

Special reprint from

Volume 26 • Number 1 • 2011

JOMI

The International Journal of
ORAL & MAXILLOFACIAL IMPLANTS

Steven E. Eckert
Editor-in-Chief

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OFFICIAL JOURNAL OF THE ACADEMY OF OSSEOINTEGRATION

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PROOF

Implant-Prosthetic Rehabilitation of the Edentulous Maxilla and Mandible with Immediately Loaded Implants: Preliminary Data from a Retrospective Study, Considering Time of Implantation

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Purpose: This study sought to evaluate treatment outcomes of implant-prosthetic rehabilitation with implants in the edentulous maxilla or mandible that were immediately loaded by fixed prostheses. Special consideration was given to the time of implantation (immediate, delayed, or late implant placement). **Materials and Methods:** Twenty-five patients who received 283 immediately loaded screw-type implants were included in this retrospective study. Data captured included patient file information, panoramic and periapical radiographs obtained during treatment, and clinical parameters examined during the recall period. Clinical and radiographic status of peri-implant soft and hard tissue was evaluated, as well as the function of prostheses and subjective assessment by the patients of the treatment. Survival/success rates were analyzed with respect to the time of implantation. **Results:** Following a maximum observation period of 120 months (median 29 months) postimplantation and subsequent immediate functional loading, implant survival was 99.6% (one implant failed after 20 months). The success rates were 98.2% for implants and 88% for patients; five implants in three patients did not meet success criteria. Neither the implant site nor the time of implantation were associated with unsuccessful outcomes. Implant-related evaluations revealed a significant association between implant success and implant length of 10 mm or less ($P < .018$). **Conclusion:** Within the limits of this study, immediate loading of rough-surfaced, screw-type implants supporting fixed dentures for the treatment of edentulous maxilla or mandible appears to be a reliable treatment option with a high probability of success. The time of implantation did not influence implant survival or success rates. *Int J Oral Maxillofac Implants* 2011;26:139–147

Key words: delayed implantation, dental implants, edentulism, fixed prostheses, immediate loading, immediate implant placement, implant-prosthetic rehabilitation, late implantation

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Immediate prosthetic restoration and loading overcome many of the disadvantages involved in the provisional prosthetic treatment often used during the implant healing period. This includes interference with masticatory function, impaired speaking abilities, and sometimes adverse effects on esthetics.¹ Moreover, the implant failure rate is higher in patients undergoing implant treatment for an edentulous maxilla, compared with patients with partially edentulous maxillae. One suggested explanation for this has been an effect of soft tissue pressure caused by wearing removable prostheses during healing.²

The idea of immediate loading was introduced nearly 30 years ago. Originally, the procedure involved inserting at least four implants into the region between the mental foramina of the edentulous mandible, splinting them with a bar, and loading a bar-retained removable denture.³ High success rates were later reported in the maxilla as well, as long as a sufficient number of implants were immediately loaded with fixed prostheses.⁴ Nonetheless, focused scientific research about the immediate loading of implants inserted into edentulous or partially edentulous mandibles and maxillae has been done only in recent years. Meanwhile, numerous clinical studies and meta-analyses on immediate implant loading have been published, reporting high survival and success rates that are comparable to those seen for conventionally loaded implants.⁴⁻⁶ Among several factors found to predict treatment outcomes for immediately loaded implants, one of the prerequisites for a successful procedure seems to be sufficient primary implant stability.^{4,5}

The concept of immediate loading requires a high standard of knowledge and experience in implant planning, radiographic imaging analysis, clinical examination, surgery, and prosthetic treatment. A thorough exploration of the patient's dental and general medical history prior to implant planning is important to rule out risk factors for implant prognosis.⁷ Moreover, several aspects specific to the immediate loading of implants in the edentulous mandible or maxilla should be considered, as there is a minimum requirement for the sizes and number of implants. Threaded implants with a roughened surface should be preferred, as they usually achieve high primary stability as well as omitting parafunctional loading and restorations with posterior cantilevers.⁷

The rationale behind immediate implantation is to prevent atrophy of the alveolar ridge by placing implants as soon as possible following tooth removal.⁸ Moreover, implantation immediately after tooth removal minimizes surgical procedures and overall treatment time while providing an implant survival rate comparable with that of delayed implantations, which are performed after complete bone healing has occurred at the site of the former alveolar socket.⁹ Immediate loading of immediately placed implants may combine the advantages of these treatment options, and, as a result, may be considered for specific clinical situations.¹⁰ However, sites with insufficient bone volume around immediately placed implants, which generally require simultaneous bone defect augmentation, should be considered cautiously and with restraint for this approach.^{7,11} A recently published systematic review revealed insufficient scientific and clinical documentation for immediate loading of immediately placed implants combined with fixed or removable prostheses in both the maxilla and the mandible.¹²

The objective of the present study was to evaluate the impact of the time of implantation (immediate, delayed, or late implantation) on the outcome of implant-prosthetic rehabilitation of the edentulous mandible and maxilla when treated with implants immediately loaded by fixed prostheses. The working hypothesis was that there would be no significant association between success-defining parameters and the time of implantation of immediately loaded implants.

MATERIALS AND METHODS

Patients undergoing implant-prosthetic treatment of the edentulous maxilla or mandible who received implants loaded with fixed prostheses were included in this retrospective study if the implant number and distribution were considered suitable for immediate loading and if immediate loading was performed. Indications for implant-prosthetic rehabilitation were tooth loss as a consequence of periodontitis, the presence of nonrestorable decayed teeth, or apical periodontitis resulting in a completely edentulous maxilla or mandible.

Data captured from patient files enabled evaluation of the extent of bone loss at implant sites through examination of panoramic and periapical radiographs obtained during the treatment course. No additional examinations beyond those routinely necessary for the treatment were performed, and no additional parameters were evaluated. Data were recorded anonymously and encoded for data protection reasons.

Evaluated Parameters and Success Criteria

Evaluated parameters included patient demographics as well as data characterizing implant site; implant type, diameter, and length; augmentation procedures; and implantation success parameters. Additionally, smoking status and medical conditions were determined with a questionnaire. Patients were considered smokers if they reported regular daily smoking. Bruxism was ruled out by thorough investigation of patient history and by clinical evaluation.

Implant treatment was considered successful if all the following success criteria¹³⁻¹⁵ were met after implantation and prosthesis fixation, as well as at recall examinations.

- Absence of pain or discomfort or any negative subjective sensation
- Absence of clinically detectable implant mobility
- Absence of any recurrent peri-implant mucositis and/or peri-implantitis accompanied by swelling, redness, or pain of the peri-implant mucosa
- Absence of continuous peri-implant radiolucency

- Absence of a mesial and/or distal vertical bone loss of more than 30% of the endosseous part of the implant
- No need to repair or replace or change the implant-supported prosthesis
- Subjective evaluation of the treatment outcome

If one or more success criteria were not met, the corresponding implant was considered unsuccessful.

Treatment Protocol

Following a thorough clinical examination and radiographic imaging, patients were provided with detailed information regarding the planned treatment, alternative treatment options, and possible risks. Written informed consent was obtained from all patients.

All implants were placed under local anesthesia (lidocaine 2% and epinephrine 1:100,000). All patients received perioperative antibiotic treatment (amoxicillin 500 mg three times a day for 7 days) and naproxen (275 mg three times a day) for postoperative pain control.

All surgical procedures were performed in two medical centers by one general practitioner and one experienced oral and maxillofacial surgeon. Implant site preparation was performed according to the manufacturer's guidelines. Bone quality was assessed and categorized by the surgeon at the time of implant site preparation through the perception of drilling resistance and estimation of the local distribution of cortical and cancellous bone. Categorization of sites was performed according to the Misch classification.¹⁶ Immediate implant loading was performed if the surgeon perceived that initial primary implant stability was clinically sufficient.

Implants of the Alpha-Bio implant system (Alpha Bio) were used exclusively. The implant surface is conditioned by acid etching the most coronal part of the implant (1 mm from the implant shoulder), providing a surface roughness of 5 to 10 μm . The apical part of this implant is particle-blasted and acid-etched, resulting in a surface macroroughness of between 20 to 40 μm and microroughness of 2 μm .

The design of the implants used was chosen by the surgeon to be appropriate for the patient's bone quantity and quality. Implants of four different designs were used. The Alpha-Tec Dual Implant (ATI) is a cylindrical screw-type implant with self-cutting threads and a small thread distance. The Dual-Fit Implant (DFI) is a tapered implant with small thread distance that is especially suited for spongy bone to enhance primary stability. The Spiral Implant (SPI) is a tapered screw-type implant with large thread distance and variable thread design for enhanced primary stability. Prosthetic posts were all fixed by an internal-hexagon implant-abutment connection and a titanium screw.

Additionally, Arrow Press Implants (ARRP) with a tapered design, small diameter, and large thread distance were used as transgingival one-piece implants, which include the prosthetic post. Since different implant designs involved different diameters, further categorization based on diameter was performed as follows: implants with a diameter ranging between 2.9 and 3.3 mm were considered narrow, implants with a diameter of 3.75 mm were considered standard, and implant diameters ranging between 4.2 and 6.0 mm were considered wide. Implant lengths ranging between 8.0 and 10.0 mm were considered short, implants that were 11.5 to 13 mm long were considered medium length, and implants 15 to 16 mm in length were considered long.

Time of implantation was selected based on individual requirements. Immediate implantations were performed immediately following tooth removal, and implants were placed into the alveolar sockets. Delayed implantations were performed at 4 to 8 weeks after tooth removal. At that time, the former alveolar socket was covered with epithelium, but bone regeneration had not yet been completed. Late implantations were performed no earlier than 12 weeks postextraction, following complete bone regeneration in the former alveolar socket. All abutments were connected and fixed immediately following implant insertion.

After primary wound closure was achieved by suturing, abutments were ground and the prefabricated provisional fixed total dentures were relined and fixed with provisional cement. Since all implant-retained prostheses were attached immediately following implant insertion, implants were considered immediately loaded following the definitions given by Aparicio et al¹⁷ and Cochran et al.¹⁸ Definitive prostheses were provided 4 to 6 months later and fixed using provisional cement.

Recall examinations were performed 2, 7, and 14 days after fixation of the prosthesis. At this time, the aforementioned parameters were assessed by the surgeons in charge of the treatment. Radiographs were obtained after implant placement and at the 1-year recall appointment. Panoramic radiographs were selected for radiation protection reasons because of the need to evaluate multiple implants per patient. In some cases the technique involved periapical intraoral radiographs using a long-cone radiography unit with the film and implant axis parallel.

At recall examinations, any implant, prosthesis, or patient revealing one or more symptoms indicating an unsuccessful treatment outcome (eg, loosened or lost implants or prosthetic suprastructure, pain or discomfort, peri-implant mucositis or peri-implantitis) were considered unsuccessful and were excluded. If peri-implant mucositis was clinically apparent, radiographic examination was performed and horizontal

Table 1 Distribution of Patients (n = 25) According to Follow-up Period

Follow-up period (mo)	No. of patients	Σ%
120	1	4
60	2	8
> 50	3	12
> 40	3	12
> 30	9	36
> 20	19	76
≥ 12	25	100

and vertical bone levels were evaluated as mentioned earlier. The radiopaque implant with its known dimensions was used as a reference. Additionally, patients were asked to provide a subjective evaluation of the treatment outcome.

Resorbable membranes (porcine collagen, Bio Gide, Geistlich Biomaterials; or synthetic polyglactin, Vicryl, Ethicon/Johnson & Johnson) were used for alveolar ridge defect regeneration by guided bone regeneration. Deproteinized bovine bone mineral (Bio-Oss, Geistlich Biomaterials) was used to fill alveolar ridge defects as well as for sinus elevation and augmentation procedures.

Statistical Analysis

Statistical analysis was performed with SPSS software (version 16.0, IBM). In addition to a per-implant descriptive statistical analysis, which included the data of all implants, a per-patient analysis that considered one randomly selected implant per patient was performed to prevent bias resulting from individual effects. Randomization was performed by selecting one of the implants consecutively, considering the implant region. Deviations between the statistical per-implant and per-patient test results are detailed in the following section; if different results were obtained, the weaker levels of significance were selected.

Cross-table analysis, the chi-square test, and calculation of associations between several parameters were performed, in addition to descriptive statistical analysis using frequency distribution assessment. Associations were considered significant at a *P* value < .05.

Table 2 Distribution of Implants by Region

Region	Entire sample (no. and %)	Randomly selected patient (no. and %)
Maxillary R molars/premolars	40 (14.1%)	4 (16.0%)
Maxillary canines	93 (32.9%)	7 (28.0%)
Maxillary L molars/premolars	39 (13.8%)	4 (16.0%)
Mandibular R molars/premolars	20 (7.1%)	3 (12.0%)
Mandibular canines	68 (24.0%)	3 (12.0%)
Mandibular L molars/premolars	23 (8.1%)	4 (16.0%)

Entire sample n = 283; sample of one randomly selected implant per patient n = 25.

RESULTS

Twenty-five patients receiving 283 implants were included. Thirteen patients were female, and these patients received 131 of the implants. The mean age for the entire patient group was 55.2 years (standard deviation [sd] 7.90; range, 45 to 74 years). The mean observation period, starting from implant insertion and prosthetic loading, was 31.3 months (sd 21.35; range, 12 to 120 months). The distribution of patient numbers versus follow-up period is detailed in Table 1.

Three patients were smokers and received a total of 22 implants. Five patients reported a compromised medical history (three of them had chronic ischemic heart disease, one had hypothyroidism, and one had diabetes mellitus; one also reported osteoporosis). However, no patient was evaluated as exceeding American Society of Anesthesiologists status class 2. No dropouts were registered and all 25 patients were observed regularly.

Implant Distribution and Surgical Parameters

Implant distribution by region is shown in Table 2. One hundred seventy-two (63.3%) implants were placed in the maxilla and 111 (36.7%) were placed in the mandible. Of the entire sample, 70 (24.7%) implants were inserted immediately following tooth removal, 13 (4.6%) were delayed, and 200 (70.7%) were placed late (Table 3).

The most frequently used implant types were ATI (n = 172) and DFI (n = 88). Of the other designs, 11 SPI and 12 ARRP were used. Among immediate

Table 3 Distribution of Implants (n = 283) by Patient, Time of Implantation, and Arch

Pt.	Maxilla				Mandible			
	Immediate	Delayed	Late	Total	Immediate	Delayed	Late	Total
1					2		7	9
2			8	8			10	10
3							6	6
4			12	12				
5		3	6	9			6	6
6	3		6	9	1		9	10
7	6			6				
8			11	11				
9					3		4	7
10		10		10				
11			9	9			10	10
12	6			6				
13	9			9			8	8
14							8	8
15			8	8				
16	6			6				
17	9		1	10				
18	5		2	7				
19			8	8			8	8
20			7	7			6	6
21					2		6	8
22			9	9			7	7
23	1		8	9				
24	6		4	10				
25	5		4	9	6		2	8

implantations, 81.3% were performed using ATI and 9.3% used the DFI. Among late implantations, 57.2% were performed with ATI and 35.6% with DFI.

Standard-diameter (n = 138) and wide-diameter implants (n = 105) were used most frequently. Of the narrow implants (n = 40), 37.5% were of medium length and 55% were long implants. Of the short implants (n = 21), 52.4% were 4.2 mm in diameter and 33.3% were standard-diameter implants.

Short, wide implants were used more frequently in the posterior maxilla and mandible, whereas standard-diameter implants with lengths exceeding 10 mm were used significantly more frequently in anterior regions ($P < .001$). Considering the diameter grouping just described, the difference in distributions of implant diameters versus times of implantation appears marked ($P = .005$). Wide-diameter implants were used mainly for immediate implantations

(in fact, they were used in 48% of immediate implantations), whereas standard-diameter implants were preferred for late implantations (in 52.1% of cases).

Time of implantation was found to be significantly associated with the implant region: late implantations were performed significantly more frequently in the posterior maxilla and mandible, whereas immediate implantations were performed more frequently in the maxillary anterior region ($P = .0001$). In the maxilla, four prostheses were fixed using exclusively immediate implants, six prostheses were fixed with a combination of immediate and late implants, eight prostheses were fixed using only late implants, and two prostheses were supported by a combination of delayed and late implants. In the mandible, five prostheses were fixed exclusively on immediate implants, and nine prostheses were fixed on late implants.

Bone quality assessment revealed a rare appearance of D1 (1.7%) and D4 (0.4%) bone quality. Type D2 bone quality (36.9%) was found mainly in the mandible, whereas D3 bone quality (61%) was identified most frequently in the maxilla. Bone quality was not found to be associated with the extent of radiographically detectable marginal bone loss at the implant sites ($P = .495$).

Lateral ridge augmentation prior to implant placement was required in two implant sites as a staged procedure in the right and left posterior maxilla, respectively. Lateral ridge defect filling, performed at the time of implant placement, was needed for five mandibular implantation sites. Two implantation sites required sinus floor elevation and augmentation simultaneously with implant placement. Performance of augmentation procedures was not associated with treatment failure ($P = .787$). No complications were noted during implant placement or reported during the postoperative course.

Implant-Prosthetic Treatment

All patients received implant-fixed prostheses. Twenty-four of the prostheses were cemented and 10 were screw-retained. The median number of implants supporting a prosthesis in the maxilla was nine (standard deviation 1.6; range, 6 to 12). In the mandible, the median number of implants per prosthesis was eight (standard deviation 1.4; range, 6 to 10). Angulated abutments were used for 98 implants, which supported 10 of the 34 prostheses. There were no significant correlations between the use of angulated abutments and the extent of marginal bone loss ($P = .561$) or the frequency of failing one or more success criteria ($P = .684$). No prosthesis loosening was observed throughout the observation period.

With regard to the opposing dentition, 58.7% of all immediately loaded implants were opposed to implant fixed partial prostheses and 33.9% opposed natural teeth or partial prostheses fixed on natural teeth. Two hundred seventy-five implants with a marginal bone loss of up to 2 mm were opposed to natural teeth or fixed partial prostheses supported by the natural dentition (34.5%) or implant-fixed partial prostheses (59.3%). Eight implants showed a marginal bone loss of 3 to 5 mm. Of these, two implants were opposed to removable complete or partial prostheses, one was opposed to the natural dentition, and three were opposed to implant-fixed partial dentures.

Implant Loss, Parameters Limiting Prognosis, and Success Criteria

One implant (DFI, standard diameter, 13 mm in length) failed after 20 months as a consequence of peri-implant bone loss and loosening, resulting in an im-

plant survival rate of 99.6%. This implant failure was noted in the maxillary right central incisor region of a female patient who smoked about 30 cigarettes per day. The failed implant was removed and the prosthesis was adjusted. No radiographically detectable peri-implant translucencies or peri-implant marginal bone loss exceeding 5 mm were found in any of the other implants in this patient.

Radiographically detectable bone loss of more than 3 to 5 mm was observed at eight implants with lengths ranging between 10 to 16 mm. Two of these implants were 10 mm in length and were therefore considered unsuccessful, as marginal bone loss exceeded 30% of the implant length. None of the other implants showed a marginal bone loss exceeding 5 mm.

On an implant-related basis, five implants were considered unsuccessful, resulting in an overall success rate of 98.2%. On a patient-related basis, the achieved success rate was 88%. Failures included the aforementioned failed implant in a smoking patient, as well as two nonsmokers, in each of whom two implants with late implantation were determined to be unsuccessful according to the success criteria. The first of these was a male patient who experienced marginal bone loss exceeding 30% of the implant length at two standard-diameter implants, each of which were 10-mm long, in the left and right posterior regions of the maxilla. The second was a female patient who suffered from peri-implant mucositis at two narrow-diameter implants, both 13 mm in length, in the mandibular anterior region.

None of the patients reported pain or sensory discomfort, and all patients remained satisfied with the treatment result according to their subjective evaluation. This included the smoking patient who experienced the failing implant, since no changes of the prosthesis were necessary apart from relining the crown that had been supported by the failed implant. The planned prosthetic treatment result was achieved in all patients, and no prosthetic repairs were necessary throughout the observation period.

Implant length was significantly associated with implant success. Although only five implants of the entire cohort were considered unsuccessful, short implants were significantly more common in this group compared to medium and long implants ($P = .029$). A tendency toward an association was found between implant sites showing transverse ridge atrophy and unsuccessful outcomes (where one or more success criteria were not met) ($P = .063$). No significant associations were found between success and implant diameter ($P = .074$), implant type ($P = .746$), implant site (maxilla or mandible) ($P = .444$), location in anterior versus posterior regions ($P = .567$), time of implantation ($P = .394$), smoking status ($P = .150$), or use of guided

bone regeneration techniques ($P = .787$), either for all included implants or for the cohort of one randomly chosen implant per patient.

DISCUSSION

Reduction of treatment time and cost, simplified procedures, and enhancement of patient comfort are sought in modern dentistry, resulting in growing popularity of the concept of immediate implant loading. Nevertheless, critical risk analysis and treatment planning are required prior to making the decision to immediately load implants, while ensuring a predictable treatment outcome. A compilation of the current literature, focusing on both edentulous and partially edentulous patients and based on limited sample sizes and observation periods, shows that different approaches to immediate loading of implants may lead to survival rates comparable to those of implants that are allowed an unloaded healing phase before prosthetic loading. However, definitive conclusions could not be drawn.⁶ Immediate loading of immediately placed implants with fixed prostheses in the edentulous maxilla or mandible currently suffers from a lack of scientific validation by clinical data and is not well supported by the evidence.¹² As a result, retrospective clinical studies as well as prospective clinical studies focusing on long-term outcomes of immediate implant loading, considering different implantation time points, and based on larger sample sizes seem to be required to arrive at treatment recommendations. Within the limits of the retrospective evaluation of treatment courses and the outcomes presented, immediate loading of implants by fixed prostheses in the edentulous maxilla and mandible revealed relatively high implant- and patient-related survival and success rates of implants and prostheses, which could be considered comparable to conventionally loaded implants in comparable situations.

In addition to a high level of patient compliance and oral hygiene and the absence of general medical risk factors known to interfere with the patient's ability to undergo an outpatient oral surgical intervention, several local prerequisites have to be met to justify immediate implant prosthetic loading. Among these, the main requirements are sufficient bone volume and quality to allow for a primary stability of a sufficient number and size of implants, and the use of an implant system with a microstructure and macrostructure that provide high primary stability. Screw-shaped self-tapping implants with a rough surface are preferred to enhance the bone-to-implant contact area and primary stability.¹⁹⁻²² The main implant types used in this study met these requirements: they were characterized

by a microstructured surface and a screw shape with self-cutting threads. The subjective assessment of primary stability of the implants by hand-felt perception of an experienced surgeon has to be critically considered, as even objective insertion torque measurement varies between 10 to 45 Ncm with different implant designs.²³⁻²⁵ Immediate loading of implants will consequently not result in a fibrous encapsulation of the implant, although it is not osseointegrated, at the time of loading.⁶ Fibrous encapsulation of endosseous implants may be expected if the extent of micromovement between the implant and the surrounding bone exceeds a limit of 50 to 150 μm as a result of excessive loading leading to macromovements.^{26,27}

A minimum number of implants seems to be necessary to support implant-supported immediately loaded restorations in the edentulous maxilla or mandible. For the mandible, this recommended minimum is five to six implants.^{28,29} For the treatment of the edentulous maxilla with a restoration supported by immediately loaded implants, required implant numbers varying between five and nine have been reported.^{23,30} Interestingly, the use of more than 10 implants to support a maxillary implant-fixed total prostheses has been associated with a decrease in the implant survival rate to 96.3%, compared to an implant survival rate of 99.3% associated with 10 or fewer implants.³⁰

Finally, rigid splinting of all implants involved in immediate loading is recommended. Whether rigid splinting is provided by metal-reinforced provisional fixed prostheses or by acrylic resin provisional restorations that allow for micromovement of the implants within certain limits is still under discussion.^{23,29-32} The present retrospective study used metal-ceramic prostheses fixed to nine implants in the maxilla and eight implants in the mandible, on average. Two of the implants considered unsuccessful as a consequence of recurrent peri-implant mucositis were positioned in the anterior mandible, with narrow spacing between adjacent implants. This may support the concept of limiting the number of implants to ensure sufficient interimplant space for undisturbed blood supply of the surrounding bone as well as to provide sufficient space between implants and underneath the prosthesis for oral hygiene purposes. Regardless of the time of implantation, data from the present retrospective study reveal that a minimum of six immediate implants, used either alone or in combination with late implants, splinted by fixed prostheses and exposed to immediate loading, could be considered a prerequisite for a successful treatment outcome.

A recent meta-analysis revealed no statistically significant difference in survival between short and long implants with a rough surface placed in totally or partially edentulous patients; the authors concluded that

the placement of short implants is no less efficacious than the placement of implants of 10 mm or longer.³³ However, according to the retrospective study presented, immediate loading of threaded implants of 10 mm or shorter with a rough surface should be performed with caution.

The average marginal bone loss associated with implants exposed to immediate functional loading was reported to be no different from that of implants that received a conventional loading protocol.^{1,29,32} In the present study, two implants in one patient were considered unsuccessful because of marginal bone loss exceeding 30% of the implant length. Concerning this parameter for success evaluation,¹⁵ the relative influence of marginal bone loss at short implants should be considered. These implants were in the right second molar and left first molar positions in the maxilla and supported a fixed prosthesis that opposed a removable partial prosthesis that was supported by natural teeth. Since bruxism was ruled out as a cause of failure, by both thorough investigation of the patient history as well as clinical evaluation, and since the majority of implants showed an average marginal bone loss of no more than 2 mm while opposing a natural dentition or implant-fixed partial prostheses, enhanced masticatory forces should not be considered as a risk factor for marginal bone resorption within the limits of this study.

Smoking is considered a significant risk factor for implant prognosis.³⁴ One of the three smoking patients in the present study revealed an unsuccessful outcome. However, the distribution of implant failure among smokers compared to nonsmokers was not significantly different. This could be a result of the use of implants with a rough surface, as similar effects with microstructured implant surfaces in smokers were previously reported.³⁵

Although diabetes mellitus and bone metabolism impairment were considered risk factors for implant treatment,^{36,37} the two patients who reported these risk factors in their history experienced successful results. This might support the necessity of a thorough medical history, close cooperation with the general practitioner involved in treatment, and frequent recall intervals to facilitate early detection of peri-implant symptoms if they arise.

CONCLUSIONS

Within the limits of this retrospective study, it can be concluded that immediate loading of screw-type implants with a rough surface supporting fixed prostheses for the treatment of the edentulous maxilla or mandible is a predictable treatment option with a

high success rate. The time of implantation (immediate, delayed, or late) did not influence implant survival or success rates. Implants with lengths of 10 mm or less should be used with caution in edentulous patients if immediate loading with fixed prostheses is planned.

ACKNOWLEDGMENTS

The authors gratefully acknowledge Raveh Gill-More, MBA, MSc, for his valuable contribution and help in preparation of the manuscript. The authors do not have any financial interests, either directly or indirectly, in the products listed in the study. The authors report no conflict of interest.

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