Immediate Placement and Provisionalization of Maxillary Anterior Single Implants: 1-Year Prospective Study

Joseph Y. K. Kan, DDS, MS[1]/Kitichai Rungcharassaeng, DDS, MS[2]/Jaime Lozada, DDS[3]

Purpose: *This 1-year prospective study evaluated the implant success rate, peri-implant tissue response, and esthetic outcome of immediately placed and provisionalized maxillary anterior single implants.* ***Materials and Methods:*** *Thirty-five patients (8 men, 27 women) with a mean age of 36.5 years (range 18 to 65) were included in this study. Thirty-five threaded, hydroxyapatite-coated implants were placed and provisionalized immediately after each failing tooth had been removed. The definitive restoration was placed 6 months later. The patients were evaluated clinically and radiographically at implant placement and at 3, 6, and 12 months after implant placement.* ***Results:*** *At 12 months, all implants remained osseointegrated. The mean marginal bone change from the time of implant placement to 12 months was −0.26 ± 0.40 mm mesially and −0.22 ± 0.28 mm distally. No significant differences in the Plaque Index scores were noted at different time intervals. The mean midfacial gingival level and mesial and distal papilla level changes from pretreatment to 12 months were −0.55 ± 0.53 mm, −0.53 ± 0.39 mm, and −0.39 ± 0.40 mm, respectively. All patients were very satisfied with the esthetic outcome and none had noticed any changes at the gingival level.* ***Discussion:*** *Although marginal bone and gingival level changes were statistically significant from pretreatment to 12 months of follow-up, they were well within clinical expectations.* ***Conclusion:*** *The results of this study suggest that favorable implant success rates, peri-implant tissue responses, and esthetic outcomes can be achieved with immediately placed and provisionalized maxillary anterior single implants.* (INT J ORAL MAXILLOFAC IMPLANTS 2003;18:31–39)

Key words: *dental implantation, gingival esthetics, gingival recession, immediate dental implant loading, immediate dental implant placement, single-tooth replacement, temporary dental restoration*

The impending loss of a single tooth in the esthetic zone in a patient with an otherwise healthy periodontium can be a distressing experience.[1] Although single-implant tooth replacements have been documented with success,[2–6] traditional guidelines have suggested that 2 to 3 months of alveolar ridge remodeling following tooth removal and an additional 6 months of load-free healing are needed for implant osseointegration.[7,8] This extended treatment period and the need for a removable prosthesis during the healing phase may be inconvenient to certain patients. Furthermore, osseous and/or gingival tissue loss following tooth removal and implant surgical treatment may compromise esthetics and present additional challenges.[9]

Recent preliminary studies have reported high success rates following the provisional restoration of a single endosseous implant placed immediately following tooth extraction in the maxillary anterior area.[1,10,11] Besides eliminating the need for a provisional removable denture, this technique has also demonstrated the potential for preserving the existing osseous and gingival architecture.[1] The purpose of the present study was to evaluate the success rate,

[1]Associate Professor, Department of Restorative Dentistry, Loma Linda University School of Dentistry, Loma Linda, California.
[2]Assistant Professor, Department of Restorative Dentistry, Loma Linda University School of Dentistry, Loma Linda, California.
[3]Director and Professor, Advanced Education in Implant Dentistry, Loma Linda University School of Dentistry, Loma Linda, California.

Reprint requests: Dr Joseph Kan, Department of Restorative Dentistry, Loma Linda University School of Dentistry, Loma Linda, CA 92354. Fax: +909-558-4803. E-mail: jkan@sd.llu.edu

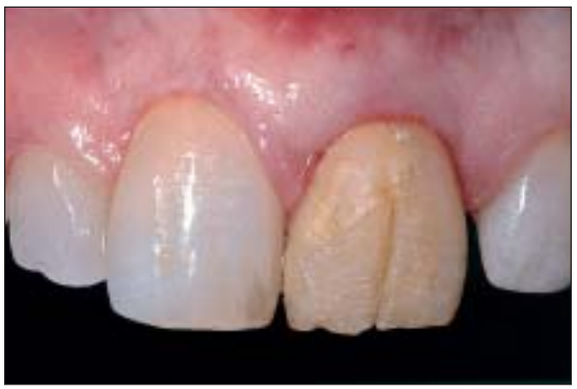

Fig 1a Preoperative labial view of the failing maxillary left central incisor.

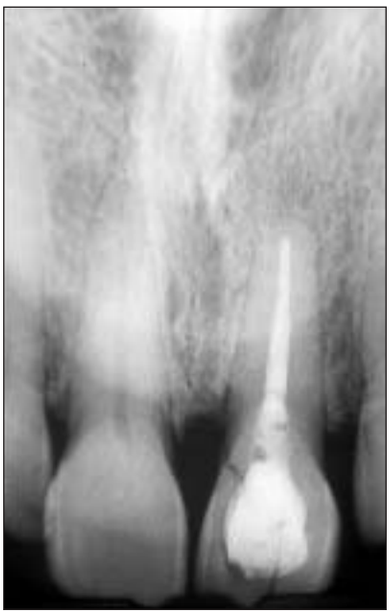

Fig 1b *(Right)* Preoperative periapical radiograph of the failing maxillary left central incisor.

peri-implant tissue response, and esthetic outcome 1 year after immediate placement and provisionalization of single implants in the anterior maxilla.

MATERIALS AND METHODS

Patient Selection

This study was approved by the Institutional Review Board of Loma Linda University and was conducted in the Center for Prosthodontics and Implant Dentistry, Loma Linda University School of Dentistry, California. The patients were selected according to specific inclusion and exclusion criteria.

Inclusion criteria were as follows:

1. Age 18 years or older
2. Presence of a single failing maxillary anterior tooth (canine or incisor) by trauma, caries, root resorption, or endodontic or periodontal failure, and with the presence of adjacent dentition (Figs 1a and 1b)
3. Presence of adequate and harmonious gingival architecture with the surrounding dentition
4. Appropriate marginal gingiva to underlying bone dimension[12] at the facial aspect (about 3 mm) of the failing tooth and interproximal aspect (about 4 to 6 mm) of the immediate adjacent teeth, as ascertained by the bone sounding technique[13,14]
5. Good oral hygiene
6. Adequate bone volume to accommodate an implant with the minimum dimension of 3.5×13.0 mm without the necessity of bone grafting

Exclusion criteria were as follows:

1. Presence of active infection around the failing tooth
2. A medical history that would complicate the outcome of the study, such as alcohol or drug dependency, history of smoking, poor health, or any other medical, physical, or psychologic reason that might affect the surgical procedure or the subsequent prosthodontic treatment and required follow-ups
3. Dental history of bruxism, parafunctional habit, and/or lack of stable posterior occlusion
4. Perforation and/or loss of labial bony plate following tooth removal and/or implant osteotomy
5. Inability to achieve primary implant stability following immediate implant placement

Clinical Procedures

All patients received the standard treatment planning and diagnostic workup and consented to the treatment. The clinical technique used in this study has been previously published.[1] An acrylic resin provisional shell (Jet, Lang Dental, Wheeling, IL) of the to-be-extracted tooth was fabricated prior to implant surgery. The surgical phase involved atraumatic tooth extraction without flap reflection (Fig 2) and immediate implant placement (Replace, Nobel Biocare, Yorba Linda, CA) if the labial bony plate was intact (Fig 3). Furthermore, primary implant stability was confirmed prior to the immediate provisionalization procedure.

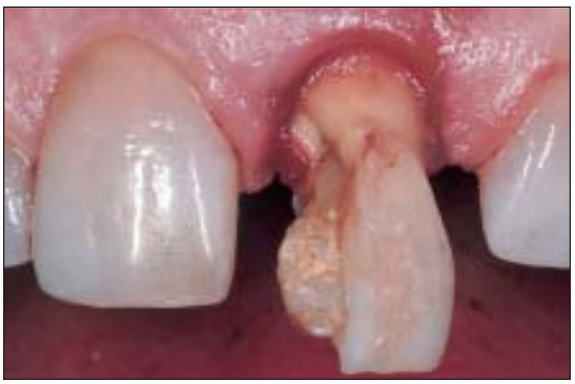

Fig 2 Atraumatic tooth extraction without flap reflection resulted in the well-preserved bone and soft tissue architecture.

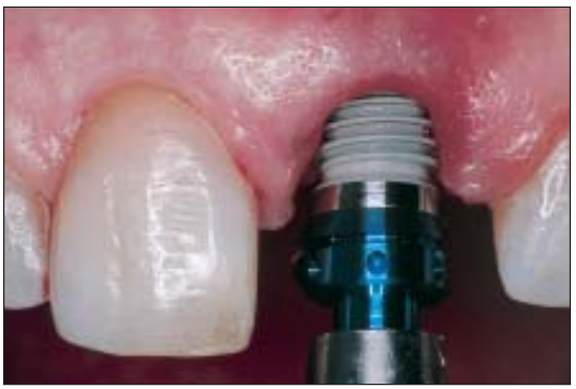

Fig 3 A 5 × 16 mm HA-coated threaded implant (Replace, Nobel Biocare) was inserted to the desired depth after sequential osteotomy.

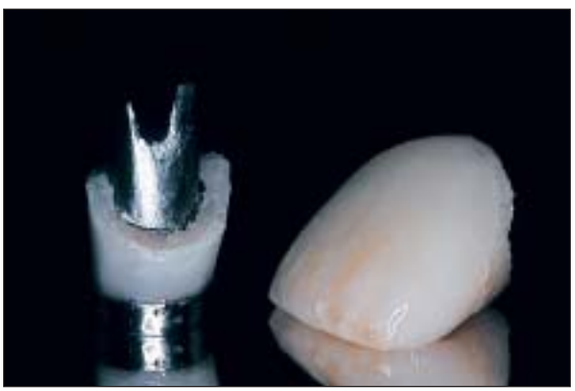

Fig 4a Customized temporary abutment and its corresponding provisional restoration. Autopolymerizing acrylic resin (Jet, Lang Dental) was applied to the temporary abutment (Replace, Nobel Biocare) to capture the cervical gingival emergence of the extracted tooth.

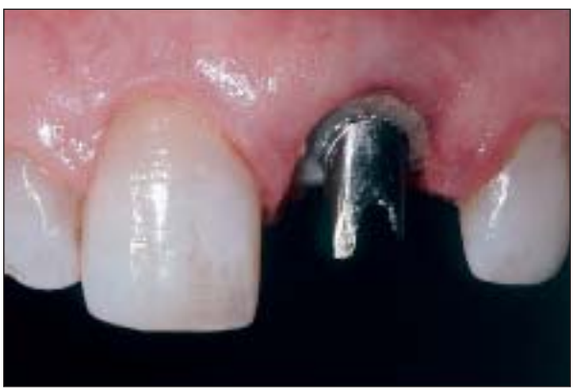

Fig 4b The customized temporary abutment (Replace, Nobel Biocare) was hand-tightened onto the immediately placed implant (Replace, Nobel Biocare).

The metal temporary abutment (Replace, Nobel Biocare) was placed onto the implant, and autopolymerizing acrylic resin (Jet, Lang Dental) was applied to the temporary abutment to capture the cervical gingival emergence of the extracted tooth (Fig 4a). The customized metal temporary abutment was then prepared extraorally and hand tightened onto the implant, and the relined provisional shell was provisionally cemented (Temp-Bond, Kerr USA, Romulus, MI) (Figs 4b and 4c). The provisional restoration was adjusted to clear all contacts in centric occlusion and during eccentric movements.

Appropriate antibiotic (amoxicillin 500 mg, 4 times daily) and analgesic (ibuprofen 800 mg, every 4 to 6 hours as needed for pain) were prescribed. Patients were instructed not to brush the surgical site, but rather to rinse with 0.12% chlorhexidine gluconate (Peridex, Procter & Gamble, Cincinnati,

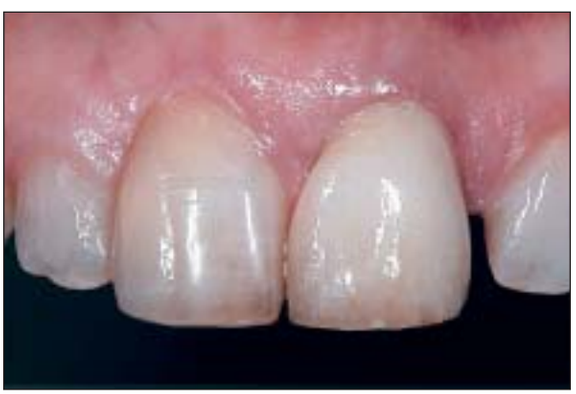

Fig 4c Labial view of the relined provisional restoration 3 days after the implant surgery. Note the preservation of the tissue architecture and minimal trauma to the surrounding tissue.

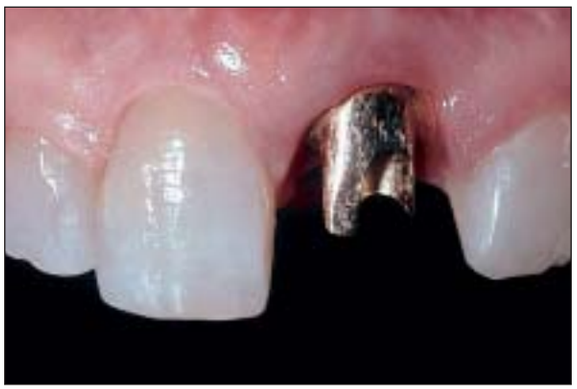

Fig 5a The definitive customized abutment with corresponding gingival emergence was tightened to 35 Ncm torque.

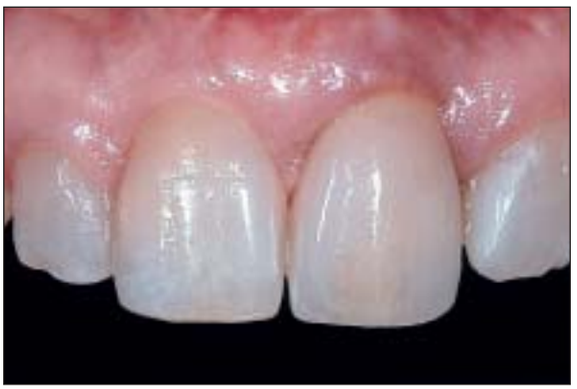

Fig 5b Labial view of the definitive implant restoration after 1 year of function.

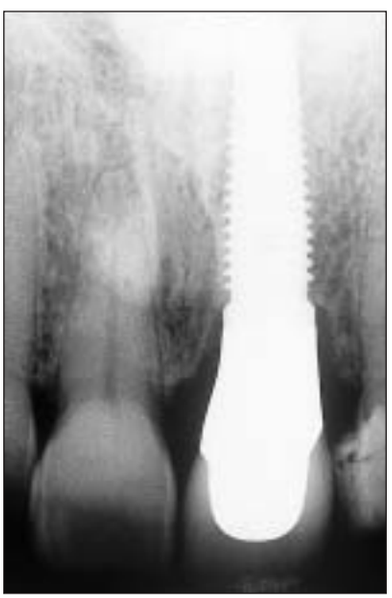

Fig 5c Periapical radiograph 1 year after the implant surgery.

OH); patients also remained on a liquid diet for 2 weeks. A soft diet was recommended for the remaining duration of the implant healing phase (5 months). Patients were advised against functioning or activities that involved the surgical site.

The final implant impression was made after 5 months using high-viscosity vinyl polysiloxane (Aquasil, Dentsply/Caulk, Milford, DE). A definitive customized abutment with gingival emergence established by the provisional restoration was fabricated using the Hexed Direct Abutment (Gold Alloy/Plastic, Replace, Nobel Biocare) and cast in Type IV gold (Monogram IV, Leach & Dillion, San Diego, CA). The finished abutment was torqued to 35 Ncm (manufacturer's recommendation, Nobel Biocare) and the definitive metal-ceramic restoration (Creation, Jensen, CT) was cemented (ImProv, Nobel Biocare) (Figs 5a to 5c).

Data Collection

All examinations and data collection were performed by 1 examiner. Evaluations were made at implant placement and provisionalization; and at 3, 6, and 12 months after implant placement. The following variables were recorded: implant success/failure,[15] marginal bone level,[16] modified Plaque Index,[17] midfacial gingival level, papilla level, and related complications. For statistical purposes, only 1 implant per patient was evaluated. For patients in whom more than 1 implant had been placed in the esthetic zone (canine–canine), the implant closest to the midline was selected.

Implant Failure. The implants were evaluated according to the success criteria of Smith and Zarb.[15] The implants were considered a failure with the presence of significant marginal bone loss, periimplant radiolucency, mobility, pain, discomfort, and/or neurosensory alteration.

Marginal Bone Change. Marginal bone change was measured using sequential periapical radiographs and the long-cone paralleling technique[18] with a commercial Rinn XCP holder (XCP post bite blocks 54-0862, Dentsply, Elgin, IL). A vinyl polysiloxane (Exabite, GC America, Alsip, IL) occlusal jig was used to standardize the angulation and position of the film to the x-ray beam. Marginal bone levels on the mesial and distal aspects of the implants at each time interval were measured at 10× magnification to the nearest 1 mm, using the apical corner of the implant shoulder as the reference point, and the changes were then calculated (Fig 6).[16]

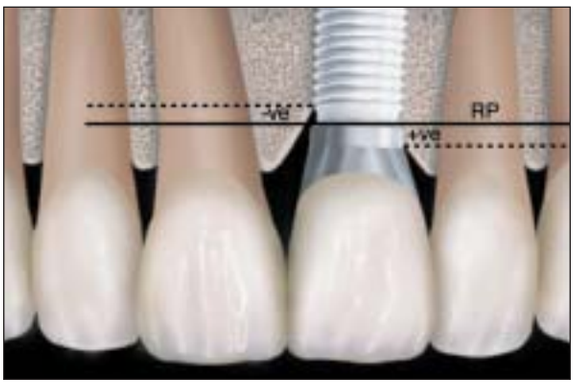

Fig 6 Measurement of marginal bone change. The reference point (RP) is the apical corner of the implant shoulder. A positive value (+ve) is denoted when implant-bone contact is more coronal to the reference point and a negative value (−ve) is denoted when implant-bone contact is more apical to the reference point.

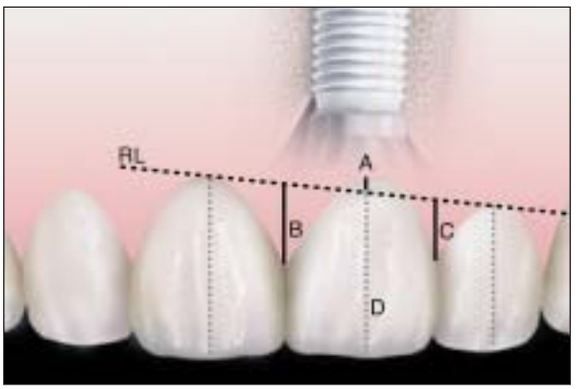

Fig 7 Measurement of gingival level changes. The reference line (RL) is the line connecting the midfacial gingival level (FGL) of the 2 adjacent teeth. The changes in the FGL of the implant restoration were evaluated by measuring its distance from the reference line (A) at each time interval. The changes in the mesial papilla level (B) and the distal papilla level (C) were measured as the distance from the tip of the papilla to the reference line as parallel to the line bisecting the implant restoration (D).

Modified Plaque Index. Presence of plaque was assessed at the labial, mesiolabial, distolabial, lingual, mesiolingual, and distolingual of the implant restoration according to the Modified Plaque Index proposed by Mombelli and coworkers[17] (0 = no plaque, 1 = plaque recognized only by running a probe across the marginal surface of the implant restoration, 2 = plaque visible to the naked eye, 3 = abundance of soft matter). For each individual restoration, only the highest score was used for statistical analysis.

Gingival Architecture Change. The midfacial gingival level (FGL), mesial (MPL), and distal papilla levels (DPL) were recorded using 35-mm slides taken at 1:1 magnification at a right angle to the tooth before extraction (pretreatment), at the time of implant and provisional placement (0 months), 3 months later, at the placement of the definitive restoration (6 months), and at the 12-month recall appointment. The measurements were made at 10× magnification to the nearest 1 mm.

The line connecting the FGL of the 2 adjacent teeth was used as the reference line (Fig 7). The changes in the FGL of the implant restoration were evaluated by measuring its distance from the reference line at each time interval. The changes in the MPL and the DPL were measured as the distance from the tip of the papilla to the reference line as parallel to the line bisecting the implant restoration at each time interval (Fig 7).

Patient's Esthetic Satisfaction. At the 12-month recall examination, the patients were asked the following questions:

1. On a scale of 0 to 10, where 0 is totally unsatisfied and 10 is totally satisfied, how would you rate your satisfaction with the esthetic outcome of your treatment?
2. Have you noticed any changes in the gum level around the implant single crown?

The questions were administered to the patients by staff who were not involved in the patient treatment.

Complications. Complications were also recorded and included soft tissue complications, significant bone loss, peri-implant radiolucency, and prosthodontic complications.

Data Analysis

Means and standard deviations were calculated for each clinical parameter at each time interval where applicable. Data were analyzed using Wilcoxon signed-rank test and repeated-measures 1-way analysis of variance (ANOVA) (SPSS software version 10, SPSS, Chicago, IL). Statistical significance was denoted when $P < .05$.

RESULTS

From 1998 to 2000, 35 consecutive patients with a mean age of 36.5 years (range 18 to 65 years) underwent immediate implant placement and restoration provisionalization. All had returned for the scheduled appointments up to the 1-year follow-up. A total of 35 threaded hydroxyapatite-coated tapered

Table 1 Location and Reason for Failure of the Tooth Replaced with Immediately Placed and Provisionalized Anterior Single Implants

	Reason for Failure			
Location	Fracture	Endodontic	Root resorption	Total
Central incisor	12	10	4	26
Lateral incisor	2	2	4	8
Canine	1	0	0	1
Total	15	12	8	35

Table 2 Cumulative Success Rate (CSR) of Immediately Placed and Provisionalized Anterior Single Implants

Time interval (mo)	No. of implants	No. of failures	CSR (%)
1–12	35	0	100
13–24	13	0	100
25–36	8	0	100
37–48	4	0	100

Table 3 Wilcoxon Signed-Rank Test on Modified Plaque Index Over Time

	Modified Plaque Index score			
Time	0	1	2	3
Pretreatment	24	11	0	0
6 months	28	7	0	0
12 months	26	9	0	0

N = 35.
$P > .05$.

Table 4 Repeated-Measures 1-way ANOVA of the Changes in the Midfacial Gingival Level (FGL) Over Time (n = 35)

Time interval	Mean ± SD (mm)
Pretreatment to 0 months	–0.36 ± 0.40*
0 to 3 months	–0.04 ± 0.40
3 to 6 months	–0.08 ± 0.34
6 to 12 months	–0.07 ± 0.19**
Pretreatment to 3 months	–0.40 ± 0.51*
Pretreatment to 6 months	–0.48 ± 0.53*
Pretreatment to 12 months	–0.55 ± 0.53*

*$P < .0001$; **$P = .03$.

implants (Replace, Nobel Biocare) were evaluated (1 implant per patient), which included 26 central incisors, 8 lateral incisors, and 1 canine (Table 1). Tooth failures were attributed to fracture (n = 15), endodontic failure (n = 12), and root resorption (n = 8) (Table 1). After at least 1 year of function (range 12 to 42 months, mean 16.7 months), all 35 implants were stable and none had lost osseointegration. This corresponds to an overall cumulative implant success rate of 100% (Table 2).

Statistically significant marginal bone changes were noted after 1 year, with mean changes of –0.26 ± 0.40 mm mesially (Wilcoxon signed-rank test, $P = .0004$; median = –0.15) and –0.22 ± 0.28 mm distally (Wilcoxon signed-rank test, $P < .0001$; median = –0.10).

Plaque Index scores of 0 (no plaque) and 1 (plaque recognized only by running a probe across the marginal surface of the implant restoration) were observed throughout the study. A Plaque Index score of 1 was recorded on 11, 7, and 9 implant restorations at pretreatment, 6 months after implant placement, and 12 months after implant placement, respectively. Wilcoxon signed-rank test showed no significant differences in the Plaque Index scores among the 3 time intervals ($P > .05$) (Table 3).

The changes in the midfacial gingival level (FGL), from pretreatment to implant surgery (0 months), 0 to 3 months, 3 to 6 months, and 6 to 12 months following the implant surgery, were –0.36 ± 0.40 mm, –0.04 ± 0.40 mm, –0.08 ± 0.34 mm, and –0.07 ± 0.19 mm, respectively. This corresponded to a statistically significant change (repeated-measures 1-way ANOVA, $P < .0001$) in the overall FGL (–0.55 ± 0.53 mm) following 1 year of function (Table 4).

The changes in the mesial papilla levels (MPL), from pretreatment to implant surgery (0 months), 0 to 3 months, 3 to 6 months, and 6 to 12 months following the implant surgery, were –0.31 ± 0.28 mm, –0.03 ± 0.33 mm, –0.16 ± 0.29 mm, and –0.03 ± 0.21 mm, respectively. This corresponded to a statistically significant change (repeated-measures 1-way ANOVA, $P < .0001$) of –0.53 ± 0.39 mm in the overall MPL following 1 year of function (Table 5).

The changes in the distal papilla levels (DPL), from pretreatment to implant surgery (0 months), 0 to 3 months, 3 to 6 months, and 6 to 12 months following the implant surgery, were –0.21 ± 0.41 mm, –0.04 ± 0.37 mm, –0.14 ± 0.27 mm, and 0.00 ± 0.21 mm, respectively. This corresponded to a statistically significant change (repeated-measures 1-way ANOVA, $P < .0001$) in the overall DPL (–0.39 ± 0.40 mm) following 1 year of function (Table 6).

Table 5 Repeated-Measures 1-way ANOVA of the Changes in the Mesial Papilla Levels (MPL) Over Time (n = 35)

Time interval	Mean ± SD (mm)
Pretreatment to 0 months	–0.31 ± 0.28*
0 to 3 months	–0.03 ± 0.33
3 to 6 months	–0.16 ± 0.29**
6 to 12 months	–0.03 ± 0.21
Pretreatment to 3 months	–0.33 ± 0.39*
Pretreatment to 6 months	–0.49 ± 0.38*
Pretreatment to 12 months	–0.53 ± 0.39*

*$P < .0001$; **$P = .002$.

Table 6 Repeated-Measures 1-way ANOVA of the Changes in the Distal Papilla Levels (DPL) Over Time (n = 35)

Time interval	Mean ± SD (mm)
Pretreatment to 0 months	–0.21 ± 0.41**
0 to 3 months	–0.04 ± 0.37
3 to 6 months	–0.14 ± 0.27**
6 to 12 months	–0.00 ± 0.21
Pretreatment to 3 months	–0.25 ± 0.48**
Pretreatment to 6 months	–0.39 ± 0.43*
Pretreatment to 12 months	–0.39 ± 0.40*

*$P < .0001$; **$P < .01$.

In response to the questionnaire, 33 of 35 patients were totally satisfied with the esthetic outcome (rated 10), while the remaining 2 patients gave their outcome a score of 9, for a mean esthetic satisfaction rating of 9.9. None of the patients had noticed any changes in the peri-implant gingival architecture throughout the study.

Four patients developed fistulae at the provisional crown/abutment and abutment/implant junctions (1 to 3 mm subgingival) during the provisional stage. Three patients experienced unseating of provisional restorations, 2 of which had multiple recurrences. Screw loosening of the customized metal temporary abutment was observed once each in 2 patients. No complications were noted after the definitive restoration placement.

DISCUSSION

The cumulative implant success rate for the immediate placement and provisionalization procedure in this study was 100% (35/35) after at least 1 year of function with a follow-up period of up to 42 months. Comparable success rates have been reported when single implants were placed in the esthetic zone using either the delayed loading approach (97%)[19] or the immediate provisionalization approach (98%).[10,11,20,21]

Although insignificant differences have been noted in the implant success rates between smooth and rough implant surfaces, recent literature seems to favor a rough surface in achieving greater magnitude and a faster rate of osseointegration.[22–27] Therefore, in immediate provisionalization situations where maximum magnitude and rate of osseointegration are desired, implants with surface treatments should be considered. Furthermore, threaded implants should be used because they provide the strongest immediate mechanical retention after placement.[28] Hence, in this study, hydroxyapatite-coated threaded implants (Replace, Nobel Biocare USA) were used.

In this study, although statistically significant marginal bone changes were noted at the mesial (–0.26 ± 0.40 mm) and distal (–0.22 ± 0.28 mm) aspects of the implants 1 year after immediate provisionalization, they were smaller than the mean marginal bone loss of 0.93 mm (range, 0.4 to 1.6 mm) observed in implants loaded in the usual delayed protocol after the first year of function.[2,5,6,19,29] The low mean marginal bone loss observed in the present study may be a result of the fact that several implants showed bone gain (range of marginal bone change = –1.4 to 0.45 mm). This may be attributed to the spontaneous bone fill to the gaps between the implant and the extraction socket following immediate implant placement. In a prospective 5-year pilot study, Andersen and coworkers also reported bone gain in 88% of immediately loaded implants.[21]

Although the influence of oral hygiene on implant success has been controversial,[11,29–35] it is generally agreed that plaque accumulation could induce negative mucosal response. No significant difference was observed in the modified Plaque Index score throughout the duration of this study; the majority of scores were 0, implying that good oral hygiene had been maintained around the implants. Since brushing to the surgical site was not recommended within the first month of implant surgery to minimize unnecessary disturbance to the healing process, oral hygiene was maintained by lightly wiping the area with a cotton swab soaked with 0.12% chlorhexidine gluconate (Peridex, Procter & Gamble).

In addition to a natural looking restoration, single anterior implant esthetics is also governed by the presence of harmonious gingival architecture.[36] Unfortunately, facial gingival recession is a common occurrence with implant restorations,[37–39] and approximately 1 mm of tissue loss can be expected

up to 1 year following definitive prosthesis placement.[10,40] Bengazi and associates[41] and Grunder[42] individually reported mean facial gingival recession of 0.4 mm and 0.6 mm, respectively, 6 and 12 months after definitive prosthesis placement. On the other hand, Small and Tarnow[40] reported greater facial recession when measurements were made after the placement of healing abutments (0.85 and 0.88 mm at 6 and 12 months, respectively). In addition, 0.47 mm mesial and 0.78 mm distal tissue losses were also reported at 12 months. In this study, despite the fact that tissue changes were measured prior to tooth removal and implant placement, and statistically significant changes ($P < .0001$) were noted in the overall mean FGL (–0.55 ± 0.53 mm), MPL (–0.53 ± 0.39 mm), and DPL (–0.39 ± 0.40 mm) following 1 year of function, this is comparable to the previously reported amount of changes.[10,40–42] Furthermore, these gingival tissue changes were within clinical expectations, as confirmed by the patients' response to the questionnaires, wherein a mean esthetic satisfactory rate of 9.9 was recorded and no patients had noticed any changes in the gingival architecture around the implant crown throughout the study. In fact, minimal mean tissue changes (facial = –0.07 mm, mesial = –0.03 mm, and distal = 0.00 mm) observed after definitive prosthesis placement (at 6 months) indicated stable peri-implant tissue. The results of this study seemed to support the efficacy of this procedure in maintaining the gingival architecture of the failing tooth.

Fistula development has been reported around anterior single implants, especially at the provisional/abutment and abutment/implant junctions, and are usually related to component loosening and/or non-optimal fit (ie, gaps).[2–5,37,38] Under such circumstances, the provisional restoration and abutment were removed, and the infected site was cleaned and disinfected with tetracycline paste (mixed with 0.12% chlorhexidine gluconate). The components were tightened and care was taken to prevent soft tissue entrapment; in all cases, the fistula resolved uneventfully. All incidences involving unseating of provisional restorations were isolated within the first few study patients, in which the prepared portion of the customized provisional abutment was polished, thereby compromising retention. These problems were resolved after the prepared portion of the abutment was left unpolished. Abutment screw loosening was observed only during the provisional stage when the abutment screw was hand-tightened and the optimal preload was therefore not achieved.

CONCLUSIONS

Based on the results of this 1-year prospective study, immediate placement and provisionalization of anterior single, hydroxyapatite-coated, threaded implants can effectively optimize peri-implant esthetics by maintaining the existing hard and soft tissue architecture of the replaced tooth. In addition, the immediate placement of a fixed provisional restoration can minimize the emotional trauma of losing a maxillary anterior tooth and eliminates the need for a removable provisional restoration. Nevertheless, although the high implant success rate demonstrated with this treatment modality might suggest it as a viable and predictable treatment option, careful patient selection and treatment planning are still as important or even more important than the treatment itself.

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