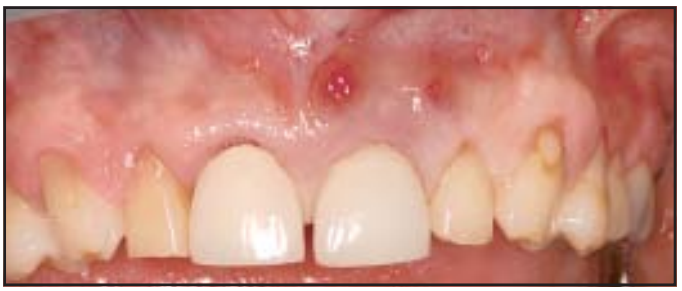
Inclusion
Systemically healthy
Nonsmoker
No significant bone loss at either extraction site(s) or adjacent teeth
At least 10 mm of bone ridge height
At least 3 to 4 mm of bone above apex of the extracted root
Good primary implant stability at placement, as determined tactilely
Absence of parafunctional habits
Absence of active periodontal disease
Exclusion
Presence of fenestrations or dehiscences on buccal plate of extraction socket
Presence of an interfacial gap greater than 2 mm between the implant surface and the wall of the socket that required grafting
Presence of chronic systemic diseases or uncontrolled conditions that could adversely affect implant treatment
Inadequate bone volume
Inability to maintain commitment to implant treatment and maintenance
Inability or unwillingness to provide informed consent

and functional needs of the case. Radiographic examinations included periapical radiographs and, if necessary, computed tomography scanning. Study casts were fabricated and mounted on semiadjustable articulators using a face bow transfer and vertical registration to determine interarch relationships, available occlusal dimensions, proposed implant positions, crown-to-root ratios, and potential complications. This allowed creation of prosthetic wax-ups and fabrication of surgical templates to guide placement of the implants relative to the planned prostheses.

Patients were prescribed antibiotic prophylaxis (500 mg amoxicillin) 1 hour prior to surgery and one tab three times daily for 1 week following surgery. Chlorhexidine gluconate 0.2% mouthrinses were also prescribed 2 minutes before surgery and twice daily for 1 week postoperative. For the first 24 hours after surgery, patients were prescribed acetaminophen and hydrocodone (500 mg Vicodin, Abbott Laboratories) as analgesics, and they were placed on diflunisal (500 mg Dolobid, Merck & Co), a nonsteroidal anti-inflammatory medication, twice daily to help control swelling.

An intrasulcular incision and circular fibrotomy were performed, and the tooth was evulsed with minimal trauma to the alveolar bone (Figs 1a, 1b, 2a, and 2b). The residual alveolar socket was thoroughly debrided to remove the periodontal ligament and all necrotic material, and the site was irrigated with a sterile saline solution (Fig 1c). Careful examination of the socket was performed to determine if the bony anatomy was sufficiently intact to proceed with the drilling sequence.

Fig 1a (right) *Baseline clinical view of the maxillary left central incisor. The patient presented with a fistula on the buccal aspect resulting from root fracture.*



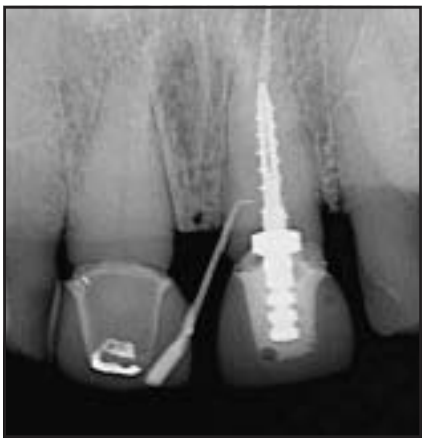
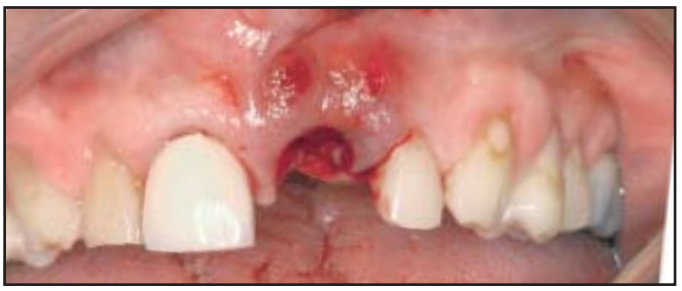


Fig 1b (left) *Preoperative radiograph showing the sinus tract leading to the post.*

Fig 1c (below) *The tooth was extracted atraumatically without flap reflection.*



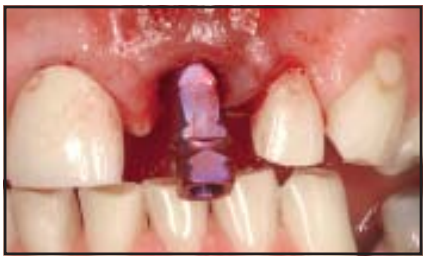


Fig 1d *Implant in place with mount still attached.*

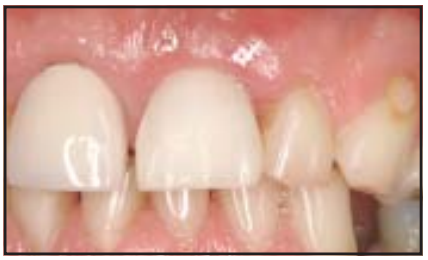


Fig 1e *Provisional prosthesis delivered immediately after implant placement.*

Fig 1g (right) *Radiograph 3 years after delivery of the definitive prosthesis.*

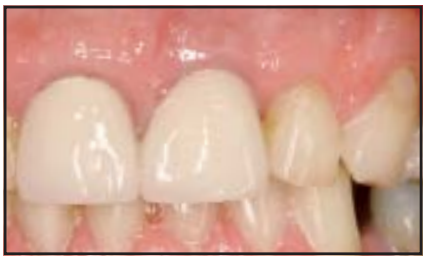


Fig 1f *Facial view of the definitive prosthesis.*

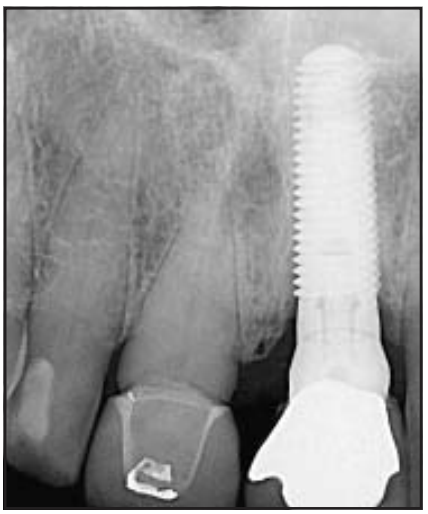


Fig 2a *The patient presented with an abscess on the facial aspect of the maxillary left lateral incisor.*

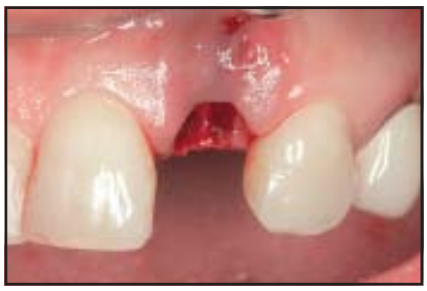


Fig 2b *The tooth was extracted carefully without flap reflection.*

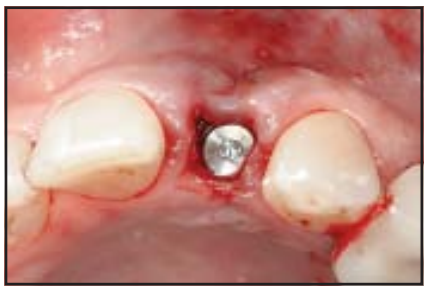


Fig 2c *An implant was placed, and the surgical cover screw was attached.*

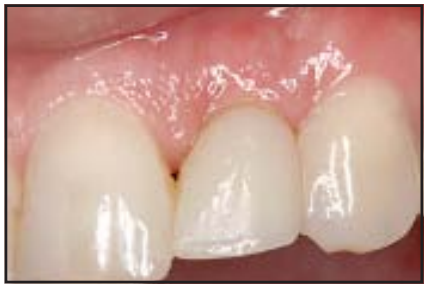


Fig 2d (left) *Provisional prosthesis in place immediately following implant placement.*

Fig 2e (right) *Definitive prosthesis 1 year after placement.*

An osteotomy was prepared toward the lingual aspect of the extraction socket via sequential cutting with graduated drills under copious irrigation according to the manufacturer's protocol. Tapered, multithreaded implants with microtextured surfaces (Tapered Screw-Vent with MTX surface, Zimmer) were placed into the prepared sites (Fig 2c) according to the system's protocol. Specific implant lengths and diameters were selected according to the individual needs of the patient. During placement, the cervical collar of the implant was positioned 1 mm apical to the crestal buccal margin. Primary stability was achieved if the implant resisted rotation and rocking under applied manual manipulation. If an implant did not achieve primary stability, the protocol stipulated that the patient would be withdrawn from the study and treated via a traditional two-stage surgical procedure.

A provisional abutment (Hex-Lock Plastic Temporary Abutment, Zimmer) and crown were prepared and delivered to the patient (Figs 1d, 1e, and 2d). Adjustments were made to ensure that the crown was out of intercuspal occlusion with the opposing arch and without contact in eccentric movement. To help maintain papillary integrity and preserve the existing vascular network, no sutures were placed.

Patients were seen at 1 week postoperative for a final impression. Approximately 1 week later, the implant was definitively restored with a custom, noble alloy abutment and cemented porcelain-fused-to-metal crown (Figs 1f, 1g, and 2e). Patients were seen 1 month after definitive restoration (6 weeks postoperative), and then were placed on a 3-month maintenance program. At all monitoring appointments, soft tissue status, occlusion, and Plaque Index scores were evaluated and recorded. Radiographic monitoring, using a standardized technique

Table 3 Criteria for Implant Success and Failure

Success
Absence of clinical mobility when tested via manual torquing and percussion
Absence of peri-implant radiolucency on periapical radiographs
Absence of pain and irresolvable clinical symptoms
Absence of mechanical complications (eg, screw loosening)
Functions according to its prosthodontic purpose
Meets the clinical needs and esthetic desires of the patient
Failure
Implant mobility
Peri-implant radiolucency on periapical radiographs
Irresolvable pain or clinical symptoms
Failure to meet the prosthodontic needs of the patient
Esthetically compromised
Repeated mechanical complications (eg, screw loosening)

(Rinn, Dentsply), was performed immediately after implant placement and postoperatively at 3 weeks, 2 months, 5 months, and then on a yearly basis.

All analyses were performed using SAS for Windows (version 9.1, SAS Institute). Demographic and operative factors for patients undergoing tooth replacement were summarized at the implant level via descriptive statistics. Continuous variables were summarized using descriptive statistics and the univariate procedure in the SAS program. Categoric variables were summarized as frequencies and percentages using the frequency procedure in SAS. Time to implant failure was summarized in months from implant placement to device failure using the lifetest procedure in SAS. The Kaplan-Meier method was used to generate estimates of implant survival rate over the first 3 years postoperative.

Results

Implant success and survival criteria, patient demographics and treatment data are summarized in Tables 3, 4, and 5, respectively. A total of 96 patients (53 women, 43 men) ranging in age from 25 to 82 years (mean, 57.3 years) were treated with 206 implants and monitored for a mean follow-up period of 23.1 months (range, 5 to 48 months; mode, 24 months).

Of the 206 implants identified during chart review, 40 implants were censured from analysis because of incomplete data: 8 implants did not have adequate data about their dimensions, and 32 patients were lost to follow-up because of moving or other factors. All 40 of the censured implants were, however, fully functioning without complications at the last clinical monitoring appointment and, thus, exhibited survival and success rates of 100%, despite

Table 4 Distribution of patients treated

Variables	No.	% of all implants placed
Sex		
Female	53	55.21
Male	43	44.79
History of periodontitis		
Periodontitis	182	88.35
No periodontitis	24	11.65
Other health-related variables		
Artificial joints	4	1.98
Breast cancer	2	0.99
Cancer	4	1.98
Cancer, heart disease, thyroid	1	0.50
Controlled diabetes	25	12.38
Diabetes, glaucoma, artificial joints	2	0.99
Heart murmur	4	1.98
Hypertension	9	4.46
Hypertension and heart murmur	6	2.97
Noncontributory	114	56.44
None	17	8.25
Smoker	16	7.92
Ulcers	2	0.99
Cause of tooth loss		
Caries	6	2.91
Deciduous tooth replacement	2	0.97
Deep caries	2	0.97
Endodontic pathology	10	4.85
Replacement of non–study-related implant	1	0.49
Root fracture with periodontitis	14	6.80
Periodontitis	95	46.12
Root fracture	69	33.50
Root resorption	7	3.40

Table 5 Distribution of 206 Implants Placed

Variable	No.	% total
Implant dimensions (mm)		
3.7 × 8.0	2	1.14
3.7 × 10.0	13	7.43
3.7 × 11.5	24	13.71
3.7 × 13.0	51	11.43
4.7 × 8.0	2	1.14
4.7 × 10.0	16	9.14
4.7 × 11.5	26	14.86
4.7 × 13	46	26.29
4.7 × 16.0	26	14.86
Arch		
Maxilla	175	84.95
Mandible	31	15.05
Tooth location		
Central incisor	46	22.33
Lateral incisor	34	16.50
Canine	18	8.74
First premolar	45	21.84
Second premolar	43	20.87
First molar	15	7.28
Second molar	5	2.43
Bone graft used		
No	138	66.99
Yes	68	33.01

their exclusion from the study data. Of the 166 implants that continued in the study, 4 implants were withdrawn because they were immediately removed at the time of surgery for lack of initial stability and immediately replaced with wider diameter implants. Among the 162 remaining implants in the study, 2 implants failed to osseointegrate and were recorded as failures. The implants were removed and the sites were grafted. After bone healing, new implants were successfully placed and restored. The remaining 160 implants remained stable and functioning with no discernible radiographic changes in bone levels on follow-up visits. Cumulative success and survival rates were both 98.77% (160 of 162), which surpassed the reported 95% survival rate for implants placed into healed sites and restored with single-tooth restorations according to a conventional delayed loading protocol.[13]

The original study objective was to estimate the implant survival curve using clinical follow-up as the time variable in the survival analysis. In this type of analysis, the value of the time variable should be either the event time/failure time or censored time. Thus, for surviving implants, their last follow-up time was treated as censored time (the time at which follow-up was stopped without a failure event). Because 99% of the data amounted to censored time, it was not possible to calculate the median survival estimate and its confidence interval. Therefore, applying the survival analysis to this data set was not deemed useful.

Periodontitis was the most common cause of tooth replacement in study subjects (46%), and most subjects had underlying (moderate to advanced) periodontitis (70%) at the time of surgery. It is important to note, however, that periodontitis and other co-morbid conditions did not appear to influence implant survival or success. Implants were more frequently placed in women (55.21%) as compared to men (44.79%). Of co-morbid conditions at the time of implant placement, co-morbidities classified as "noncontributory" were most common and accompanied 56% of implants. More than 10% of implants (12.4%) were placed in patients having a co-morbid condition of diabetes mellitus at the time of surgery.

Premolar (43%) and incisor (39%) replacements were the most common restorations, while the replacement of molars (10%) and canines (9%) was less common. One single-tooth restoration per patient was most common (97%), and implant placement in the maxilla (84.95%) was more common than in the mandible (15.05%). Implant placement did not exhibit a prevalent anatomical side (49.5% left, 50.5% right). The use of bone graft during implantation was uncommon and accompanied in 33.01% of implants. Implants were mostly large diameter (66%, 4.7 mm) with a length of 13 mm or greater (52.6%) as compared to smaller-diameter (34%, 3.7 mm) and shorter (47.4%) implants.

Discussion

As a retrospective analysis, the present study lacks the random allocation of patients into treatment and control groups, and thereby represents a low level of clinical significance. However, studies such as this often represent the first line of clinical evidence, which underscores its clinical value. Based on the lack of comparable research in the literature, it is reasonable to consider the present technique of immediately placing and loading implant-supported, single-tooth restorations as relatively new, which thereby harbors an inherently higher risk of failure. Prospective, randomized, and controlled clinical studies are needed to establish that the clinical efficacy of the present procedure is comparable to the placement and restoration of dental implants using the conventional two-stage technique.

Conclusion

Implants immediately placed into fresh extraction sites, provisionalized with nonoccluding prostheses, and definitively restored within 2 weeks with single-tooth restorations achieved survival and success outcomes of 98.77%, which are equivalent to reported outcomes for implant-supported, single-tooth restorations subjected to a conventional delayed loading protocol. Periodontitis and other co-morbid conditions did not influence the outcomes.

Acknowledgments

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