Immediate Versus Conventional Loading for the Maxilla with Implants Placed into Fresh and Healed Extraction Sites to Support a Full-Arch Fixed Prosthesis: Nonrandomized Controlled Clinical Study

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Purpose: *To compare immediate and conventional loading of fixed full-arch maxillary prostheses supported by implants placed in healed and fresh postextraction sites.* ***Materials and Methods:*** *This prospective, controlled, nonrandomized 12-month study included 30 consecutive patients requiring fixed full-arch maxillary prostheses supported by implants placed in healed and fresh extraction sites. Fifteen patients were treated with conventional loading (control group), and 15 were treated with immediate loading (test group). Each patient received six to eight implants; implants with insertion torque < 35 Ncm were conventionally loaded and excluded from the analysis. Implant success, biologic and prosthetic complications, success of the immediately loaded provisional prostheses, and marginal bone loss were assessed and analyzed statistically.* ***Results:*** *One test group patient failed to attend recall visits and was excluded from the study, and 16 implants did not achieve insertion torque of 35 Ncm and were excluded from analyses. The final sample included 29 patients and 193 implants (94 test implants, 99 control implants). Implant success rates were 96.8% (test) and 99.0% (control). In the test group, the most common complications were screw loosening and tooth fractures; in the control group, dentures caused discomfort and soft tissue irritation. The success rate of the immediately loaded prostheses was 100%. Average bone loss was 0.61 ± 0.21 mm for test implants and 0.53 ± 0.18 mm for control implants. Differences between loading protocols were not statistically significant.* ***Conclusions:*** *No significant differences in implant success and peri-implant marginal bone loss were seen in the current 12-month comparison of immediate and conventional loading of maxillary fixed full-arch prostheses. Biologic and prosthetic complications were rare with both loading protocols, and all immediately loaded provisional fixed prostheses performed successfully.*
Int J Oral Maxillofac Implants 2013;28:1116–1124. doi: 10.11607/jomi.3119

Key words: *full-arch prosthesis, immediate implants, immediate loading*

Immediate loading is defined as the establishment of occlusal function of implants during the first week following placement, early loading is done between 1 week and 2 months after placement, and conventional loading is initiated at least 2 months after surgery.[1] The traditional implant treatment protocol proposed that implants should remain unloaded during osseointegration to avoid the formation of fibrous tissue between the bone bed and implants, and this has resulted in predictable and high success rates.[2]

Implant-supported fixed full-arch prostheses are currently the treatment alternative that best replaces lost natural teeth and best rehabilitates oral function for edentulous patients. According to the literature, immediately loaded implants with fixed full-arch prostheses, placed both immediately postextraction and in healed sites in the maxilla, achieve very high success rates over several years of follow-up.[3–6] Degidi et al[3] studied 388 implants, of which 213 were placed immediately following extraction. After 5 years only six implants had been lost, yielding 98.1% and 98.9% survival rates for immediate and nonimmediate

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Table 1 Subject and Implant Inclusion and Exclusion Criteria

Inclusion criteria	Exclusion criteria
• Age > 18 y • Full-mouth plaque score and full-mouth bleeding score ≤ 25% • Partially edentulous maxilla with indication to have all remaining teeth extracted • Planned definitive rehabilitation: fixed full-arch implant-supported prosthesis • Sufficient bone height and width to place six to eight implants (at least 10 mm long and at least 3.8 mm in diameter) without performing bone grafting procedures (sinus elevation, block bone grafts, or guided bone regeneration); however, coverage of peri-implant defects and/or gap filling with autologous bone or beta-tricalcium phosphate did not prevent inclusion in the study • Six or more implants with insertion torque ≥ 35 Ncm; for immediate postextraction implants, ≥ 4 mm of apical bone were requested to ensure the necessary primary stability • Signature of informed consent document • Minimum follow-up of 12 months after implant loading	• Sites with acute infection • Implants placed with insertion torque < 35 Ncm • Medical conditions contraindicating implant surgery - Current pregnancy or lactation - Smoking habit - History of bisphosphonate therapy - Current chemotherapy or radiotherapy of head and neck • Severe bruxism • Poor oral hygiene or lack of cooperation with treatment protocol • Incomplete data gathering or failure to attend scheduled control appointments

implants, respectively. In a recent study, Gillot et al[5] performed immediate loading with provisional fixed full-arch maxillary prostheses in 113 consecutive patients treated with 323 implants placed in healed sites and 352 placed in fresh sockets. After 6 months, only six implants, five inserted in fresh sockets and one in a healed site, had been lost; no significant difference was found between implants placed in healed sites versus fresh extraction sites.

Esposito et al,[7] in a recent update of their Cochrane systematic review on loading protocols, found no evidence of a difference in either prosthesis failure or implant failure in the first year, but some evidence of a small reduction in bone loss favoring immediate loading, with some heterogeneity. However, none of the 15 randomized controlled trials that these authors found comparing between immediate and conventional loading were performed in edentulous maxillae. According to a 2009 literature review of Gallucci et al,[8] immediate loading of implants supporting fixed full-arch prostheses in the maxilla had been studied in only three retrospective studies and one prospective study, with survival rates ranging between 87.5% and 98.3%; prosthetic survival had been reported in only one study, which cited a 100% survival rate.

Therefore, the aim of this prospective controlled nonrandomized study with a 12-month follow-up period was to evaluate differences between immediate and conventional loading protocols for fixed full-arch maxillary prostheses supported by implants placed in healed and fresh extraction sites. The following clinical and radiographic variables were assessed: implant success, biologic and prosthetic complications, success of the provisional immediately loaded prostheses, and peri-implant marginal bone loss.

MATERIALS AND METHODS

Study Design and Patient Selection

Between April 2008 and April 2010, 30 consecutive patients with seriously unfavorable prognoses for their maxillary dentition and who therefore required an implant-supported fixed full-arch prosthetic rehabilitation supported by immediate and nonimmediate implants were recruited. A clinical prospective controlled nonrandomized study was performed at the Oral Surgery Unit of the Faculty of Medicine and Dentistry, University of Valencia, Spain. The inclusion and exclusion criteria for the study are detailed in Table 1. The choice of procedure was determined at the time of surgery according to the established treatment protocol for this type of patient at the Oral Surgery Unit. Accordingly, 15 consecutive patients fulfilling the selection criteria were treated following a conventional loading protocol (control group) until July 2009. During this time, a training period on the subject of immediate loading was taking place in the Oral Surgery Unit, and, beginning in September 2009, an immediate loading protocol with a fixed full-arch maxillary prosthesis was implemented for suitable patients. The next 15 consecutive patients fulfilling the inclusion criteria were, therefore, treated with this protocol (test group).

This research was performed following the principles of the Declaration of Helsinki regarding research on humans; accordingly, all patients were fully informed about the study and procedures and were asked to provide written informed consent before taking part. The study design was approved by the ethical board of the University of Valencia (ref no. H1275992266359).

Preoperative Evaluation

Thorough medical histories, clinical examinations, and panoramic radiographs were performed in all cases. Cone beam computed tomographic scans were obtained to assess the availability of bone whenever the surgeon considered this necessary. Diagnostic wax-ups were used to assess tooth locations and emergence profiles, occlusion, lip support, and esthetic parameters. Removable dentures were prepared for all patients, and acrylic resin surgical templates for intraoperative registration of implant positions were prepared for test group patients (Fig 1a).

Periodontal treatment was provided whenever necessary to control inflammation prior to extraction and implant placement. Within 10 days prior to the implant placement surgery, a full-mouth professional prophylaxis appointment was scheduled.

Surgical Procedure

All surgeries were performed by the same surgeon (MP) with local anesthesia (4% articaine with 1:100,000 adrenalin, Inibsa) and intravenous conscious sedation administered by an anesthesiologist (1% propofol solution, Diprivan, Astra Zeneca; and midazolam, Dormicum, Roche). Extractions of remaining teeth were performed as atraumatically as possible, and the sockets were thoroughly debrided. In the test group cases, two to four teeth were conserved to stabilize the resin surgical template and were extracted after registering the positions of th1e implants. Each patient received six to eight Kohno SP implants (Sweden & Martina) (Fig 1b) with the Dual-Engineered Surface (zirconium sandblasted/acid-etched titanium surface treatment at the coronal part of the implant, high-roughness plasma-spray surface treatment of the apical part of the implant). Whenever possible, healed sites were preferred to fresh postextraction sites. When possible, immediate postextraction implants were placed without flap elevation. Anterior immediate implants were placed toward the palatal, and posterior immediate implants were placed in the palatal root sockets. Mucoperiosteal flaps were elevated whenever they were considered necessary to visualize bone or for regeneration. To enhance primary stability, drills and osteotomes were used together to prepare the implant beds. Implants were positioned at the crestal level. Insertion torque values were obtained from the surgical motor. Implants achieving an insertion torque < 35 Ncm were not considered adequate for immediate loading and were excluded from the study. A minimum of six implants with adequate primary stability were required to perform immediate loading. Therefore, whenever fewer than six implants presented < 35 Ncm insertion torque in either group, the patient was excluded. Control group implants were left to heal submerged; test group implant positions were registered and then healing caps were screwed in place. Particulate autogenous bone obtained from drilling was used to cover any dehiscences and fenestrations and to fill implant-bone gaps wider than 2 mm. When it was not possible to obtain sufficient autogenous bone from drilling, beta-tricalcium phosphate (KeraOs, Keramat) was used. Flaps were closed using Polisoft 4/0 sutures (Sweden & Martina).

Patients were prescribed 1 g amoxicillin (GlaxoSmithKline) twice daily for 6 days starting 1 hour prior to surgery,[9] 600 mg ibuprofen (Bexistar, Laboratorio Bacino) three times per day for 5 days, and 0.12% chlorhexidine mouth rinse (GUM, John O. Butler/Sunstar) twice daily commencing 3 days prior to surgery and for 2 weeks thereafter. Patients were instructed in adequate hygiene maintenance, and a soft diet was recommended for 8 weeks. Sutures were removed 7 days after surgery.

Prosthetic Procedures

All prosthetic procedures were performed by the same prosthodontist (JA) and the same dental technician.

In the immediate loading group, implant positions were registered intraoperatively. Provisional abutments were screwed onto the implants, pieces of sterile rubber dam were used to protect the surgical field, and the impression template was stabilized on the remaining teeth and the mucosa of the maxillary tuberosity. The provisional abutments were then splinted to the impression template with DuraLay resin (Reliance Dental Manufacturing). This information was transferred to the patient's diagnostic cast and used to make an acrylic resin provisional full-arch screw-retained metal-reinforced prosthesis with no distal cantilever, which was placed within the first week after implant placement (Figs 1c to 1f). The occlusion was adjusted to provide a balanced distribution of forces. Immediately loaded prostheses were not removed until at least 10 weeks after implant placement. Carefully adapted provisional removable dentures were used until the immediate fixed prostheses were ready; the control group patients used the provisional removable dentures until the definitive prostheses were placed.

In the conventional loading group, stage-two surgery was performed 2 months after implant insertion; the soft tissues were then allowed to heal for 2 weeks. In both groups, the procedures to make the definitive

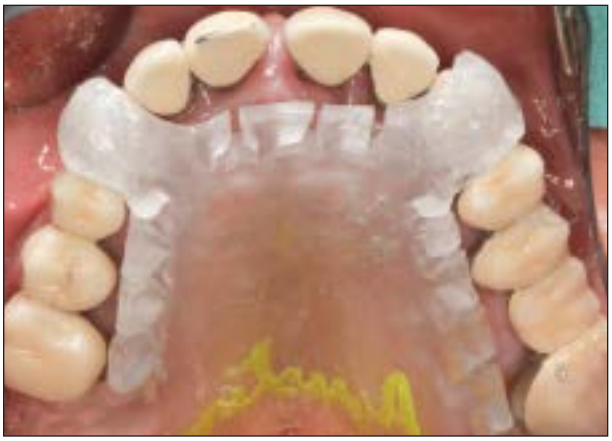

Fig 1a The stability of the acrylic resin template was verified preoperatively.

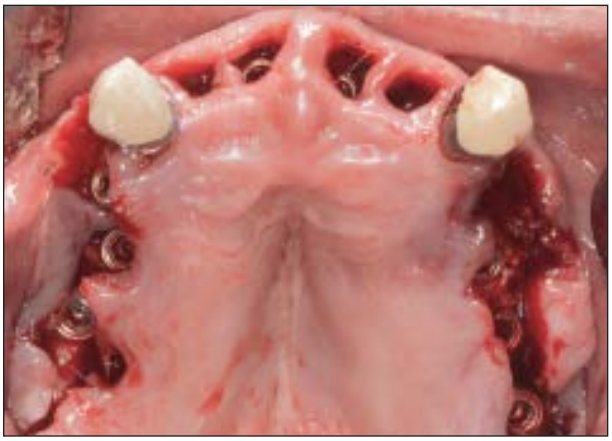

Fig 1b Eight implants were placed; the canines were preserved temporarily to stabilize the template.

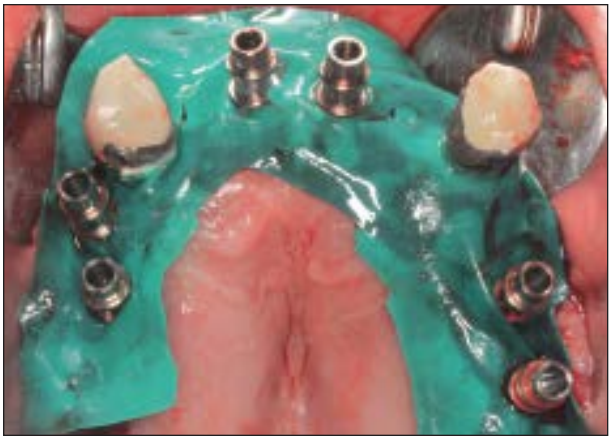

Fig 1c Provisional abutments and sterile rubber dam. The two posterior implants did not achieve sufficient initial stability and were left unloaded.

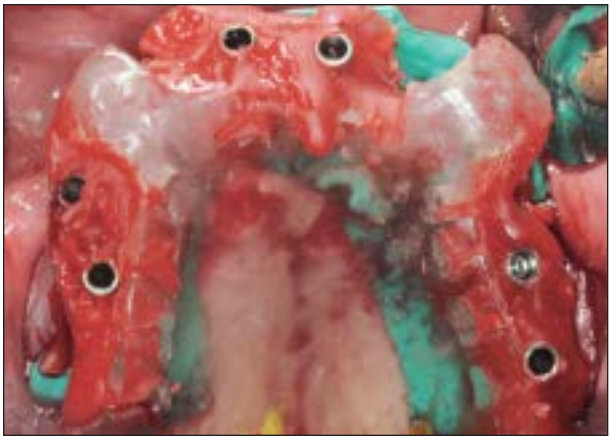

Fig 1d Registration of implant positions with DuraLay resin.

Fig 1e The implant positions were transferred to a modified diagnostic cast.

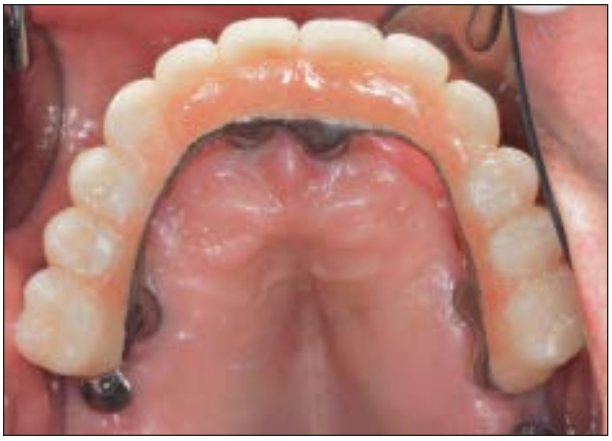

Fig 1f The provisional immediately loaded metal-reinforced fixed prosthesis.

prostheses began approximately 10 to 12 weeks after implant surgery, and these were placed 4 weeks later. Screw-retained full-arch metal-ceramic prostheses were made, with distal cantilevers of up to 10 mm allowed. The occlusion was adjusted to minimize loading on distal cantilevers.

Data Collection and Follow-up

All data were collected by a single trained clinician (DP), who was not the surgeon or the prosthodontist, following a pre-established protocol. Patient age (at implant placement); sex; type of opposing arch (natural, fixed tooth-supported prosthesis, fixed implant-supported metal–acrylic resin prosthesis, fixed implant-supported metal-ceramic prosthesis, removable implant-retained prosthesis); and the primary reason for extraction of the remaining maxillary dentition (periodontal disease, caries, endodontic failure) were recorded. During surgery, the number of implants was registered, and for each implant the position, length, and diameter, along with the type of recipient site (fresh postextraction socket or healed bone) were registered.

Patients were routinely checked 1, 2, 3, 6, and 12 months after implant placement. During these visits, the presence of problems or complications, including the conditions considered as criteria for success, were evaluated. Oral hygiene advice was given to patients, and professional calculus and plaque removal procedures were performed at 6 and 12 months, with occlusal adjustment was performed when necessary.

Implant success was determined according to the clinical and radiographic criteria defined by Buser et al[10]: *(1)* absence of clinically detectable implant mobility, *(2)* absence of pain or any subjective sensation, *(3)* absence of recurrent peri-implant infection, and *(4)* absence of ongoing radiolucency around the implant after 6 and 12 months of loading.

Any biologic and prosthetic complications were recorded at the regular follow-up visits, as were any patient complaints. Based on the Consensus Report of the Seventh European Workshop on Periodontology,[11] any patients with peri-implant gingival redness, swelling, and bleeding on probing but without radiographic signs of bone loss were considered to have peri-implant mucositis. Those implants for which the soft tissue lesion was associated with marginal bone loss and sometimes with suppuration and/or increased probing depth were considered to have peri-implantitis. The provisional and definitive prostheses were checked for fractures, screw loosening, and adequacy of occlusal scheme. Immediately loaded prostheses were considered successful whenever the prosthesis did not have to be removed because of fracture or implant loss and when comfortable rehabilitation of oral function had been accomplished.

Peri-implant marginal bone levels were evaluated using periapical radiographs obtained at baseline (provisional prosthesis placement for the test group, implant placement for the control group) and at the 12-month follow-up visit using the XMIND intraoral system (Groupe Satelec-Pierre Rolland) and an RVG intraoral digital receptor (Dürr Dental). Periapical radiographs were made using the paralleling technique with a film holder and an aiming device (Rinn XCP, Dentsply/Rinn). If the bone levels around the study implants were not clearly visible, new radiographs were made. Peri-implant marginal bone levels were measured by the same operator using Cliniview 5.1 software (Instrumentarium Imaging). Each image was calibrated using the known diameter of each implant. The vertical distance from the outer edge of the implant shoulder (reference point) to the most coronal bone-to-implant contact was measured to the nearest 0.1 mm. Peri-implant marginal bone resorption at the mesial and distal aspects of the implants was calculated from the change in bone level between the baseline and the 1-year control radiographs; for each pair of measurements, the larger value was used.[12] Intraexaminer reliability was determined before evaluating the entire implant sample by reassessing a total of 50 randomly selected sites on duplicate measurements performed on different days. An intraclass correlation coefficient of 0.911 was obtained, showing excellent agreement between the two sets of data. According to Dahlberg's d-value, a 0.047-mm error was estimated in the measurement method.

Statistical Analysis

Statistical analysis was performed with nonparametric tests for implant success, as this was a noncontinuous variable, and marginal bone loss, as this was a continuous variable with asymmetric distribution. The chi-square test and the Mann-Whitney test (MW) were used to evaluate homogeneity within the two groups in relation to the demographic and clinical parameters. The MW was used to assess differences in the primary variables, ie, loading protocol and type of recipient site. The Kruskal-Wallis test was used to assess differences in implant success between groups, determined by considering the loading protocol and the type of recipient site simultaneously. The sample size of the study ensured a statistical power of 0.95 to detect differences between loading groups, for an effect size of 0.5. Statistical analysis was performed with SPSS 15.0 software (IBM) using an alpha value of .05. A biostatistician with expertise in dentistry analyzed the data without knowing the group assignment.

RESULTS

One patient belonging to the test group failed to attend the scheduled recall visits because of personal reasons and was excluded from the study. The final patient sample consisted of 29 patients (16 women and 13 men) with a mean age of 55.4 ± 9.8 years (range, 28 to 77 years). All patients included in the study underwent a minimum of 12 months of follow-up, with

Table 2 Details of the Patient Sample and Analysis of Homogeneity Between Study Groups

Factor	Immediate loading	Conventional loading	Test (*P* value)
Age (y)	53.1 ± 10.6	57.6 ± 8.8	MW = 4,204.5 (.83)
Sex (F/M)	6/7	9/7	Chi^2 = 11 (.91)
Opposing arch			Chi^2 = 13.27 (.58)
Natural or fixed teeth-supported	6	7	
Fixed metal-resin implant-supported	4	3	
Fixed metal-ceramic implant-supported	2	4	
Removable implant-retained	2	1	
Primary reason for extraction			Chi^2 = 9.17 (.47)
Periodontal disease	10	11	
Caries	1	3	
Endodontic failure	3	1	

Table 3 Details of the Implant Sample and Analysis of Homogeneity Between Study Groups

	Immediate loading	Conventional loading	Test (*P* value)
Implant position			Chi^2 = 11.06 (.136)
Anterior region	49	43	
Premolar region	30	34	
Molar region	15	22	
Implant length (mm)			MW = 4,036.5 (.122)
10	23	16	
11.5	30	31	
13	18	33	
15	8	7	
Implant diameter (mm)			Chi^2 = 3.01 (.23)
3.8	11	13	
4.25	75	71	
5.0	8	15	
Recipient site			Chi^2 = 12.17 (.37)
Fresh socket	49	56	
Healed bone	45	43	

an average of 20 months (range, 12 to 36 months). Table 2 provides information on patient age and sex, opposing arch status, and primary reason for teeth extraction. No statistically significant differences existed between the two study groups in these variables.

The 29 patients included in the study received a total of 209 implants. Sixteen implants—nine in the test group and seven in the control group, all of which were placed in molar regions—did not achieve the minimum insertion torque of 35 Ncm and were excluded from analysis, left submerged, and loaded conventionally. Therefore, the final implant sample consisted of 193 implants, 94 in the test group and 99 in the control group. All patients received at least one immediate postextraction implant, and the mean number of immediate postextraction implants per patient was 3.5 in the test group and 3.7 in the control group. Table 3 describes the entire implant sample with regard to position, length, and diameter of implants and whether the recipient site was healed or not. There were no statistically significant differences between the study groups.

The overall implant success rate after the 12-month follow-up was 97.9%. Four implants failed—three in the test group and one in the control group—yielding success rates of 96.8% and 99.0%, respectively. Two implants belonged to the same patient. All four implants had been placed in fresh extraction sockets, presented mobility within the first 8 weeks after insertion, and were removed. All the other implants fulfilled the success criteria defined by Buser et al[10] after 12 months. Differences in success rates between loading protocols were not statistically significant (MW = 4,504.5; *P* = .102), nor were differences in the type of recipient site significant (MW = 4,148.0; *P* = .199). Three lost implants were placed immediately postextraction and immediately loaded; when the combination of loading protocol +

type of recipient site was analyzed, the results showed a moderate tendency to significance but were nevertheless not statistically significant (KW = 6.8; $P = .076$).

No complications occurred during the surgeries, and the only postoperative complications were pain and inflammation, which were absent or slight in most cases and moderate or severe in only a few cases. Seven implants in four patients (two patients in each group) presented with mucositis at the 12-month control visit. All cases resolved within 2 weeks after professional prophylaxis and mouth rinse with chlorhexidine 0.12%. No cases of peri-implantitis were seen.

The most common complications in the test group were related to the provisional prostheses, although all were minor and could be easily fixed. Four patients arrived at the 1- or 2-month control visits with loosened screws, which were retightened. One patient appeared at the 2-month control visit with a fractured acrylic resin tooth; however, the definitive rehabilitation process was already underway and the repair of the tooth was not considered necessary.

All control group patients complained of some level of discomfort with the provisional removable denture: Five presented with ulcers or soft tissue irritation, and four reported that they hardly ever used their denture. One test group patient arrived at the 12-month visit with a fractured central incisor in the definitive metal-ceramic rehabilitation, which had to be removed and sent to the dental technician for repair; in this case, the opposing arch was a metal-ceramic fixed prosthesis. The success rate of the provisional prostheses was 100%. No prostheses had to be removed, despite the early loss of two implants in the same patient; in this case, the prosthesis was kept in place with the support of the remaining six implants.

The average bone level at baseline was 0.2 mm from the reference point in both the test and control groups. After 12 months, the test group patients had lost an average of 0.62 mm of peri-implant bone (range 0.1 to 1.0 mm, standard deviation [SD] 0.23 mm), compared to 0.55 mm (range 0.2 to 1.0 mm, SD 0.26 mm) in the control group. Differences between the two groups for peri-implant bone level changes at the 12-month follow-up were not statistically significant ($P = .310$). Mean bone level changes for the test group implants placed in healed sites and fresh sockets were 0.54 mm (range 0.1 to 0.9 mm, SD 0.23 mm) and 0.74 mm (range 0.3 to 1.0 mm, SD 0.31 mm), respectively. Mean bone level changes for control group implants placed in healed sites and in fresh sockets were 0.51 mm (range 0.2 to 0.8 mm, SD 0.25 mm) and 0.61 mm (range 0.2 to 0.9 mm, SD 0.28 mm), respectively. The type of recipient site had no statistically significant influence on bone resorption in either group (test group, $P = .211$; control group, $P = .232$).

DISCUSSION

According to recent literature reviews, immediate loading of implants with fixed full-arch prostheses can be performed in the maxilla, but there is still a lack of scientific evidence, especially regarding any differences between immediate and conventional loading protocols.[7,8] Only two controlled studies were found.[13,14] Ostman et al[13] performed a nonrandomized prospective study of 20 consecutive patients treated with 123 immediately loaded implants and a previously treated control group of another 20 consecutive patients treated with 120 conventionally loaded implants. Another study by Tealdo et al[14] involved two unmatched groups: 34 patients were treated with immediate postextraction implants and immediate loading (test group), while 15 patients had implants placed 3 months after dental extractions and were rehabilitated following the conventional loading protocol (control group). Moreover, test group patients received four to six implants each, while control group patients received six to eight implants each. Randomized assignment of the loading protocol to previously selected patients would provide the high-quality evidence for loading protocols that is lacking in the literature, but the technically and economically demanding procedures involved in this implant therapy make it difficult to perform randomized clinical trials. In spite of the reduced sample size—29 patients and 193 implants (although with a statistical power of 95%)—and a nonrandomized design, the present study aimed to add to the available evidence for loading protocols with fixed full-arch prostheses in the maxilla by comparing immediate and conventional loading protocols in 30 consecutive patients selected by means of strict, uniform criteria and treated by the same team of professionals using exactly the same procedures, with the exception of the timing of loading.

Most authors consider primary implant stability as the key requirement for immediate loading. Most studies have established a minimum implant insertion torque between 30 and 45 Ncm[13–16] and have considered six implants as the lowest adequate number to achieve a predictable outcome in the maxilla.[3,16–18] If enough implants are placed, immediate loading can be performed, even when all implants have not achieved adequate stability, by leaving unstable implants unloaded.[15] For this reason, the present study regarded the insertion of eight implants as preferable, and in all cases the insertion torque was ≥ 35 Ncm for six or more implants. Implants placed with < 35 Ncm insertion torque (n = 16; test group = 9, control group = 7) were excluded from either group. The aim of this exclusion criterion was to enable the comparison of immediate and conventional loading of implants placed

with adequate primary stability, given that implants that fail to achieve stability at insertion should not be considered candidates for immediate loading. Most authors consider 10 mm as the minimum adequate implant length for immediate loading,[4,14] although some studies have reported the use of 8-mm implants in combination with longer ones.[16,19] Regarding implant diameter, diameters of approximately 4 mm are usually the first choice.[4,14,20] The use of narrower implants has been reported, but only when strictly necessary, with lengths of 13 to 15 mm, and when splinted to wider implants.[13,15,21] Accordingly, in the present study, all implants were required to be at least 10 mm long and at least 3.8 mm wide in both groups. Most studies of immediate loading have assumed that implants placed in grafted bone should not be loaded immediately.[6,13,17–19,22] According to the ITI Consensus Conference in 2008, conventional loading should be the first choice whenever sinus elevation and/or reconstruction of the alveolar ridge are performed.[23] Accordingly, the present study excluded any patients for whom bone grafting procedures (sinus elevation, block bone grafts, or guided bone regeneration) were necessary.

Four implants failed, three in the test group and one in the control group, yielding 96.8% and 99.0% success rates, respectively, but this difference was not statistically significant. The two available controlled studies[13,14] suggest that survival rates achieved with immediate loading with fixed full-arch prostheses are comparable to those of conventionally loaded implants; however, as in the present study, the outcome was slightly worse when immediate loading was performed: Ostman et al[13] reported survival rates of 99.2% and 100% for immediate and conventional loading, respectively, after 12 months, and Tealdo et al[14] obtained 93.9% and 95.9% survival rates, respectively, after 36 months. Three of four failed implants in the present study were placed immediately postextraction and immediately loaded, yielding a 93.9% success rate for this subgroup. The difference versus immediate postextraction + conventional loading (98.2%) was noteworthy, although not statistically significant. Similarly high survival rates have been reported, independent of the status of the recipient site. Degidi et al[3] studied 388 immediately loaded implants, of which 213 were immediate postextraction; survival rates after 5 years were 98.1% and 98.9% for immediate and nonimmediate implants, respectively. Pieri et al[15] treated nine patients with implants placed in postextraction (n = 24) and healed sites (n = 42); only one implant failed in each group, yielding success rates of 95.8% and 97.6%, respectively.

Biologic and prosthetic complications are rare in studies of immediate loading with full-arch prostheses. Both in the literature and in the present study, the only postoperative complications were swelling and pain, which was generally slight and moderate or severe in only a few cases.[3,24] Seven implants in four patients presented with mucositis at the 12-month control visit, which was easily treated, and no cases of peri-implantitis were found. Similarly, van Steenberghe et al[17] studied 184 implants placed in 27 patients and found mucositis in four patients and peri-implantitis in one patient at the 12-month follow-up visit. These were successfully treated, but the number of implants affected in each patient was not specified.

The most frequent complications in studies of immediate loading are those related to the provisional prostheses, most of which are minor and can be easily resolved. Van Steenberghe et al[17] found a broken screw in one patient and occlusal material fractures in two patients. The only complication in the study of Pieri et al[15] was the fracture of an acrylic resin tooth, which happened in three cases. In the present study, four cases presented with loosened screws in the provisional prostheses, which were retightened; one patient presented with a fractured acrylic resin tooth at the 2-month examination. The most severe complications reported in the literature were those leading to implant failures: Grunder[19] and Malo et al[22] described fractures of all–acrylic resin prostheses that resulted in the loss of implants because of harmful forces. No severe prosthetic complications occurred in the present study. Despite the early loss of two implants in the same patient, no provisionals had to be removed, and a 100% success rate was obtained. Several studies have reported the outcome of immediately loaded provisionals; most of them reported 100% survival rates, despite the loss of one or more implants in some cases.[13,15,25] Only Jaffin et al[16] had to substitute a fixed prosthesis for a removable denture during osseointegration in a single case following the loss of several implants.

Two studies have analyzed differences in peri-implant bone loss between immediately and conventionally loaded implants with fixed full-arch prostheses in the maxilla.[13,14] Tealdo et al[14] used paralleled intraoral radiographs to assess bone loss after 12, 24, and 36 months. Bone loss was significantly lower in the immediate loading group at all time points: After 12 months it was 0.8 ± 0.8 mm for the immediate loading group and 1.4 ± 0.8 mm for the conventional loading group; after 24 months, the values were 1.0 ± 0.9 mm and 1.7 ± 0.9 mm, respectively; and after 36 months, average loss was 1.1 ± 0.9 mm and 1.8 ± 1.1, mm respectively. Ostman et al[13] observed an average of 0.8 ± 0.9 mm of bone loss for immediately loaded implants and 0.9 ± 1.0 mm for conventionally loaded implants after a 12-month follow-up, without a statistically significant difference. In the present study, after 12 months, test

implants presented an average bone loss of 0.61 mm and control implants showed an average of 0.53 mm loss, which was not a significant difference. Mean bone loss for test implants placed in healed sites and in fresh sockets were 0.51 mm and 0.78 mm, respectively, and the type of recipient site had no statistically significant influence on bone resorption. Pieri et al[15] analyzed differences between immediately loaded immediate postextraction implants (0.6 ± 0.3 mm) and nonimmediate implants (0.5 ± 0.2 mm), but their results did not differentiate between maxillary and mandibular implants.

CONCLUSIONS

The present study, with a short follow-up period and a small sample, observed no statistically significant differences in implant success and peri-implant marginal bone loss after immediate or conventional loading with fixed full-arch prostheses of implants placed in postextraction and healed sites in the maxilla. Biologic and prosthetic complications were rare among both loading protocols, and all provisional immediately loaded fixed prostheses functioned successfully. Additional studies with longer follow-up times and larger samples are required to better evaluate the influence of loading protocols on the alveolar bone response and the outcome of dental implant therapy.

ACKNOWLEDGMENTS

A grant holder of the VALi+d aid program for Young Researchers awarded by the regional government of Valencia (Consellería de Educación, Generalitat Valenciana) participated in the present study. None of the authors have any conflicts of interest to disclose.

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