The Long-Term Evaluation of Two-Unit Fixed Partial Dentures on Short, Threaded Implants: Delayed Versus Immediate Loading

Michele Perelli, DDS/Roberto Abundo, DDS, MD
Giuseppe Corrente, DDS, MD/Carlo Saccone, DDS
Hector Sarmiento, DMD, MSc
Yu Cheng Chang, DDS, MSc
Joseph P. Fiorellini, DMD, DMSc

Placement of short implants is a common approach to rehabilitate edentulous areas. The objective of this study was to evaluate the long-term survival of 7.0- and 8.5-mm implants placed in either a delayed or immediate loading protocol. Life table analysis revealed the implants treated with the delayed loading protocol had a 90.9% survival rate and the implants treated with the immediate loading protocol had a survival rate of 92.0%. The results of this 8-year prospective study demonstrate similar survival rates of short, cylindrical threaded implants placed by either a delayed or immediate loading protocol. Int J Periodontics Restorative Dent 2020;40:e157–e162. doi: 10.11607/prd.4273

Maxillary and mandibular posterior regions may represent a significant challenge in implant-supported rehabilitations due to the reduced available bone height and width. Tooth extraction, periodontitis, and the presence of anatomically limiting conditions (including the inferior alveolar nerve, mental foramen, lingual concavities, and maxillary sinus floor) may limit and/or reduce the native bone volume for implant placement. Different surgical techniques have been developed to augment the basal bone for the primary purpose of placing implants with what has been considered to be a minimum standard length.

Maxillary sinus lift techniques for the development of adequate bone volume are well documented.1,2 Standard-length implants placed in these scenarios demonstrate high success and survival rates but have greater risks of surgical complications, such as membrane perforations, hemorrhaging, postoperative sinusitis, morbidity, and increased costs.3–7 In the mandible, vertical guided bone regeneration, alveolar distraction osteogenesis, onlay bone grafting, interpositional bone grafting, and alveolar nerve transposition have been utilized to augment posterior regions.8–11 All these mandibular augmentation techniques are surgically demanding and may be followed by complications.
affecting the soft tissues that are difficult to treat, such as membrane exposures, graft infections, and inferior alveolar nerve injury.\textsuperscript{12,13}

Recently, the use of short-length implants with an infrabony height of less than 8 mm have been shown to be a satisfactory alternative to bone augmentation in posterior areas. Although some reports demonstrate that the use of short implants has lower success and survival rates, more recent studies with long-term follow-ups report traditional rates.\textsuperscript{14,15} Generally, 5.0- to 8.5-mm–long implants can be a viable, if not better, alternative to bone augmentation procedures.\textsuperscript{16–18} Ravida et al completed a meta-analysis of 1,612 implants and suggested there was a similar survival rate for extra-short and long implants after 3 years.\textsuperscript{19}

The objective of this prospective study was to evaluate the long-term survival of short 7.0- and 8.5-mm threaded implants placed in either a delayed or immediate loading protocol.

### Materials and Methods

The study was approved by a Human Studies Committee, and patients signed an informed consent. Patients who presented with a minimal basal bone height below the maxillary sinus and above the inferior alveolar nerve were included in the study. Patients were enrolled in the study when inclusion and exclusion criteria were satisfied (Table 1).

Four clinicians (M.P., R.A., G.C., C.S.) treated all study patients. Conventional radiographs or computed tomography were utilized to form a treatment plan for implant placement. Implants were placed in the premolar or molar regions of the maxilla or mandible.

Patients in either the delayed or immediate loading protocol were treated utilizing the same surgical protocol. After full-thickness flap reflection, implant osteotomies were prepared with a combination of drills and a Piezosurgery White device (Mectron). In particular, the Piezosurgery device was used to initially prepare the osteotomies and/or correct angulation, whereas drills were used for defining and correctly shaping the sites. Cylindrically shaped, threaded dental implants (Premium, Sweden & Martina) were inserted with a minimum of 25 Ncm torque to obtain adequate primary stability. Following flap closure, patients received antibiotics, analgesics, as well as chlorhexidine for the 2-week immediate postoperative period.

When planned, impressions were immediately taken after surgery and implants were loaded with screw-retained provisional prosthesis within 24 hours. In the delayed loading protocol, a provisional restoration was delivered after a 6-month healing period for maxillary implants and a 3-month period for mandibular implants. After 6 months of loading for both treatment groups, implants were manually tested for stability with a reverse torque and restored with cement- or screw-retained restorations. All study implants were followed by a single examiner (M.P.) over the 8-year period. Clinical and radiographic examinations were scheduled after implant placement; after the conventional healing period (6 months for maxilla and 3 months for mandible); at the time of crown insertion; at 1, 6, and 12 months after prosthetic loading; and yearly thereafter. Outcome measures included postoperative complications (infection, nerve injury, sinus perforation), implant failure, prosthesis failure (ceramic fracture, screw loosening, screw fracture), and radiographic bone levels.

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<th>Table 1 Study Subject Exclusion Criteria</th>
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<td><strong>Criterion</strong></td>
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<td>Head and neck irradiation within the last year</td>
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<td>Chemotherapy for a malignancy</td>
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<td>Inadequate oral hygiene</td>
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<td>Untreated periodontal disease</td>
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<td>Psychiatric issues</td>
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<td>Acute infection in the area intended for implant placement</td>
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<td>Participation in other trials</td>
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<td>Extractions sites with less than 3 months of healing</td>
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were evaluated with intraoral radiographs taken with the paralleling technique. Bone level changes were measured as a percentage, utilizing the known length of the implant body as a reference. For statistical analysis, means and standard deviations were calculated, and life table analysis was used for implant survival and t test for comparisons.

Results

A total of 44 patients (24 women and 20 men) with 69 implants were enrolled in the study. Forty-six implants were inserted in the maxilla and 23 in the mandible. A delayed loading protocol was utilized for 44 implants, and 25 were immediately loaded (Table 2). Implants were restored with single crowns or splinted restorations (Table 3). No surgical or postsurgical complications occurred during the study with the exception of implant loss. Overall, 6 maxillary implants failed during the study (Table 4). With both protocols, all implant failures occurred before the end of the first year. At 8 years, life table analysis revealed a cumulative overall implant survival rate of 95.6% (86.9% in the maxilla and 100% in the mandible). After 8 years, implants treated with the delayed loading protocol and the immediate loading protocol had survival rates of 90.9% and 92.0%, respectively (Table 5). There were no prosthetic failures over the 8-year observation period. Lastly, radiographic bone loss in both groups was approximately to the level of the smooth collar with the exception of 2 immediately loaded implants (1 in the maxilla and 1 in the mandible) in the same nonsmoking patient. Bone loss around these implants reached approximately the first and second thread and then stabilized. Implants in the delayed loading group had a mean (minimum/maximum) bone loss of 0.97 mm (0.1/1.7 mm) at 6 months and 1.24 mm (1.0/2.4 mm) at 8 years. The implants in the traditional loading protocol had bone losses of 1.0 mm (0.1/2.0 mm) at 6 months and 1.29 mm (1.0/2.7 mm) at 8 years. There was no statistical difference between loading protocols at each time period. However, both loading protocols demonstrated a statistically significant difference between baseline and the 8-year follow-up.

Discussion

The results of the present study indicate that short dental implants can be utilized in the rehabilitation of the posterior mandible and maxilla. The clinical performance in either a delayed or immediate placement protocol demonstrated acceptable short- and long-term survival rates and successful restoration. Over the years, there have been multiple clinical studies that have included
various implant lengths ranging from 6 mm to more than 14 mm. Generally, the survival and success rates in the uncompromised patient have been greater than 90%. Although short dental implants have been available for some time, early studies indicated that survival was related to length and diameter. Winkel et al evaluated 7-, 8-, 10-, 13-, and 16-mm implants with widths of 3+ and 4+ mm.15 Although, there were no differences in crestal bone loss, shorter and/or narrow implants had a statistically lower survival rate compared to longer/wider ones. Over time, implants 8.5 mm or less in length have become more predictable when used in a traditional loading protocol. The reduction in implant length and improved survival has developed over the past several decades. The primary factor for this change has been the modification of the microdesigns of dental implants. Most importantly, the standard implant body has evolved from a machined to a textured surface, which results in greater bone-to-implant contact.20 In a multicenter study, Levine et al found that 8-mm-long titanium, plasma-sprayed, screw-type implants had a failure rate of only 1.8%.21 Urdaneta et al evaluated ultrashort (5 × 5.0 mm or 5 × 6.0 mm) and short (8 × 6.0 mm) implants over an average time of 20 months.22 These hydroxyapatite-coated implants had an overall survival rate of 92.2%. There was no statistical difference in survival between the ultrashort and short implants. In separate 5-year prospective studies of maxillary and mandibular implants, Perelli et al (2011 and 2012) followed short (5 and 7 mm) implants.23,24 Survival for implants placed in the maxilla was 90%, whereas mandibular survival was significantly lower at 84%. When short implants were included in a meta-analysis, Annibali et al found that rough surface characteristics improved survival by 4.6% when compared to machined implants.25 As was found in this study, there is increasing evidence that the use of short implants in a delayed approach can have survival rates comparable to longer implants. However, the authors caution the clinician regarding the use of short implants. Similarly, in a meta-analysis by Papaspyridakos et al, the use of a short implant (<6 mm) needs to be selected carefully due to the higher variability and lower predictability in survival rates compared with longer implants. The range of survival rates varies from 86% to 100% for short implants but 95% to 100% for longer implants.26

The current study also included the use of short dental implants, which were inserted and loaded within 24 hours. The predictable immediate loading of dental implants was documented by Tarnow et al in 1997.27 In a full-arch protocol of 69 loaded threaded implants, only 2 implants were lost. The high survival rate was attributed to the use of threaded implants with a minimum length of 10 mm and cross-arch stabilization. Jaffin et al noted in a similar protocol that there was minimal radiographic bone loss over a 5-year observation period.28 When single-tooth implants were evaluated in immediate and early loading protocols, Testori et al demonstrated that there were no major clinical differences in implant survival.29 In 2014, Benic et al conducted a systematic review of loading protocols for single-implant crowns that were immediately or conventionally loaded and inserted with minimal torque and implant stability quotient.30 In the 11 included studies, implant length ranged from 8 to 16 mm, with the majority above 10 mm. Although the analysis involved immediate placement and loading studies, the treatment modalities resulted in equally successful survival and marginal bone loss.

Overall, the use of dental implants in the comprehensive rehabilitation of edentulous areas has become a standard of care.31 As a result of this predictability, clinicians have been extending the indications for use of standard- and shorter-length implants. Many of these extensions of use involve accelerated healing times and more rapid restorations and rehabilitation of severely atrophic jaws. In addition, procedures that involve increasing bone volume have been minimized in order to facilitate rehabilitation. As several of these procedures have associated morbidities and lowered predictability, both the clinician and patient have sought to streamline care. Immediate implant placement with or without loading has been one of the best examples of this extension of use. In this present study, patients did not require procedures such as sinus augmentation, ridge augmentation, nerve repositioning, etc, which would prolong treatment time and have possible complications, patient discomfort, and increased costs.
Conclusions

The results of this 8-year study demonstrate the satisfactory survival of short, cylindrical threaded implants with either a delayed or immediate loading protocol. The use of short implants can be considered, with caution, as a valid alternative with reduced complications, time, and costs for the patient as compared to bone grafting procedures in sites where there is limited bone.

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References


