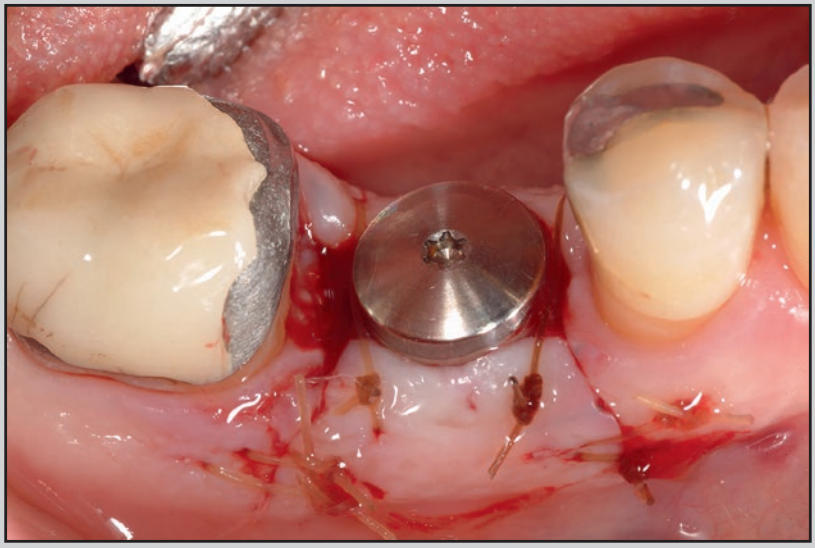
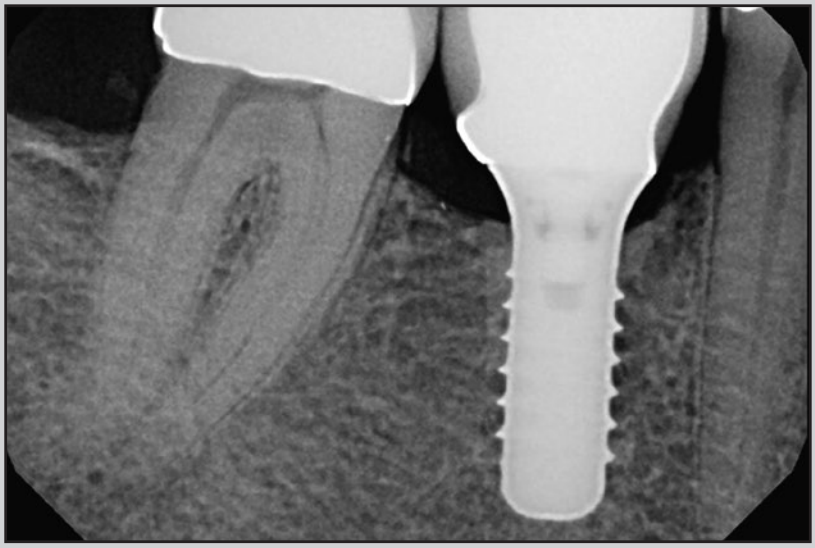
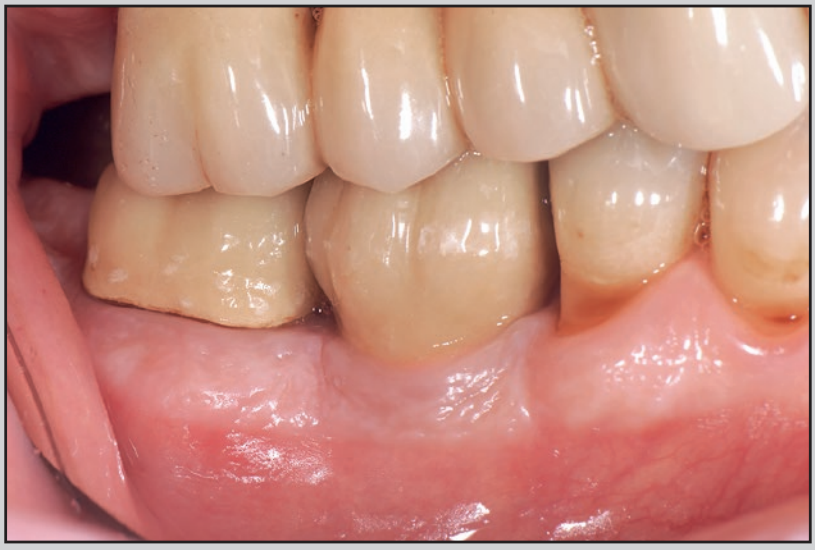
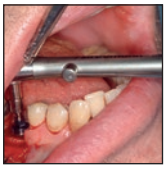






Early Loading of Posterior Nonsubmerged Titanium Implants with a Modified Sandblasted and Acid-Etched Surface: A Prospective Case Series with Up to 149 Months of Follow-up



Robert A. Levine, DDS[1]/Diksha Katwal, DDS, MSD[2]
Pin-Chuang Lai, DDS, PhD[2]/John Bruce, DMD[3]
William C. Scarfe, BDS, FRACDS, MS[2]
Michael M. Bornstein, Prof Dr med dent[4]

The purpose of this prospective study was to evaluate the success rates and prosthetic complications of implants with a modified sandblasted and acid-etched (SLA) surface inserted for posterior single-implant crown restorations. Final crowns were placed 3 to 4 weeks after surgery, and patient follow-up spanned 10 years in a private practice setting. A total of 22 patients (8 women, 14 men) with 25 posterior implants placed (16 mandible, 9 maxilla) were selected, including only implants for posterior single-implant crowns with insertion torque values of ≥ 35 Ncm at placement. Twenty-one implants passed the reverse torque test at 3 to 4 weeks after implant placement, and final restorations were placed. Three patients (4 implants) had "spinners," and there was one patient dropout after completion of the final restoration. All patients were recalled for clinical exams, digital periapical radiographs, and clinical photos at short-term (≤ 5 years) and long-term (> 5 years) follow-up appointments. The Community Periodontal Index of Treatment Needs was also determined at the initial and follow-up visits. Crestal bone level was measured at crown placement (T1), short-term follow-up (T2; mean: 29.4 months), and long-term follow-up appointments (T3; mean: 114.4 months). Twenty patients (23 implants) returned for examination at T2, and 15 (18 implants) were available at T3. For the 17 implants available at all evaluations, statistically significant bone loss was found from T1 to T2 (0.23 ± 0.30 mm), and the mean crestal bone level appeared stable from T2 to T3. Based on clinical and radiographic findings, the success rate for the implants and restorations at T2 and T3 was graded as 100%. Therefore, it can be stated that an early loading protocol of 3 to 4 weeks using a modified SLA surface at premolar/molar single-tooth locations can result in favorable clinical and radiographic long-term results. Int J Periodontics Restorative Dent 2021;41:51–59. doi: 10.11607/prd.4703

[1]Private Practice, Philadelphia, Pennsylvania, USA; Department of Periodontology & Oral Implantology, Maurice H. Kornberg School of Dentistry, Temple University, Philadelphia, Pennsylvania, USA.
[2]Department of Oral Diagnosis and Oral Health, University of Louisville School of Dentistry, Louisville, Kentucky, USA.
[3]Graduate Periodontics, University of North Carolina at Chapel Hill, Chapel Hill, North Carolina, USA.
[4]Oral and Maxillofacial Radiology, Applied Oral Sciences and Community Dental Care, Faculty of Dentistry, The University of Hong Kong, Hong Kong SAR, China; Department of Oral Health & Medicine, University Center for Dental Medicine Basel UZB, University of Basel, Basel, Switzerland.

Correspondence to: Dr Robert A. Levine, Pennsylvania Center for Dental Implants & Periodontics, 9880 Bustleton Ave, Suite 211–212, Philadelphia, PA 19115, USA. Fax: 215-677-7212.
Email: rlevine@padentalimplants.com

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Rehabilitating missing teeth with dental implants has become a standard of care since its introduction almost 50 years ago.[1] There is a general consensus of predictable long-term success and high survival rates (over 90%) at 10 years after implant insertion.[2] Implant surface technology has seen many developments over the last two decades. The results from animal studies demonstrate that a sandblasted and acid-etched surface (SLA) performs histomorphometrically better than titanium plasma-sprayed surfaces (TPS) with regard to bone apposition and removal torque values.[3,4] Clinical studies using SLA implants prove superior to TPS implants when restored at 6 weeks, resulting in similar or improved survival rates.[5,6] This being considered, early loading (from 48 hours to 12 weeks) has become an accepted protocol for restoring implants using an SLA surface[7] and has resulted in shortened treatment periods for patients.[6]

More recently, a modified sandblasted and acid-etched surface (modSLA; SLActive, Straumann) was developed, and it includes the chemical modification of hydroxylated/hydrated TiO_2 under N_2 conditions. The modSLA surface is hydrophilic and has higher surface free energy.[8] Several investigators have evaluated

bone-to-implant contact (BIC) in SLA- and modSLA-surfaced implants and found 60% more bone at 2 weeks as well as enhanced BIC during the first 4 weeks of the healing process for modSLA implants.[8,9] In a 12-month multicenter clinical study, Ganeles et al demonstrated that modSLA surfaces are safe and predictable in early and immediate loading protocols, even in situations with poor bone quality.[10] This property of modSLA implants allows them to be used in more clinically demanding situations, such as immediate loading, and they have consistently shown improved patient outcomes with survival rates comparable to conventional loading protocols.[11,12]

One way of evaluating implant performance and long-term outcome is by considering marginal bone loss. A recent study evaluated the performance of SLA and modSLA implants over of 6.5 years.[13] For SLA and modSLA surfaces, the authors reported marginal bone loss of 0.24 mm and 0.17 mm at 20 months, respectively, as well as 0.71 mm and 0.53 mm at 81 months, respectively. In a multicenter clinical study, Nicolau et al recently reported 10-year data of modSLA implants inserted in the posterior arches.[14] The average change in crestal bone level between the permanent crown insertion (approximately 5 to 6 month postsurgery) and the 10-year follow-up visits was 1.25 mm and 0.89 mm for the immediate and early loading groups, respectively.

The purpose of this prospective study was to evaluate the long-term survival rates and prosthetic complications of implants with a modSLA surface used for posterior single-tooth replacements restored with definite crowns between 3 to 4 weeks after surgery. The hypothesis to be tested was that this approach in the posterior regions can be as predictable a treatment procedure as the similar approach using a standard SLA loading protocol after 6 to 8 weeks. To the best of the authors' knowledge, this is the first study reporting long-term data from modSLA implants inserted in a private practice setting using an early loading protocol.

Materials and Methods

Study Population

All patients were referred to the primary author's private periodontal practice in Philadelphia for replacement of missing or hopeless premolars and molars. After a review of the medical and dental history and thorough periodontal, occlusal (including self-reported bruxism based on self-awareness and/or signs/symptoms associated with temporomandibular disorder), and radiographic examinations, the patients were recruited to the clinical study and signed a written informed consent in accordance with the guidelines of the World Medical Association Declaration of Helsinki.[15] For patient recruitment, strict inclusion and exclusion criteria were used, similar to the ones previously published[16] by the same group (see Appendix Table 1 in the online version of this article at quintpub.com/journals). A total of 22 patients (8 women, 14 men) with ages ranging from 26 to 78 years (mean: 54.6 ± 13.1 years) were enrolled from July 2006 to October 2008. Reasons for initial tooth loss included nonrestorable tooth fractures (n = 14), nonrestorable severe recurrent coronal dental caries (n = 8), tooth agenesis (n = 1), advanced periodontal disease (n = 1), and endodontic failure (n = 1). After the initial visit, the patients were sent back to their referring dentists for fabrication of a diagnostic wax-up with a surgical guide template to allow for optimal implant placement. In addition, initial nonsurgical periodontal therapy and oral hygiene instructions were provided before surgical appointments.

Surgical Procedure

The surgical procedure was similar to the one presented in a previous study of the same group assessing SLA implant performance.[16] Before surgery, each patient was confirmed to have clinically healthy periodontal conditions and acceptable oral hygiene levels. All surgical procedures were performed under local anesthesia under aseptic conditions in a private-practice setting. All patients received antibiotic prophylaxis (amoxicillin or clindamycin) and a nonsteroidal anti-inflammatory drug (NSAID; ibuprofen or naproxen) 1 hour before surgery. The implants were placed with the use of a custom-made, clear, hard acrylic surgical guide template. Initial incisions were made in the edentulous areas to maximize keratinized gingiva at the facial aspect upon clo-

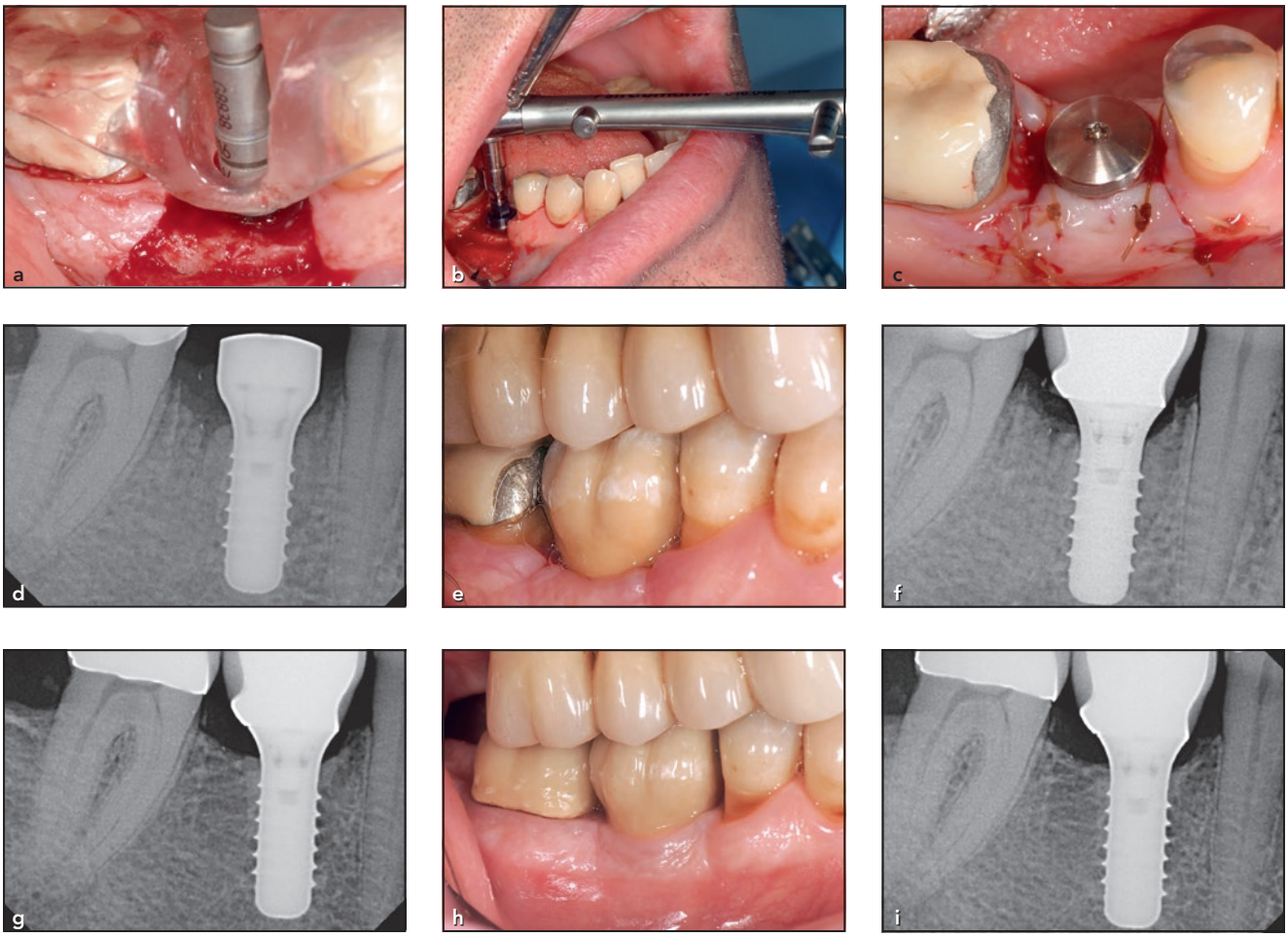

Fig 1 *A representative case of a successful mandibular molar implant.* (a) *Day of surgery. The anatomically correct surgical guide template in place with direction indicator at site 46 (FDI system). The tooth was removed 7 months prior.* (b) *A 4.8 × 12–mm implant was placed. Insertion torque test at > 35 Ncm. The patient joined the study.* (c) *Final closure with 4-0 chromic gut sutures after contouring the buccal/lingual flaps for good soft tissue preservation.* (d) *Digital periapical radiograph taken the day of surgery.* (e) *Clinical view of the final crown after cementation at 4 weeks. The crown contours were developed with the lab to allow papilla fill over time with ideal crown contours.* (f) *Digital intraoral radiograph of the final crown at 4 weeks, showing the patient's bone level at T1.* (g) *Five-year digital intraoral radiograph, showing the patient's bone level at T2. No obvious crestal bone loss was noted compared to T1.* (h) *Ten-year clinical view and* (i) *digital radiograph, showing the patient's bone level at T3. No obvious crestal bone loss was noted compared to T1 and T2.*

sure. Full-thickness flaps were raised to gain access to the osseous crest. Regular- or wide-neck implants with a modSLA surface (SLActive) were inserted according to the manufacturer's recommended drilling protocol, except the 3.5-mm trephine drill was substituted for the 3.5-mm twist drill without pretapping to optimize primary stability.[17] An intrasurgical digital radiograph was used to confirm appropriate depth and subsequent final implant length. All bone sites were at least 1 mm thick buccally and lingually after final implant bed preparation. There was no grafting necessary for any of the implants in the study. The implants were inserted by hand with the manufacturer's torque wrench device. If a 35-Ncm insertion torque was achieved (Figs 1 to 3), the patients were informed that they were officially enrolled in the study. Each implant was positioned to facilitate a good emergence profile and soft tissue sculpturing for the final restoration. The flaps were contoured as needed and sutured around the healing abutments.

Elastomeric impressions were taken either on the day of surgery or within 24 to 48 hours after. The

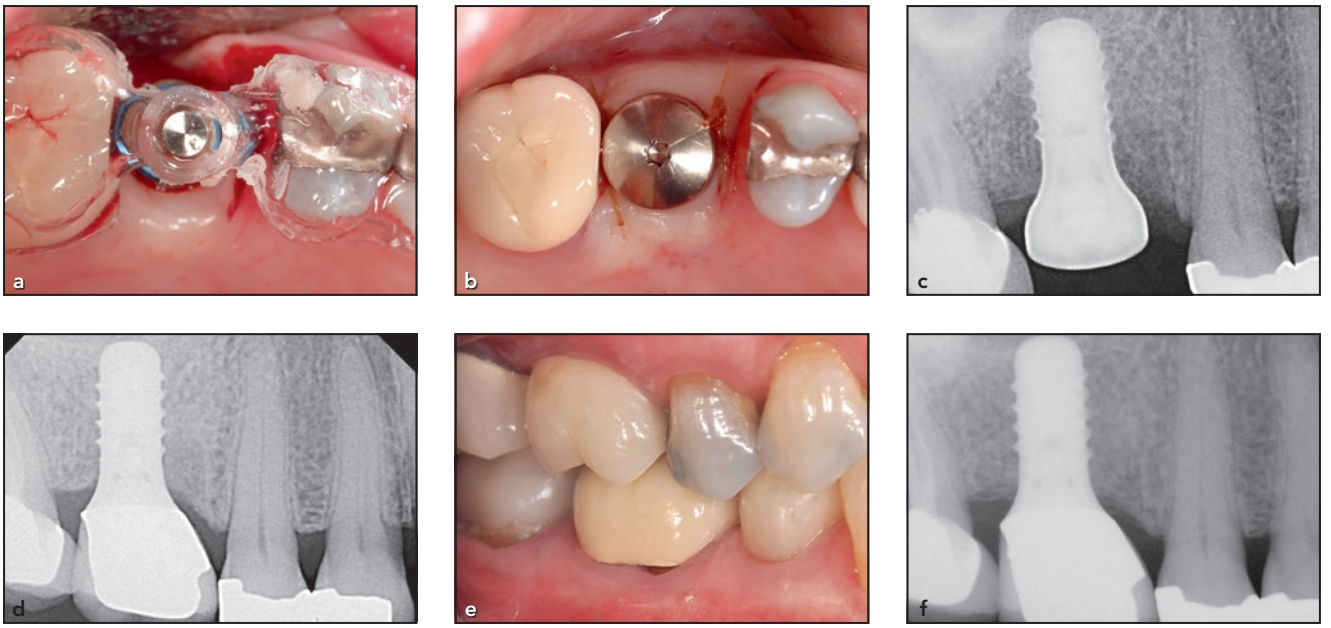

Fig 2 *A representative case of a successful maxillary molar implant.* (a) *Day of surgery. The anatomically correct surgical guide template in place with final implant position noted at a well-healed edentulous ridge at site 16. The tooth was lost 7 months prior.* (b) *A 10 × 4.8–mm implant in situ with a 3-mm healing abutment;* (c) *Radiograph taken the day of surgery. The patient was prescheduled with a coordinated same-day appointment with her restorative dentist, who made implant-level impressions for a single cemented crown.* (d) *Radiograph at 4 weeks postinsertion of the crown after confirmation of successful torque test at 35 Ncm. The crown was inserted the same day at her restorative dentist's office in a coordinated same-day appointment.* (e) *Clinical and* (f) *radiographic views at 11 years.*

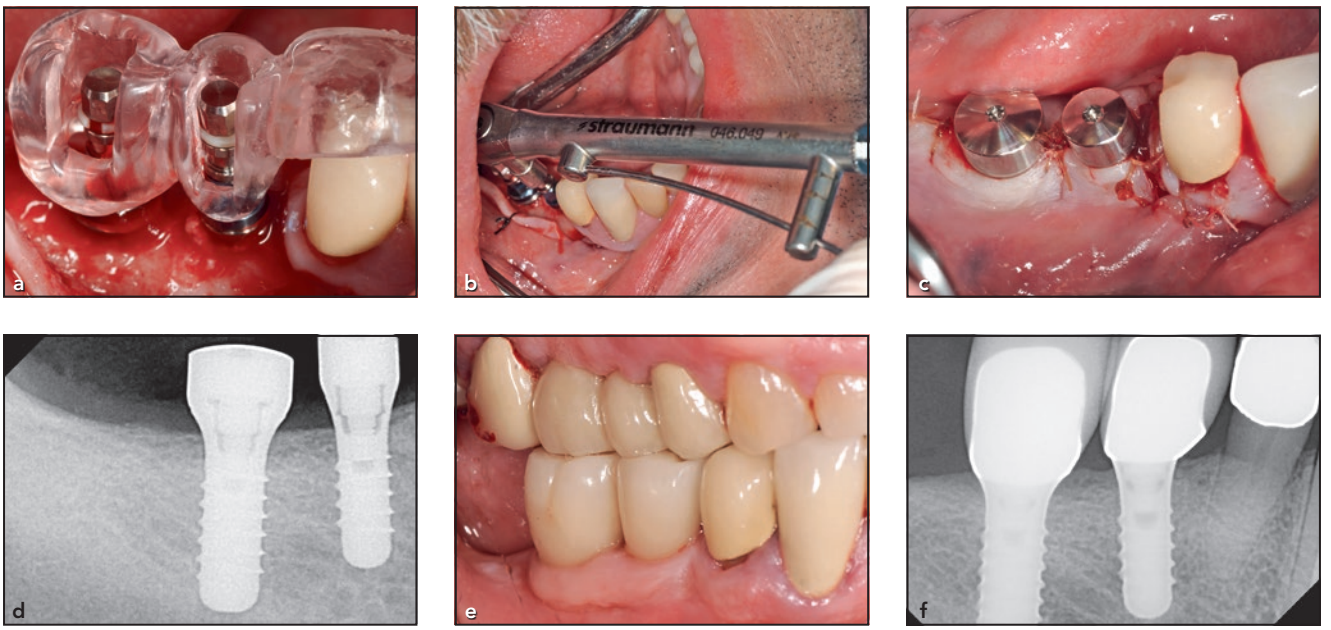

Fig 3 *A representative case with an unsuccessful first torque test, which failed due to discomfort or spinning upon the 35-Ncm applied torque. The test was passed after an additional 4 weeks of healing.* (a) *Anatomically correct surgical guide template in situ on the day of surgery after implant placement at sites 45 and 46 (FDI system).* (b) *Successful torque test for both implants (> 35 Ncm) on the day of surgery. The patient joined the study.* (c) *Closure with 4-0 chromic gut sutures. Note the maintenance of keratinized gingiva at the facial aspect.* (d) *Radiograph taken the day of surgery. A 10 × 4.1–mm implant was used for site 45 and a 12 × 4.8–mm implant for site 46. On the day of the torque test, 3 weeks after implant placement, the patient experienced slight discomfort between 25 and 30 Ncm at both sites. The patient was retested 4 weeks later, at which time the test was successful for both sites, with no reported discomfort.* (e) *Clinical and* (f) *radiographic views at 11 years.*

dental laboratory was instructed to fabricate ideal interproximal and subgingival crown contours for optimal future soft tissue maturation of the interproximal papilla with plans to be ready for insertion at the patients' respective restorative dentist's office in 3 to 4 weeks. Postoperative instructions included no chewing on the side of the surgery before delivery of final crowns, use of chlorhexidine gluconate mouthwash twice a day for 2 weeks, the use of NSAIDs for 3 to 5 days, and completion of the week's dosage of their respective antibiotic. A nonstandardized periapical radiograph was taken prior to dismissing the patient.

Postoperative Follow-ups

Each patient was evaluated at 2 and 3 to 4 weeks postoperative. At the latter appointment, the soft tissue was assessed and bone healing was confirmed with the reverse torque technique (RTT) at 35 Ncm by the primary author. Patients with implants judged as successful using the RTT then went to their restorative dentist on the same day for delivery of the final abutment and crown.

The patients received periodontal follow-ups either exclusively with their general dentist or alternating with the periodontist's office based on their individual needs. Periodic recall appointments were scheduled at the primary author's office, and digital periapical radiographs, a clinical examination, and clinical digital photos of the study implants were performed.

Clinical and Radiographic Parameters

The primary outcomes of this study were the success rate of the inserted dental implants and the radiographic bone loss over the study period. The success rate was determined based on the criteria published by Buser et al.[18] These criteria include the absence of the following: *(1)* persistent subjective complaints, such as pain, foreign body sensation, and/or dysesthesia; *(2)* peri-implant infection with suppuration; *(3)* mobility; and *(4)* continuous circumferential radiolucency around the implant.

A supplemental criterion for long-term implant success is to calculate the average peri-implant bone loss. In the present study, the radiographic peri-implant bone level was determined at three major time periods depending on the follow-up appointments:

T1: installation of the final crown

T2: short-term follow-up appointments (≤ 5 years postoperatively)

T3: long-term follow-up appointments (> 5 years postoperatively)

For the radiographic measurements, the distance between the implant shoulder and the first visible BIC (DIB) was measured at the mesial and distal aspects of each implant using digital periapical radiographs with the long-cone technique.[8] Two examiners (D.K. and P.C.L.) who were not involved in the surgical or prosthetic rehabilitation of the patients performed the measurements using the Delphi method to achieve an agreement. The method is an iterative process designed to obtain consensus among experts through one or more rounds of discussion.[19] All digital radiographs were enlarged on the computer, and the measurement was calibrated with the known implant thread pitches. One final DIB value was calculated for each implant based on the average of the mesial and distal values. Furthermore, marginal bone changes over the course of the study were then calculated using the change in the DIB values from T1 to T3 (ΔDIB T2–T1, ΔDIB T3–T1, and ΔDIB T3–T2).

The Community Periodontal Index of Treatment Needs (CPITN)[20] was initially assessed on the date of implant surgery (after periodontal treatment, if needed) and again at T2 and T3 follow-up appointments. The score per patient was based on the following:

0 = no need for further treatment/no signs of periodontal disease in any sextant

1 = need to improve personal oral hygiene/gingival bleeding after gentle probing in any sextant

2 = need for professional cleaning of teeth, plus improvement in personal oral hygiene/supra- and subgingival calculus in any sextant

3 = need for professional cleaning of teeth, plus improvement in personal oral hygiene/pathologic pockets of 4 to 5 mm in any sextant

4 = need for more complex treatment to remove infected tissue/pathologic pockets ≥ 6 mm in any sextant

For each patient, the following data were recorded upon enroll-

ment: age, gender, smoking status, reasons for initial tooth loss, status of opposing dentition (implants, teeth, or crown and partial denture on teeth), bruxism (self-reported), implant locations, and dimensions of implants. Additional data collected during follow-up appointments included implant complications, clinical photos, and periapical radiographs.

Statistical Analysis

Descriptive statistics were performed for all data collected. For all statistical tests, the significance level was set at $\alpha = .05$. Student *t* test was used for overall differences in CPITN scores among initial visit, date of surgery, T2, and T3. Paired *t* test was used to compare the values from the 17 implants that were available at both T2 and T3 visits, and *P* values were adjusted with Bonferroni correction as post hoc evaluation (the adjusted significance for this test was $\alpha = .0167$). Logistic regression models were used to test for potential associations between implant spinning (dependent variables) and implant length, implant diameter, implant location (premolar vs molar), arch (maxilla vs mandible), opposing dentition, reasons for initial tooth loss, bruxism, and CPITN values at initial visits and at implant placement. All analysis was completed using STATA statistical software, version 11 (StataCorp).

Results

Among the 22 patients initially enrolled in the study, 20 (23 implants) returned for the short-term follow-up visit (mean: 29.4 ± 7.8 months; range: 17 to 44 months), and 15 (18 implants) returned for the long-term follow-up (mean: 114.4 ± 15.5 months; range: 77 to 149 months). One patient returned only once at 77 months postoperative, and the data for that implant was analyzed only with the implants available at T3. One patient did not return after crown placement, and therefore the respective information for the implant at T2 and T3 was not available for analysis.

Of all inserted implants, 10 had a diameter of 4.1 mm, a smooth neck section of 1.8 mm, and a shoulder diameter of 4.8 mm, and were placed at premolar locations (Appendix Table 2). The remaining 15 implants had a diameter of 4.8 mm, a smooth neck section of 1.8 mm, and a shoulder diameter of 6.5 mm, and were placed at molar locations. The implant lengths varied from 8 to 12 mm, and 9 out of 25 implants were placed in the maxilla. The opposing arches consisted of implants (n = 8), natural teeth (n = 13), or crown and partial-denture restorations supported by natural teeth (n = 4). There were no complications during the healing phase 3 to 4 weeks prior to the RTT test. At RTT testing, 4 implants in three patients were spinning or causing discomfort. Those patients were scheduled to return 6 to 8 weeks later instead of going to their restorative dentists, at which time all 4 implants passed the RTT.

When the patients were examined initially, a mean CPITN of 2.44 was calculated (Appendix Table 3), which significantly reduced to 0.72 after periodontal treatment and oral hygiene instruction ($P < .001$). In general, oral hygiene was well maintained by the majority of patients after implant and crown placement. Mean CPITN values slightly increased to 0.83 at T2 and then decreased again to 0.56 at T3.

The mean DIB values from all 24 implants at T1, 23 implants at T2, and 18 implants at T3 are summarized in Appendix Table 4. It was evident that the crestal bone level decreased significantly ($P = .005$) between T2 and T1, then remained stable after T2, as the mean difference between T2 and T3 was only 0.01 mm. Based on clinical and radiographic examinations at follow-up visits and the predetermined criteria for success, all 23 implants at T2 and 18 implants at T3 were considered successful, resulting in a success rate of 100%.

Logistic regression analysis indicated that a CPITN value of 3 at implant placement was the only factor among all tested variables that exhibited a significant association with a spinning implant (OR: 19; 95% CI: 1.15, 314.97; $P = .04$).

Discussion

Titanium dental implants are considered a gold standard for replacing lost teeth with high clinical success rates. Several physical factors, including different implant surfaces, designs, and materials, have re-

portedly contributed to implant success.[2] Altogether, these physical properties can improve primary implant stability, increase BIC, and shorten the initial healing period, allowing specifically designed implants to be theoretically loaded as early as 3 to 4 weeks postoperatively for single-tooth indications. The present prospective study reported favorable long-term outcomes up to 12 years after placement for modified SLA–surface implants inserted in the posterior arches. All 24 implants included were considered successfully integrated and functioning at about 3 years postsurgery, and 14 patients (17 implants) returned for their 10-year follow-up appointments, demonstrating a 100% success rate based on strict clinical and radiographic criteria.

One major reason for the success reported in this study is attributed to the improved implant surface properties. Buser et al studied the effect of implant surface modifications on the bone-to-implant interface 3 and 6 weeks after insertion,[8] finding that SLA implants showed superior BIC (50% to 60%) compared to titanium plasma-sprayed (30% to 40%) or electropolished implants (20% to 25%). Karabuda et al reported on the differences between SLA and modified SLA surfaces at 15 months for bilateral edentulous spaces.[21] They found no difference in survival rates between the implants but noted that modified SLA implants demonstrated better stability and reduced marginal bone loss 8 weeks after loading. Şener-Yamaner et al found that modified SLA–surface implants have a greater BIC at 2 and 4 weeks compared with a regular SLA surface.[13] While it is clear that titanium implants with a modified SLA surface demonstrate better early stability and less marginal bone loss, the effect of early loading on marginal bone loss has yet to be fully investigated.

Currently, implant loading protocols are classified as immediate loading, when the prosthesis is connected within 1 week after implant placement; early loading, when the prosthesis is connected between 1 week and 2 months after implant placement; and conventional loading, when more than 2 months pass before connecting the prosthesis to the implant. Esposito et al have reported that under ideal conditions, there is no difference in success rates between these loading protocols, and there is no evidence of a clinically relevant difference for either implant failure, prosthesis failure, or bone loss associated with different loading times.[22] Another consensus report stated that both conventional and early implant loading are well-established protocols and should be considered routine.[7] Similarly, a recent systematic review stated that early loading of single-implant crowns is a predictable procedure in terms of implant survival and marginal bone stability.[23]

Implant stability is one of the most important prognostic factors for implant success.[24] Primary stability and insertion torque values are the most commonly used criteria for selecting loading protocols. Modified SLA–surface implants demonstrate significantly higher values for these clinical parameters.[25] The present study utilized the insertion torque value (35 Ncm) to determine implant stability during the surgical protocol, and bone healing was confirmed with RTT at 3 to 4 weeks. At this time point, four implants in three patients were spinning, implying that primary implant stability was not achieved for these implants. Three of the four implants were in the premolar area, one was in the maxilla, and three were in the mandible. One spinning implant was placed in an 84-year-old woman with osteoporosis. A systematic review reported no difference in implant survival rates between patients with and without osteoporosis, at neither the implant nor patient levels, but there was a significant marginal bone loss around implants with osteoporosis.[26] In the present study, the marginal bone loss around this specific implant at the 10-year follow-up was comparable to that in patients without osteoporosis. The results from the logistic regression model indicated a statistically significant association between spinner implants and the CPITN value at implant placement. This emphasizes the importance of periodontal therapy and maintenance in implant candidates who have a history of or ongoing periodontal inflammation.

Based on clinical and radiographic examination, all 24 implants inserted were considered successful. This high success rate was consistent with a recent study by Gallucci et al in which favorable success rates from early and delayed implant loading protocols for modified

SLA–surface implants was reported.[23] For implants inserted using an early loading protocol with a mean follow-up of 28.9 months, success rates of 82.4% to 100% were found, with a weighted cumulative survival rate of 98.3%. For implants inserted using a delayed loading protocol with conventional loading and a mean follow-up of 30.6 months, success rates of 80% to 100% were found, with a weighted cumulative survival rate of 97.7%. Another multicenter clinical study from 19 implants centers in 10 countries also showed promising long-term results in support of an early loading protocol on modified SLA–surface implants placed in the posterior area.[14] These authors reported an implant survival rate of 97.1% at the 10-year postoperative follow-up. The reported crestal bone loss between permanent crown placement and the 10-year follow-up was 0.89 mm. Although the reported bone loss is higher than that in the present study (0.24 mm), both can be considered highly successful. In the present study and the study by Nicolau et al,[14] the crestal bone level remained stable between the 3rd and 10th postoperative years.

Conclusions

Within the limitation of the present study, it can be stated that modified SLA–surface implants in conjunction with an early loading protocol can be placed in healed posterior maxillary and mandibular sites in systemically healthy patients with a predictable long-term success rate. Patients could benefit from this shortened treatment protocol and be able to regain both their oral health and dental function sooner than with other methods.

Acknowledgments

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Appendices

Appendix Table 1 Inclusion and Exclusion Criteria

Inclusion criteria	Exclusion criteria
• Ages ≥ 21 years • Needing single/multiple posterior implant restoration • Sufficient alveolar ridge height, width, and mesiodistal space to accept a 4.1- or 4.8-mm–wide implant with a minimum length of 8 mm • A healed site (at least 3 months postextraction) not requiring any bone augmentation (type 3 or 4 implant placement) • Insertion torque value ≥ 35 Ncm at implant placement • Willingness to sign informed consent	• History of alcoholism or drug abuse • Pregnancy • Untreated periodontitis • Medical contraindications that would affect bone/soft tissue healing (ie, uncontrolled diabetes, blood disorders) • History of cervicofacial radiation therapy • Poor oral hygiene or poor history of compliance to preventative dental care • History of a severe bruxing habit • Heavy smokers (> 20 cigarettes per day)

Appendix Table 2 Demographic Data of Placed Implants

	Implant characteristics										CPITN score, n			
	Length, mm			Diameter, mm		Location, n		Arch, n		Bruxism, n	At initial visit		At placement	
Implants (n)	8	10	12	4.1	4.8	Premolar	Molar	Max	Man		0–2	3–4	0–2	3
All (25)	3	10	12	10	15	11	14	9	16	12	11	14	22	3
At T2 (23)	3	10	10	9	14	9	14	7	16	12	9	14	20	3
At T3 (18)	3	8	7	8	10	8	10	6	12	10	7	11	16	2
Spinners (4)	1	1	2	3	1	3	1	1	3	1	00	4	2	2

CPITN = Community Periodontal Index of Treatment Needs; T2 = short-term follow-up appointment (≤ 5 years); T3 = long-term follow-up appointment (> 5 years); Max = maxilla; Man = mandible.

Appendix Table 3 CPITN Scores of All Inserted Implants During the Study Period

	Initial visit, n (%)	Date of surgery, n (%)	T2, n (%)	T3, n (%)
Score				
0	2 (8)	13 (52)	12 (52.3)	10 (55.5)
1	7 (28)	9 (36)	7 (30.4)	7 (38.9)
2	2 (8)	0 (0)	1 (4.3)	0 (0)
3	6 (24)	3 (12)	2 (8.7)	1 (5.6)
4	8 (32)	0 (0)	1 (4.3)	0 (0)
Mean ± SD	2.44 ± 1.42	0.72 ± 0.98[a]	0.83 ± 1.15[a]	0.56 ± 0.78[a]
P[a]	–	< .001	< .001	< .001

Community Periodontal Index of Treatment Needs (CPITN)[20]: 0 = no need for further treatment/no signs of periodontal disease in any sextant; 1 = need to improve personal oral hygiene/gingival bleeding after gentle probing in any sextant; 2 = need for professional cleaning of teeth, plus improvement in personal oral hygiene/supra- and subgingival calculus in any sextant; 3 = need for professional cleaning of teeth, plus improvement in personal oral hygiene/pathologic pockets of 4 to 5 mm in any sextant; 4 = need for more complex treatment to remove infected tissue/pathologic pockets ≥ 6 mm in any sextant.
[a]Changes compared to the values at the initial visit.

Appendix Table 4 Radiographic Measurement of Marginal Bone Levels Around Implants

	DIB at T1	DIB at T2	DIB at T3	ΔDIB T2–T1	ΔDIB T3–T1	ΔDIB T3–T2
All patients (n = 22)						
Mean ± SD, mm	1.87 ± 0.35	2.13 ± 0.42	2.12 ± 0.42	–	–	–
Minimum, mm	1.15	1.35	1.33	–	–	–
Maximum, mm	2.68	3.03	3.13	–	–	–
Implants, n	25	23	18			
Fully compliant patients (n = 14)						
Mean ± SD, mm (*P*)	1.90 ± 0.38	2.13 ± 0.44	2.14 ± 0.46	0.23 ± 0.30* (.005)	0.24 ± 0.40 (.0255)	0.01 ± 0.25 (.909)
Minimum, mm	1.15	1.35	1.33			
Maximum, mm	2.68	3.03	3.13			
Implants, n	17	17	17			

DIB = distance between the implant shoulder and the first visible bone-to-implant contact, measured at the mesial and distal aspects of each implant using digital periapical radiographs with the long-cone technique.
*Statistically significant between-group differences ($P < .0167$ after Bonferroni correction).