

Long-Term Retrospective Study of 3.0-mm-Diameter Implants Supporting Fixed Multiple Prosthesis: Immediate Versus Delayed Implant Loading

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Purpose: Narrow dental implants are commonly used to restore narrow alveolar ridges. Although the good performance of narrow dental implants supporting multiple prostheses has been repeatedly demonstrated, there are few studies analyzing their performance in a long-term follow-up together with the influence of the loading protocol. Thus, the objective was to assess the influence of implant loading protocol (immediate vs delayed) on the long-term outcomes of 3.0-mm-diameter dental implants supporting fixed multiple prostheses. **Materials and Methods:** This retrospective cohort study included 202 3.0-mm-diameter dental implants supporting multiple prostheses placed between January 2006 and April 2009. Immediate loading was performed when the implants were inserted in bone types I, II, and III and achieved an insertion torque ≥ 25 Ncm; otherwise, delayed loading was performed. The survival of the dental implants was recorded together with clinical and demographic information of the participants. The prosthetic complications (ceramic chipping, screw loosening, screw fracture, decementation, prosthesis failure) were also recorded. The marginal bone loss since insertion and the marginal bone loss since loading were calculated. **Results:** Delayed implant loading was performed in 131 implants and immediate loading in 71 implants. The follow-up time was 106 ± 40 months and 117 ± 38 months in the delayed and immediately loaded implants, respectively. The implant loading protocol (delayed vs immediate) showed no influence on the implant survival rate (96.2% vs 97.2%) and the marginal bone loss since insertion (1.2 ± 1.0 mm vs 1.2 ± 1.0 mm). **Conclusion:** The implant loading protocol (immediate vs delayed) did not influence the long-term outcomes (survival and marginal bone loss) of 3.0-mm-diameter dental implants supporting fixed multiple prostheses. These results are in favor of considering immediately loaded narrow dental implants as a viable treatment alternative for horizontally resorbed ridges. Nevertheless, future randomized clinical trials are needed to confirm these observations. *Int J Oral Maxillofac Implants* 2020;35:1229–1238. doi: 10.11607/jomi.8180

Keywords: bone atrophy, immediate loading, implantology, long-term survival, narrow dental implants

Dental implantology is an accepted strategy to restore the masticatory function of edentulous patients. Since the first endosseous titanium dental implants were designed early in the 1960s, the technology has evolved rapidly, leading to the development of designs and techniques with predictability and safety.¹ The development of this field is related to the good clinical outcomes obtained with modern dental implants and the beneficial effect of oral implantology on the quality of life of edentulous patients.²

In this context, the design of dental implants is adapted to varied anatomy in patients. Clinicians have

frequently restored resorbed alveolar ridges where it is not possible to place a standard-diameter implant.^{3–10} Different surgical strategies have been proposed to address anatomical limitations, such as ridge expansion or ridge split techniques, obtaining predictable results.¹¹ Nevertheless, narrow-diameter implants represent an alternative to invasive horizontal bone augmentation techniques such as block grafting, reducing healing time and discomfort for patients.¹² Narrow dental implants, however, have a smaller surface area (for osseointegration), are considered more vulnerable to loading forces,¹³ and are often used in complex clinical situations. These limitations should encourage the study of long-term outcomes of narrow dental implants.

Narrow-diameter implants are implants that have a diameter ≤ 3.5 mm.¹² Several studies have reported similar survival and peri-implant marginal bone loss with narrow dental implants compared with standard-diameter implants. The follow-up period of these studies rarely exceeds 5 years,^{3,12–16} and furthermore, authors have reported the need of studies with longer periods of follow-up.^{15,17}

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Additionally, regarding the predictability of performing immediate loading in narrow dental implants, a published systematic review with meta-analysis proposed that loading narrow dental implants during the first 3 months after insertion could increase the failure rate.⁷ Besides, those few studies reporting the long-term performance of narrow dental implants (> 5 years) commonly followed a conventional loading protocol.^{18,19} In this context, studying the long-term evolution of narrow dental implants and evaluating the impact of immediate loading protocols in these reduced-diameter implants would add new information that could influence the decision-making process during the surgical planning.

Thus, the objective of this retrospective study was to assess the effect of implant loading protocol (immediate vs delayed) on the long-term outcomes of 3.0-mm narrow dental implants supporting multiple fixed prostheses. The outcome variables were implant survival, marginal bone loss, occurrence of biologic complications, and occurrence of prosthetic complications.

MATERIALS AND METHODS

Study Design

This article was written following the STROBE (Strengthening the Reporting of Observational studies in Epidemiology) guidelines.²⁰ This study was an observational retrospective cohort study in which dental implants placed in patients fulfilling the following criteria were included:

Inclusion criteria:

- Age > 18 years
- 3.0-mm-diameter implants placed between January 2006 and April 2009
- Implants supporting fixed partial or complete prosthesis

Exclusion criteria:

- Single-unit dental implants

Implant Placement Surgical Protocol

The same experienced practitioner (E.A.) treated all patients following the standard practice in a single private clinic. Prior to the intervention, the surgical planning was done with the aid of a CBCT scan that was visualized using specialized software.

Before surgery, patients received oral hygiene sessions and appropriate prophylaxis. One hour before the intervention, patients received 2 g of amoxicillin and 1 g of acetaminophen. Antibiotic administration continued for 5 to 7 days after surgery.^{21,22} Implant sites were prepared using a low-speed drilling procedure

without irrigation. Alveolar ridge expansion and alveolar ridge split techniques were also performed when necessary.²³ The dental implants included in this study had an external hexagonal connection, with 3.5-mm platform width, 3-mm implant body diameter, and acid-etched surface (Tiny implants, BTI Biotechnology Institute). Before placement, implants were humidified with calcium-activated plasma rich in growth factors (PRGF). The autologous PRGF was obtained following the manufacturer instructions (PRGF, BTI Biotechnology Institute). Briefly, blood was collected in 9-mL citrated tubes and centrifuged for 8 minutes at room temperature.²⁴ Then, the plasma column just above the buffy coat was separated into two fractions: fraction 1 and fraction 2. Fraction 2 was located just above the buffy coat (2 mL). Fraction 1 was the rest of the plasma column above fraction 2. To activate the coagulation cascade and the platelets, 10% calcium chloride solution was added to fraction 2. While still in liquid state, the implant surface was wetted by fraction 2. The implant was then placed in the bone.

The immediate or delayed implant loading was performed following specific clinical criteria. Immediate loading was performed when the implants were inserted in bone types I, II, and III and achieved an insertion torque ≥ 25 Ncm.

After the intervention, patients were advised to take acetaminophen (1 g/8 hours) as needed for pain relief. Patients were also instructed on how to maintain proper oral hygiene around implants. Finally, a panoramic radiograph was taken just after the intervention to verify the adequate placement of the implants.

The provisional prosthesis was made of titanium framework with veneered composite resin. After at least 4 months, the provisional prosthesis was replaced by the definitive prosthesis. The definitive prosthesis was made of chrome-cobalt structure framework with veneered porcelain. The number of implants and number of prosthetic units were calculated and recorded.

After the surgical phase, patients were scheduled following the standard procedures for periodic evaluations at 10 days after intervention, at 1 month, at 3 months, at 6 months, at 1 year, and subsequently, once a year. Radiographs were carried out yearly to assess the marginal bone loss during the follow-up period.

The implant survival was defined as the physical presence of the dental implant in the patient's mouth at the last follow-up visit. The prosthetic failures and complications were also registered.

For marginal bone loss assessment, all panoramic radiographs were performed using a positioning pin (with patient's chin resting on a standard device) and with the Frankfurt plane parallel to the ground. Measurements on the panoramic radiographs were

Table 1 Patient-Related Characteristics of Study Groups

Variable	Total	Delayed loading	Immediate loading	Significance (P)
No. of patients (%)	95	56	39	–
Age: Mean ± SD (years)	57.5 ± 9.4	57.4 ± 9.1	57.7 ± 9.9	.866
Sex				
Male (%)	10/95 (10.5)	4/56 (7.1)	6/36 (16.7)	.198
Female (%)	85/95 (89.5)	52/56 (92.9)	30/36 (83.3)	
Smoking				
Smokers (%)	12/95 (12.6)	5/56 (8.9)	7/36 (19.4)	.193
Nonsmokers (%)	83/95 (87.4)	51/56 (91.1)	29/36 (80.6)	
Cigarettes per day (mean ± SD)	12 ± 8.24	16.17 ± 10.00	10.29 ± 5.82	.213
No. of dental implants	202	131	71	

performed by computer software (Sidexis XG, Sirona Dental Systems). The radiographs were calibrated (1:1) by the known implant length. The distance between the uppermost point of the implant platform and the first bone-to-implant contact was measured both mesially and distally at the baseline and in the last available radiograph. Two baseline marginal bone levels were considered: the level at implant insertion and the level at implant loading. The marginal bone loss was calculated as the difference of the marginal bone level at baseline and at the last available radiograph. The marginal bone loss was expressed as the mean of the mesial and distal bone loss.

Marginal bone loss (since implant loading) equal to or higher than 2 mm was considered as a biologic complication.²⁵

Statistical Analysis

Data included in the final database and the statistical analyses were verified by two independent researchers (S.F.R., M.H.A.).

The two study groups were formulated according to the implant loading protocol (immediate vs delayed loading). Implant- and patient-based descriptive analyses were performed. Absolute and relative frequencies were calculated for qualitative variables and mean and standard deviation for quantitative variables. The Shapiro-Wilk test was applied to analyze the normality of the distribution of the quantitative variables. The chi-square test was employed to compare qualitative variables. The influence of qualitative variables with two categories over marginal bone loss was studied using the Mann-Whitney test or *t* test as appropriate. Meanwhile, the effect of continuous variables on marginal bone loss was assessed with linear regression. The survival rate of the dental implants was assessed by Kaplan-Meier analysis. The influence of variables in the survival rate was compared with the log-rank statistic.

Then, a multiple regression analysis was performed to test the effect of the implant loading protocol and the number of prosthetic units per implant on the marginal bone loss. All the statistical analysis was performed using the IBM SPSS Statistics v15 software package (SPSS). Statistical significance was set at $P < .05$.

RESULTS

Study Cohort

From the initial sample composed of 410 narrow dental implants, the application of inclusion/exclusion criteria resulted in a final sample of 202 implants placed in 95 patients. Two hundred and two implants were excluded because the date of surgery was later than April 2009. Another six implants were also excluded because they were single-unit implants.

In the final sample, 71 implants met the criteria for immediate loading, and 131 did not. The patient demographic characteristics are presented in Table 1. The mean patient age was 58 ± 9 years. Eighty-five patients were women, and 10 were men. Twelve patients were smokers at an average of 12 (range: 5 to 30) cigarettes per day, and 83 patients were not smokers. When comparing demographic data depending on the loading protocol (immediate or delayed protocol), no statistical differences were observed between groups.

3.0-mm Narrow-Diameter Implants

The implant lengths were 8.5 (21 implants), 10 (35 implants), 11 (35 implants), 13 (98 implants), and 15 mm (13 implants). The mean insertion torque was 39.3 ± 20.2 Ncm. Table 2 indicates that only 16.4% of the implants were placed after alveolar ridge split. Each dental implant supported a mean of 1.4 ± 0.4 prosthetic units. The overall implant-related outcomes showed that the implant survival rate was 96.5%

Table 2 Implant-Related Characteristics of Study Groups

Variable	Total	Delayed loading	Immediate loading	Significance (P)
Follow-up, mean ± SD (mo)	107 ± 39	106 ± 40	117 ± 38	.009**
Implant survival (%)	195/202 (96.5)	96.2	97.2	.644
Localization				
Anterior (%)	96/202 (47.5)	57/131 (43.5)	39/71 (54.9)	.121
Posterior (%)	106/202 (52.5)	74/131 (56.5)	32/71 (45.1)	
Maxilla (%)	109/202 (54.0)	98/131 (74.8)	11/71 (15.5)	.001***
Mandible (%)	93/202 (46.0)	33/131 (25.2)	60/71 (84.5)	
Length, mean ± SD (mm)				
8.5 mm (%)	21/202 (10.4)	16/131 (12.1)	5/71 (7.0)	.003
10 mm (%)	35/202 (17.3)	28/131 (21.3)	7/71 (9.9)	
11 mm (%)	35/202 (17.3)	25/131 (19.1)	10/71 (14.1)	
13 mm (%)	98/202 (48.5)	59/131 (45.0)	39/71 (54.9)	
15 mm (%)	13/202 (6.4)	3/131 (2.3)	10/131 (14.1)	
Initial torque, Mean ± SD (Ncm)	39.3 ± 20.20	34.2 ± 19.3	48.7 ± 18.5	.001***
Horizontal bone augmentation surgery				
None (%)	75/202 (37.1)	34/131 (26.6)	41/71 (57.7)	.001***
Expansion (%)	93/202 (46.0)	64/131 (48.8)	29/71 (40.8)	
Ridge split (%)	34/202 (16.8)	33/131 (24.5)	1/71 (2.4)	
Type of prosthesis				
Partial	173/202 (85.6)	116/131 (88.5)	61/71 (85.9)	.935
Complete	29/202 (14.4)	15/131 (11.5)	10/71 (14.1)	
Ratio of prosthetic units and number of supporting implants, mean ± SD	1.4 ± 2.1	1.3 ± 0.33	1.5 ± 0.45	.001***

P* < .01.*P* < .001.**Table 3** Results of Follow-up of Narrow-Diameter Implants

Variable	Total	Delayed loading	Immediate loading	Significance (P)
MBL since loading				
Mean MBL, mean ± SD (mm)	0.9 ± 1.0	0.7 ± 0.9	1.2 ± 1.0	< .001***
MBL since insertion				
Mean MBL, mean ± SD (mm)	1.2 ± 1.0	1.2 ± 1.0	1.2 ± 1.0	.906
Biologic complications (%)	26/202 (12.9)	15/131 (11.4)	14/71 (19.7)	.187
Survival (%)	195/202 (96.5)	96.2	97.2	.644

****P* < .001. MBL = marginal bone loss.

(Table 1). A total of seven implants placed in six different patients failed along the follow-up period. From these seven implants, four were osseointegration failures occurring before the implant loading and early after the insertion and three were intentionally removed due to changes in the prosthetic design. From the remaining implants, two failed 2 years after the placement and one implant 5 years after the surgery. From the recorded variables, smoking (*P* = .005) and complete prosthesis (*P* < .001) were the factors

that negatively affected the survival rate of the dental implants (Table 1). In this sense, 12 subjects in the studied cohort were smokers (12.6%), and 3 of them presented implant failures, in contrast to 4 implant failures that occurred in 3 nonsmoker subjects (83 patients, 87.4%). Similarly, 29 dental implants supported complete prostheses (14.4%), and 5 of the detected failures occurred among these dental implants. In contrast, two failures of dental implants supporting partial prostheses were detected during the follow-up

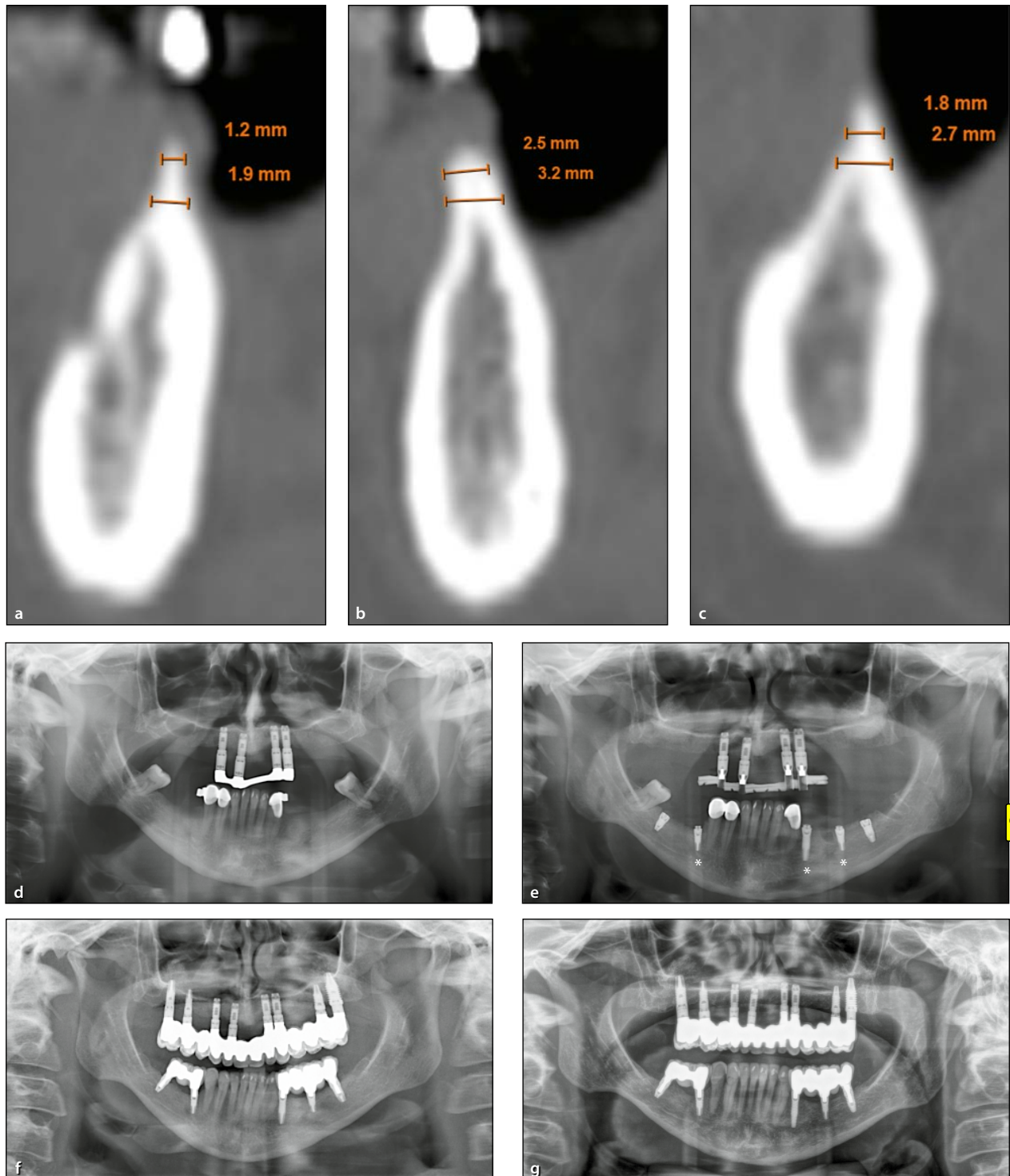


Fig 1 CBCT measurement of the width of the residual alveolar ridge at 1 and 3 mm of the crest: (a) mandibular right second premolar, (b) mandibular left first premolar, (c) mandibular left first molar. Panoramic radiographs showing evolution of patient and 3.0-mm-diameter implants in mandible: (d) before treatment, (e) after implant placement for delayed loading, (f) placement of definitive prosthesis, and (g) after 136 months of implant insertion. * = 3.0-mm-diameter implants.

(173 dental implants, 85.6%). Conversely, the marginal bone loss, since insertion and loading, was 1.2 ± 1.0 and 0.9 ± 0.1 mm, respectively (Table 3). The occurrence of biologic complications, understood as the

occurrence of marginal bone loss higher than 2 mm, occurred around 12.9% of the dental implants. Figures 1 and 2 show examples of clinical cases treated with 3.0-mm dental implants.

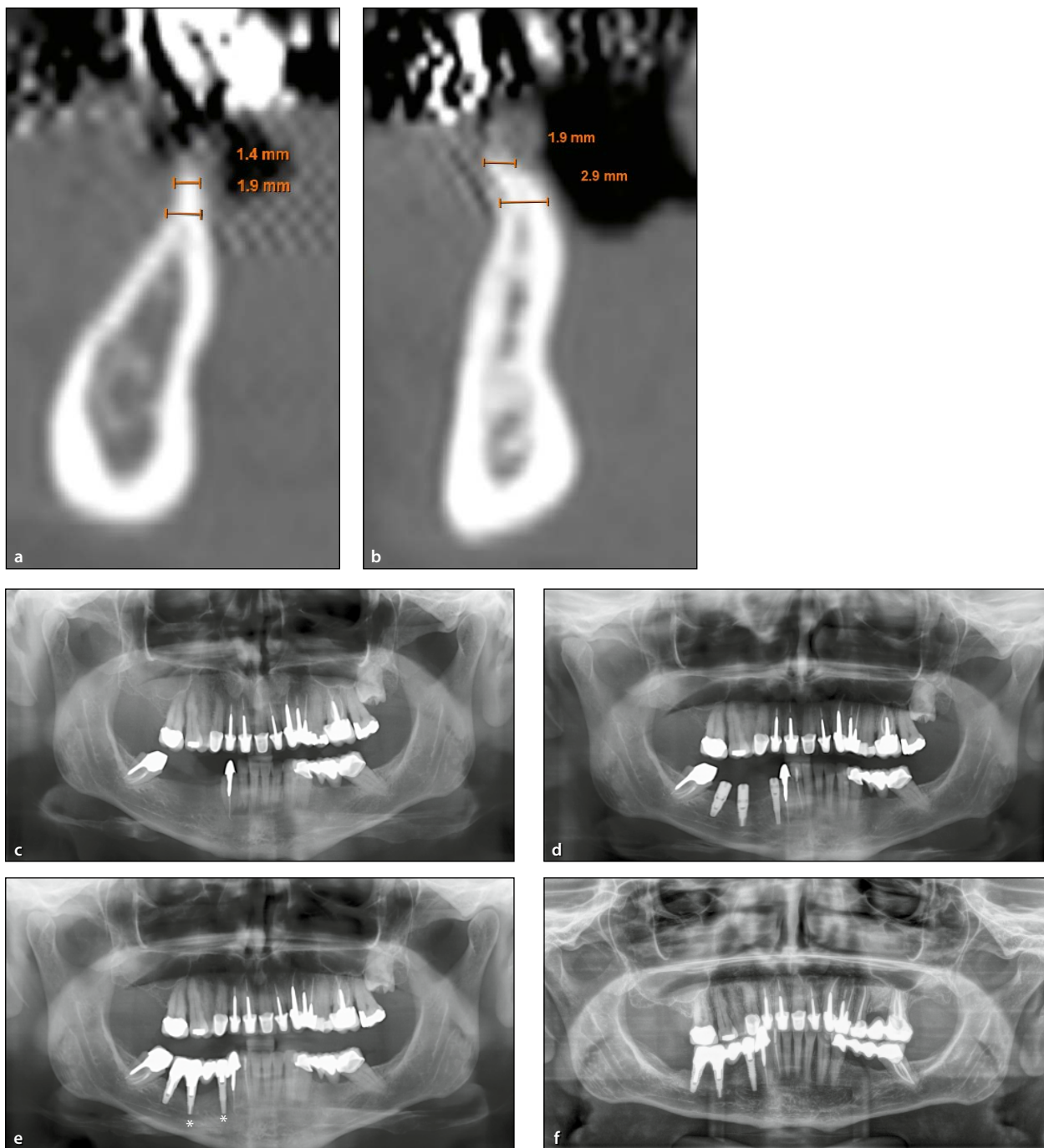


Fig 2 CBCT measurement of the width of the residual alveolar ridge at 1 and 3 mm of the crest: (a) mandibular right first molar, (b) mandibular right first premolar. Panoramic radiographs showing evolution of patient and 3.0-mm-diameter implants in mandible: (c) before treatment, (d) after implant placement for immediate loading, (e) placement of definitive prosthesis, and (f) after 156 months of implant insertion. * = 3.0-mm-diameter implants.

Immediate Versus Delayed Implant Loading

Delayed implant loading was performed in 131 implants and immediate loading in 71 implants. The implant survival rate was 96.2% and 97.2% for delayed and immediately loaded implants, respectively, showing no statistically significant differences. The marginal bone loss was 1.2 ± 1.0 mm for both groups.

Table 1 shows the characteristics of the 95 patients included in the study. Fifty-six patients (131 implants) were in the delayed loading group and 36 (71 implants) in the immediate loading group. The patients in the delayed group were 57 ± 9 years of age, while the patients in the immediate loading group were 58 ± 10 years of age. There were 52 women and 4 men in the delayed loading group. The immediate loading

group had 30 women and 6 men. Smoking was reported by 5 patients in the delayed group at an average of 16 (range: 12 to 30) cigarettes per day. In the immediate loading group, 7 patients were smokers at an average of 10 (range: 5 to 20) cigarettes per day. The statistical analysis showed no significant differences between the groups regarding the patient-related characteristics.

Table 2 shows the characteristics of the 202 dental implants included in the study. In the delayed implant group, the implant lengths were 8.5 mm (16 implants), 10 mm (28 implants), 11 mm (25 implants), 13 mm (59 implants), and 15 mm (10 implants). In the immediate loading group, the implant length distribution was 8.5 mm (5 implants), 10 mm (7 implants), 11 mm (10 implants), 13 mm (39 implants), and 15 mm (10 implants). The differences in the implant lengths between the groups were statistically significant, indicating longer implants in the immediate loading group. In this group, the implants were more frequently placed in the mandible (60 implants vs 33 implants in the delayed loading group).

Immediately loaded implants were associated with less frequency of horizontal bone augmentation surgeries (29 with bone expansion and 1 with alveolar ridge split). Meanwhile, 64 implants in the delayed loading group were associated with bone expansion and 33 with alveolar ridge split. In the delayed loading group, 116 implants supported partial fixed prostheses and 15 supported complete fixed prostheses. For the immediate loading group, 61 implants supported partial fixed prostheses and 10 supported complete fixed prostheses. The ratio between the prosthetic units and the number of supporting implants was higher in the immediate loading group (1.5 vs 1.3).

The follow-up time was 106 ± 40 and 117 ± 38 months in the delayed and immediately loaded implants, respectively ($P = .009$). A total of seven implants placed in six different patients failed along the follow-up period. The delayed loading group accounted for five failures and the immediate loading group for two. Thus, the implant survival rate was 96.2% and 97.2% for delayed and immediately loaded implants, respectively, showing no statistically significant differences. From these seven implants, four were early failures occurring before implant loading and three were intentionally removed due to changes in the prosthetic design.

The influence of the recorded variables in the implant survival rate was evaluated. From the recorded variables, smoking ($P = .005$) and complete prosthesis ($P < .001$) were the factors that negatively affected the survival rate of the dental implants. In this sense, 12 subjects in the studied cohort were smokers (12.6%), and 3 of them presented implant failures, in contrast to 4 implant failures that occurred in 3 nonsmoker

subjects (83 patients, 87.4%). Similarly, 29 dental implants supported complete prostheses (14.4%), and 5 of the detected failures occurred among these dental implants. In contrast, two failures of dental implants supporting partial prostheses failed during the follow-up (173 dental implants, 85.6%). Since smoking and type of prosthesis were statistically associated with implant failure, these variables were included in a multivariate model together with the loading protocol. This analysis revealed that the loading protocol was not statistically associated with implant failure ($P = .492$).

In contrast, the marginal bone loss since insertion was 1.2 ± 1 mm for both groups. The marginal bone loss since loading was 0.7 ± 0.9 mm for the delayed loading group and 1.2 ± 1.0 mm for the immediate loading group ($P < .001$). The presence of statistically significant differences for the marginal bone loss since loading and their absence for the marginal bone loss since insertion indicated that the reference time point is acting as a confounder variable. The marginal bone loss since loading did not indicate the amount of bone remodeling that occurred between implant insertion and implant loading. The influence of the recorded variables in the marginal bone loss was also evaluated. It was observed that the number of prosthetic units per implant was significantly associated with a higher marginal bone loss measured since the implant loading. Moreover, considering that follow-up time could affect bone loss, these variables were included together in a multivariate regression model. This analysis confirmed that the implant loading protocol was independently associated with a higher marginal bone loss measured since the implant loading. Interestingly, these differences disappeared when the bone loss was calculated taking the implant insertion as the reference point ($P = .906$), proposing that the reference time point is acting as a confounder variable. The numbers of implants that presented marginal bone loss ≥ 2 mm were 15 and 14 implants in the delayed and immediate loading groups, respectively, showing no statistically significant differences.

The occurrence of prosthetic failures and complications was also analyzed (Table 4). A total of 12 prosthetic complications occurred in 9 patients. Ten of these complications occurred in the delayed loading group in 7 patients. These complications were as follows: three events of prosthesis renewal due to the insertion of new implants, four events of chipping of the veneering ceramic material, two events of abutment screw fracture, and one event of decementation. For the immediate loading group, one case of decementation and one chipping of the veneering were detected in two different patients. It is worth mentioning that two patients with probable bruxism accounted for two events of chipping and two screw fractures.

Table 4 Occurrence of Prosthetic Complications During the Follow-up Time

Case no.	Complication	Loading protocol	Cemented/ screw- retained	Partial/ complete	No. of implants in the protheses	No. of prosthetic pieces
1	Chipping of the ceramic veneering material	Immediate loading	Cemented	Partial	2	2
2	Chipping of the ceramic veneering material #1	Delayed loading	Screwed	Complete	10	12
	Chipping of the ceramic veneering material #2		Screwed	Complete	10	12
	Abutment screw fracture		Screwed	Complete	10	12
3	Decementation	Delayed loading	Cemented	Complete	10	13
	Prosthesis renewal (insertion of additional new implants)					
4	Chipping of the ceramic veneering material	Delayed loading	Cemented	Partial	4	7
5	Chipping of the ceramic veneering material	Delayed loading	Cemented	Partial	3	4
6	Decementation	Immediate loading	Cemented	Partial	3	3
7	Abutment screw fracture	Delayed loading	Screwed	Complete	6	10
8	Prosthesis renewal (insertion of additional new implants)	Delayed loading	Cemented	Partial	3	3
9	Prosthesis renewal (insertion of additional new implants)	Delayed loading	Cemented	Partial	3	3

DISCUSSION

Ortega-Oller et al, in a systematic review with meta-analysis, observed higher probability of narrow dental implant failure if implant loading was performed within the first 3 months after insertion.⁷ Thus, the aim of this study was to assess the long-term outcomes of narrow dental implants and the influence of implant loading protocol.

In this study, a total of seven implant failures were detected, resulting in a survival rate of 96.5%, and all of them occurred within the first 5 years after insertion. This survival rate is in accordance with previous studies performing long-term follow-up of narrow dental implants, ranging from 91.4% to 98.7%.^{8,10,18} Likewise, the observed peri-implant marginal bone loss (0.87 ± 0.98 mm) was also within the previously reported ranges (from 0.69 to 1.74 mm).^{8,9,18} These results are comparable to the values observed after long-term follow-up of regular-diameter dental implants.¹⁴ Nevertheless, the absolute values of marginal bone loss should be interpreted with caution due to the risk of error derived from measuring in panoramic radiographs. The good performance of the narrow dental implants observed in this study could be related to implant splinting. Indeed, implant splinting reduced the stress suffered by the dental implants and the surrounding bone.²⁶ In contrast, as previously proposed in systematic reviews,²⁷ smoking was identified as a risk factor for implant failure. Besides, implants supporting complete protheses also presented a higher failure rate. In

this sense, a higher marginal bone loss rate has been previously proposed for implants supporting full-arch protheses.²⁸

When comparing performance of narrow dental implants according to the loading protocol, significant differences were observed between the study groups (immediate vs delayed loading) in relation to maxillary or mandibular localization, implant length, and initial torque. These differences could be explained by the clinical criteria used to perform immediate loading (bone types I, II, and III and an insertion torque ≥ 25 Ncm). The observed differences regarding the application of horizontal bone augmentation techniques have to be interpreted with caution, as immediate loading was performed at very low frequency for implants placed by ridge split techniques. This fact could confound the chi-square statistics.

The number of prosthetic units per implant was higher for the immediately loaded implants, and they were followed up during a longer time. The multivariate regression analysis revealed that the immediate loading protocol was associated with higher marginal bone loss measured since implant loading. Nevertheless, these differences disappeared when the bone level at implant insertion was used as the reference point to calculate the marginal bone loss. Taking these results together, it can be concluded that the marginal bone loss measured in the delayed loading group is not considering the bone resorption occurring between the implant insertion and implant loading. Measuring the marginal bone loss since implant insertion has

shown comparable performance between immediate and delayed loading of narrow dental implants. This is in agreement with previous studies and systematic reviews, where it has been proposed that immediate and conventional loading in standard-diameter implants present similar marginal bone loss outcomes.²⁹ Furthermore, the results presented here are opposite to those proposed by previous studies reporting higher failure rates of narrow dental implants subjected to immediate loading.⁷ These differences can probably be explained by the followed criteria for performing immediate loading. In this sense, an appropriate criterion based on the bone type and insertion torque is essential to ensure long-term predictability.

Several studies have reported the occurrence of prosthetic complications in relation to the use of narrow-diameter implants to support fixed prostheses. Garcez-Filho et al studied 40 narrow dental implants, reporting abutment screw loosening (six events) and two events of ceramic fracture.³⁰ Arisan et al studied 302 narrow dental implants and observed 51 events of decementation, 13 events of porcelain fracture, and 10 events of screw loosening.¹⁸ The study by Zinsli et al included 298 narrow dental implants and reported 3 events of screw loosening, 25 events of tightening of the occlusal screw, and 1 event of porcelain fracture.³¹ Mangano et al included 324 narrow dental implants and observed 4 events of decementation, 3 events of porcelain fracture, and 1 event of abutment screw loosening.⁹ Pieri et al studied 113 narrow dental implants and registered 1 event of framework fracture, 3 events of screw fractures, 4 events of decementation, 3 events of screw loosening, and 1 event of ceramic fracture.¹³ From these studies, the most frequent complications were decementation, screw loosening, and ceramic fracture. In the present study, the most frequent complications (although with very low frequency) were chipping of the ceramic veneering material and prosthesis renewal (due to the insertion of additional new implants). It is worth mentioning that two events of chipping of the ceramic veneering material and one event of abutment screw fracture occurred in the same patients with parafunctional habits (probable bruxism). Brägger et al found a significant correlation between bruxism and technical prosthetic complications but not with implant failure.³² Increased overloading would biomechanically stress the implant-prosthesis system. After a long period of function, this overloading may cause a prosthetic complication (prosthesis/implant/screw fracture, chipping, screw loosening, or decementation).^{33–35}

Finally, among the limitations of this study, it has to be mentioned that there is a higher female and partial prosthesis proportion, and it must be taken into account that long-term studies are frequently characterized by a high rate of patients lost to follow-up.

Thus, these retrospectively observed results have to be confirmed in future clinical trials comparing the performance of different loading protocols in narrow-diameter implants with long-term follow-up.

CONCLUSIONS

The implant loading protocol (immediate vs delayed) did not influence the long-term outcomes (survival and marginal bone loss) of 3.0-mm-diameter dental implants supporting fixed multiple prostheses. These results are in favor of considering immediately loaded narrow dental implants (insertion torque ≥ 25 Ncm) as a viable treatment alternative for horizontally resorbed ridges (bone types I, II, and III). Smoking and complete prosthesis were risk factors for the survival of 3.0-mm-diameter implants.

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