Radiographic Changes Around Immediately Restored Dental Implants in Periodontally Susceptible Patients: 1-year Results

Jacob Horwitz, DMD[1]/Otman Zuabi, DMD[2]/Eli Machtei, DMD[3]

Purpose: *There is little information available about radiographic bone changes around immediately restored implants in periodontally compromised patients. The aims of this study were to evaluate the effect of immediate restoration on radiographic bone changes and to compare radiographic changes between arches and between healed and extraction sites in periodontally susceptible patients.* ***Materials and Methods:*** *Patients received periodontal treatment. "All in one" implant surgery was then performed: Hopeless teeth were extracted, debridement around remaining adjacent teeth was performed, implants were inserted guided by a surgical stent, and a prefabricated screwed provisional restoration was immediately delivered on selected implants. Periapical radiographs using a parallelism appliance were taken at implant surgery and 6 and 12 months postsurgery. The distance between the alveolar crest and the implant shoulder was measured at the mesial and distal aspect of each implant. Bone changes were compared between immediately restored, submerged, and nonrestored implants; between arches; and between healed and extraction sites.* ***Results:*** *Nineteen patients received 74 implants. Twelve implants in 4 patients failed within the first 6 months. Mean bone changes (± SE) between baseline and 12 months ranged between −1.19 ± 0.19 mm and −1.88 ± 0.3 mm. No difference was found between restored versus nonrestored sites or between maxillary and mandibular sites. Bone loss was slightly higher in healed sites.* ***Conclusions:*** *First-year bone changes around immediately restored dental implants in periodontally susceptible patients were slightly higher than most reports in the literature. This indicates a potential influence of periodontal disease on the success rate of dental implants.* INT J ORAL MAXILLOFAC IMPLANTS 2008;23:531–538

Key words: *bone loss, dental implants, immediate loading, periodontal disease*

One of the various indications of implant therapy is the replacement of periodontally hopeless teeth. The successful use of dental implants for more than 3 decades has been extensively documented for both conventional and immediate implant therapy.[1-9] In a recent review of the literature,[10] implant patients who had been treated for periodontitis were shown to run a greater risk for developing complications, evidenced because of loss of supporting bone and implant loss, as compared to individuals without such a history. Likewise, Hardt et al[11] also found a higher failure rate in patients who experienced loss of alveolar-bone support. Implants placed in sites where teeth were removed for periodontal reasons were 2.3 times more likely to fail than implants placed in other sites.[9] However, other investigators have demonstrated survival rates in periodontally compromised patients that were similar to those reported for healthy patients.[12]

Immediate restoration of dental implants has been gaining popularity in recent years.[13–23] Published survival and success rates for such protocols seem to be similar to those of the traditional protocol of loading at 3 to 6 months after implant insertion. Immediate restoration of dental implants can have significant advantages, especially in the esthetic zone, including shortening treatment time and improving the esthetic outcome. Obviously, patients with hopeless teeth due to periodontal disease would benefit from such a treatment modality, especially if those teeth could be extracted and immediately restored with implant-supported crowns or partial prostheses.

[1]Senior Staff Physician, Unit of Periodontology, Department of Oral and Dental Medicine, Rambam Health Care Campus, Haifa, Israel; Instructor, Faculty of Medicine, Technion, Haifa, Israel.
[2]Senior Staff Physician, Unit of Periodontology, Department of Oral and Dental Medicine, Rambam Health Care Campus, Haifa, Israel.
[3]Department head, Unit of Periodontology, Department of Oral and Dental Medicine, Rambam Health Care Campus, Haifa, Israel; Professor, Faculty of Medicine, Technion, Haifa, Israel.

Correspondence to: Dr Jacob Horwitz, Unit of Periodontology, Department of Oral and Dental Medicine, Rambam Health Care Campus, PO Box 9602, Haifa 31096, Israel. Fax: +972 4 854 3057. E-mail: j_horwitz@rambam.health.gov.il

Crestal bone loss is often used to evaluate implant status and success.[24] Conventional radiography using the long-cone paralleling technique with positioning devices is generally used to evaluate marginal bone changes at interproximal sites of osseointegrated implants.[25] Crestal bone loss ≤ 1.5 mm in the first year is considered a criterion for implant success.[1] Reports of average crestal bone loss around immediately restored implants at 1 year postplacement range from 0.01 mm to 0.78 mm.[26,27] There is little short- or long-term data available about radiographic bone changes in immediately restored implants in periodontally compromised patients.

Therefore, the aims of the present study were *(1)* to evaluate the influence of immediate restoration on radiographic bone changes around dental implants and *(2)* to compare radiographic bone changes between the maxilla and the mandible and between healed and extraction sites in periodontally compromised patients.

MATERIALS AND METHODS

Patients being treated by the Unit of Periodontology at the Rambam Health Care Campus were asked to participate in the study if they were between the ages of 18 and 75, had been diagnosed with chronic periodontitis based on clinical and radiographic assessments,[28] had no complicating systemic conditions that contraindicated surgical periodontal and implant treatment (eg, pregnancy, uncontrolled diabetes), and required *(1)* a fixed full-arch restoration for the maxilla or mandible or *(2)* a fixed partial implant-supported restoration in the esthetic zone.

Patients received periodontal treatment, including oral hygiene instructions, scaling and root planing, and periodontal surgery, as necessary. Casts, periapical and panoramic radiographs, and computerized tomography (CT) were used for evaluation and treatment planning. Treatment options were presented to the patient, and final eligibility was ascertained when patients expressed their preference for a fixed restoration.

The study was carried out in accordance with the Helsinki Declaration guidelines. All patients signed an informed consent form.

Implant surgery included extraction of teeth that had inadequate attachment to be maintained.[29] Implants (MIS Implant Technologies, Shlomi, Israel) were inserted with the aid of a surgical guide. One or 2 implants were used for the support of partial prostheses. In fully edentulous arches, 3 to 4 implants were used for the support of a provisional restoration. Implant stability quotient (ISQ) was used as a guide in deciding between immediate and conventional restoration, and implant locations were selected strategically to provide an adequate provisional esthetic solution. Conical abutments were connected to the implants, and a prefabricated screw-retained restoration was adjusted and delivered according to the following guidelines:

1. Care was taken to achieve a passive fit to the implants.
2. No contact between the restoration and adjacent teeth was allowed.
3. Single and partial-arch restorations were delivered with no occlusal contact of the restoration with the opposing arch in intercuspation or lateral or protrusive movement.
4. Full-arch restorations were placed in balanced occlusion. The rest of the implants either received healing abutments and were left to heal (nonsubmerged 1-stage implants) or were submerged for a period of 6 months. The opposing-arch dentition consisted of natural teeth and/or a fixed tooth-supported restoration.

Patients were prescribed a postoperative 0.2% chlorhexidine mouthrinse, amoxicillin (500 mg thrice a day for 7 days), and analgesic therapy as necessary.

Patients were examined 7 to 10 days after surgery for suture removal and then after 2 weeks, 4 weeks, 8 weeks, and 3 months. At 6 months the restoration was removed, interim implant success was evaluated, second-stage surgery was performed for the submerged implants, and patients were referred to a prosthodontist for their definitive prosthetic restorations. Failed implants were replaced by additional implants, which were not included in the analysis.

All implants observed could be categorized as *(1)* immediately restored, *(2)* submerged, and *(3)* nonsubmerged and not restored.

Three groups of implants were observed: immediately restored (R), Submerged (S) and nonsubmerged nonrestored (NR).

Periapical radiographs were made with a parallelism appliance (XCP film holder; Rinn/Dentsply International, York, PA) at implant surgery and at 6 and at 12 months postsurgery. All radiographs were digitized and stored electronically using a scanner (DiMAGE Scan Elite II; Konica Minolta Holdings, Chiyoda-ku, Tokyo 3, Japan). Next, using computer software for digital measurement (Virtual Measuring Tape, Tel Aviv, Israel), the distance between the alveolar crest and the implant shoulder was measured at the mesial and distal aspect of each implant (Fig 1). Radiographic data are reported as the distance in millimeters between the implant shoulder and alveolar bone crest (mean ± SE), both separately for the mesial and distal aspects of the implants and also as means of the mesial and distal values.

Data Management and Analysis

Data analysis was performed using the SPSS 11.5 statistical package (SPSS, Chicago, IL). Univariate and multivariate linear mixed models were used for the comparison of bone loss between groups. The implant was chosen as the statistical unit. Adjustments were made for the presence of multiple implants in the same subject, immediate restoration, extraction sites, and jaw. The Kolmogorov-Smirnov test was applied to residuals from the model to test the normality assumption.

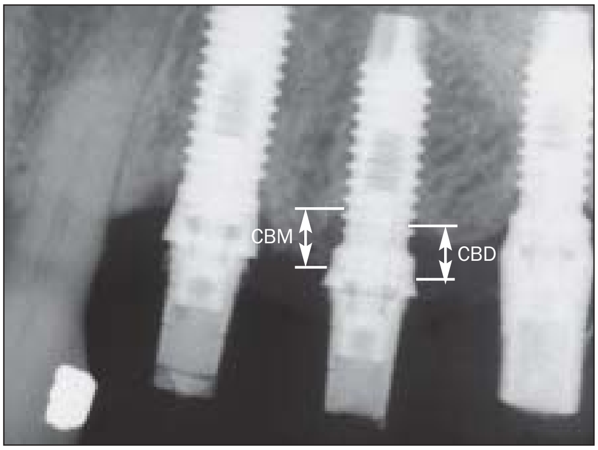

Fig 1 Radiographic measurement of bone level changes. CBM = the distance between the implant shoulder and the mesial bone level. CBD = the distance between the implant shoulder and the distal bone level.

RESULTS

Nineteen patients (17 women and 2 men) between 34 and 79 years old (mean ± SD, 53 ± 8.62) were accepted into the study. Patients were generally diagnosed with moderate to severe generalized chronic periodontitis, which was evidenced by their extensive bone loss; mean remaining bone support, calculated as the ratio between alveolar bone height and root length, was 52% (range, 31% to 76%; data not shown).

The study sample included 3 maxillary full-arch prostheses, 2 mandibular full-arch prostheses, 7 maxillary partial prostheses, 5 mandibular partial-arch prostheses, and 5 single-tooth restorations (1 mandibular and the rest maxillary). Forty-one implants were immediately placed after tooth extraction, and, of those, 26 were immediately restored. The rest (n = 33) were inserted in edentulous ridges. Grafting materials were used for 18 implants. Twelve implants failed, resulting in an overall 1-year survival rate of 84%. Two of the failed implants were grafted.

The Kolmogorov-Smirnov test was applied to residuals from the model to test the normality assumption. No deviations from normality were found. A detailed description of clinical results is given elsewhere.[30]

Baseline bone levels were comparable in failed and surviving implants (0.33 ± 0.1 mm vs 0.52 ± 0.24 mm, respectively, $P > .05$). Mean baseline bone height was 0.52 ± 0.11 mm for the immediately restored group, 0.09 ± 0.06 mm for the submerged group, and 0.34 ± 0.21 mm for the nonrestored groups (Table 1). Differences did not reach statistical significance. Mean bone level changes from 0 to 6 months were similar for the various loading groups, ranging between –0.71 and –0.99 mm ($P > .05$; Table 2). There was a statistically significant difference in mean bone level changes from 6 to 12 months between the immediately restored and submerged groups (–0.24 ± 0.13 mm vs –0.85 ± 0.12 mm, respectively, $P < .05$) as well as a difference in mesial bone loss from 6 to 12 months between the immediately restored and submerged groups (–0.27 ± 0.17 mm and –0.99 ± 0.18 mm, respectively, $P = .05$). However, the differences in distal bone loss for these groups did not reach statistical significance (–0.32 ± 0.69 mm vs –0.72 ± 0.15 mm). Mean bone level changes from 0 to 12 months were between –1.19 ± 0.19 mm and –1.88 ± 0.3 mm in the various treatment groups, the difference not reaching statistical significance.

Nonextraction sites were compared to extraction sites (Table 3). Mean bone changes between 0 and 6 months were similar for nonextraction and extraction groups ($P > .05$). Mean bone level changes from 0 to 12 months for nonextraction versus extraction sites did not reach statistical significance, while there was a significant difference for distal bone level changes between these groups ($P < .05$).

Data was also stratified between maxillary and mandibular implants (Table 4). No significant differences were found in bone level changes between the groups.

DISCUSSION

Survival and success rates for dental implants placed in periodontally susceptible patients may be reduced compared to periodontally healthy individuals.[10] Various studies have presented a relatively large variability in survival rates for immediately restored implants (80% to 100%).[31–33] In a recent review,[34] the 12-month survival rates with immediate/early loading ranged from 80% to 100%, while control (delayed

Table 1 Baseline Peri-implant Bone Levels in mm

	Crestal bone level					
	Mesial		Distal		Mean	
	Mean	SE	Mean	SE	Mean	SE
Immediately restored	0.52	0.14	0.50	0.15	0.52	0.11
Submerged	0.03	0.07	0.15	0.10	0.09	0.06
Nonrestored	0.54	0.23	0.14	0.25	0.34	0.21
P	.087		.144		.067	

Table 2 Bone Level Changes in mm According to Restoration Type

Change in crestal bone level	Immediately restored		Submerged		Nonrestored		*P**	
	Mean	SE	Mean	SE	Mean	SE	Univariate	Multivariate
0 to 6 mo								
Mesial	−0.87	0.15	−0.69	0.20	−0.62	0.31	.566	.420
Distal	−1.09	0.16	−1.01	0.27	−0.80	0.30	.794	.569
Mean	−0.99	0.13	−0.88	0.21	−0.71	0.26	.543	.349
6 to 12 mo								
Mesial	−0.27	0.17	−0.99	0.18	−0.66	0.38	.044	.050
Distal	−0.32	0.69	−0.72	0.15	−0.91	0.42	.177	.248
Mean	−0.24	0.13	−0.85	0.12	−0.79	0.40	.039	.046
0 to 12 mo								
Mesial	−1.19	0.19	−1.72	0.23	−1.29	0.36	.239	.251
Distal	−1.33	0.16	−1.70	0.27	−1.88	0.30	.185	.450
Mean	−1.27	0.18	−1.71	0.21	−1.59	0.28	.320	.385

*Analysis of variance.

Table 3 Bone level Changes in mm of Nonextraction Sites Versus Extraction Sites

Change in crestal bone level	Nonextraction		Extraction		*P**
	Mean	SE	Mean	SE	
0 to 6 mo					
Mesial	−0.92	0.16	−0.65	0.15	.2090
Distal	−1.11	0.17	−0.93	0.18	.4775
Mean	−1.03	0.14	−0.80	0.14	.2694
6 to 12 mo					
Mesial	−0.59	0.15	−0.57	0.20	.3128
Distal	−0.72	0.14	−0.35	0.13	.0664
Mean	−0.63	0.13	−0.44	0.15	.3469
0 to 12 mo					
Mesial	−1.51	0.15	−1.23	0.23	.3182
Distal	−1.81	0.16	−1.25	0.21	.0388
Mean	−1.66	0.14	−1.23	0.20	.0896

*Student *t* test.

loading) implant survival rates ranged from 95% to 100%. In the present study, the 12-month survival rate for immediately restored implants was 100% for implants supporting partial prostheses; it was 93% for the 2 mandibular full-arch cases and 52% for the 3 maxillary full-arch cases. The overall survival rate of 84%, although low, falls within the range reported in the literature. Possible reasons for failures in the present study include periodontal disease and loading characteristics. Most failures occurred in cases of full-arch rehabilitation, where all remaining teeth had to be extracted due to the extent and severity of periodontal disease. In those cases, loading in intercuspation and lateral excursions was immediate. The combination of the 2 parameters might have led to an increased risk of failure.

Table 4 Bone Level Changes of Maxillary Versus Mandibular Implants

Change in crestal bone level	Maxilla		Mandible		
	Mean	SE	Mean	SE	*P**
0 to 6 mo					
Mesial	−0.79	0.13	−0.76	0.19	.8729
Distal	−0.97	0.18	−1.07	0.17	.6985
Mean	−0.88	0.13	−0.94	0.16	.7673
6 to 12 mo					
Mesial	−0.60	0.16	−0.55	0.19	.8297
Distal	−0.50	0.12	−0.58	0.18	.6818
Mean	−0.55	0.13	−0.51	0.16	.8609
0 to 12 mo					
Mesial	−1.38	0.18	−1.34	0.23	.8614
Distal	−1.43	0.20	−1.64	0.18	.4538
Mean	−1.41	0.17	−1.49	0.18	.7453

*Student *t* test.

Once the implants are integrated, it is valuable to examine patterns of radiographic bone changes and relate them to criteria used to evaluate implant success, both short and long term.[1] In the present study, mean baseline bone level was higher for submerged 2-stage implants. Implants in this group were placed more apically than nonsubmerged implants to allow primary flap closure. Bone loss at 6 months, however, was similar in the submerged and nonsubmerged groups. From 6 to 12 months, crestal bone loss decreased to 0.27 to 0.32 mm in the immediately restored group, while in the submerged group, in which second-stage surgery was performed, it was higher (0.69 to 1.01 mm). Interestingly, first-year bone loss in the submerged group was slightly higher than in the immediately restored group, despite a shorter exposure to the oral environment. This corroborates the findings of Lorenzoni et al,[33] who found that bone loss was lower in immediately restored implants versus conventionally restored ones. Second-stage surgery, which may be accountable for 40% of initial bone loss,[35] may partly explain this phenomenon.

First-year mean bone loss in the present study ranged between 1.19 and 1.88 mm in the various study groups. This amount of bone loss corroborates results from some previous publications.[1,36] One-year results in the literature, however, vary widely. De Bruyn et al,[37] in a study with similar loading groups, found an average marginal bone loss at 1 year of 1.6 mm, which is similar to the present study. Abboud et al[26] found at 12 months a mean change in marginal bone level of only 0.01 mm. Calandriello et al[38] found 0.71 mm bone loss after 12 months, and Lorenzoni et al[33] reported mean coronal bone level changes of 0.45 and 0.75 mm at 6 and 12 months. Rocci et al[39,40] found marginal bone resorption of 0.9 to 1 mm after 1 year of loading. Other publications report on crestal bone loss around immediately loaded implants at 6 months[19,41] and also at 1, 2, 4, 6, and 7 years.[19,42–46] Mean bone loss in these studies ranges from 0.01 mm to 0.78 mm. The magnitude of first-year bone loss in conventionally restored implants is around 1 mm.[47] In a review of the literature, Ganeles and Wismeijer[48] concluded that bone loss in immediately restored implants is similar to conventional loading.

In view of the above, first-year bone loss in the present study is in the high end of the range reported in previous studies. The effect of the patients' periodontal disease history on implant success rate has been previously described[49-51] and reviewed[10] and may be a significant factor affecting bone loss in those patients.

Variations in host immune-inflammatory response, which are known to affect periodontal destruction,[52] may affect bone levels around implants. This, however, has not been reported as yet. To the contrary, patients positive for IL-1 genotype that were treated for periodontal disease and received dental implants were not more prone to implant loss.[53]

Additional factors such as surgical-, host-, and implant-related factors[14] cannot be addressed here due to lack of controls for these parameters. Nevertheless, all treatment procedures were performed by the same surgeons, which provided a certain consistency of surgical factors.

Excessive occlusal forces were reported to have no influence on bone levels in dogs.[54] In the present study, the immediately restored group exhibited less bone loss than the submerged group. However, it is possible that the destructive influence of excessive occlusal forces was expressed in implant failures and that surviving implants did not have abnormally high occlusal forces, which may lead to increased bone loss.

It would be valuable to investigate the influence of implant-related factors, such as implant geometry and surface characteristics, on success rates and, in particular, bone levels, since Esposito et al,[55] in a review of the literature, found minor but statistically significant differences for peri-implant bone level changes between different implant types.

Although implants placed immediately postextraction had a significantly lower survival rate, the remaining implants in this subgroup demonstrated lower bone loss than implants placed in healed edentulous ridges. In a recent literature review,[56] the percentage of implant loss for immediately placed implants in retrospective studies ranged from 0% to 14.8%, with the highest rates of implant loss reported for immediately placed and loaded implants. In this review, the included prospective studies had a total of 1,126 implants placed in extraction sockets, with implant loss ranging between 0% and 40%.[57] In the present study, 35% of immediately restored implants placed in extraction sockets failed, while only 6% of nonextraction site implants failed.[30] This stands in contrast to the potential benefit of immediate implantation in preserving bone levels[58] and in contrast to a review of the literature which found that short-term survival rates and clinical outcomes of immediate and delayed implants were similar and comparable to those of implants placed in healed alveolar ridges.[59] The low survival rate of immediate implants in the present study may result from the combination of extraction of periodontally diseased teeth and loading of the implants.

No difference was found in bone level changes between maxillary and mandibular implants, which corroborates the findings of Quirynen et al,[60] who found no difference in bone loss between the maxilla and mandible. In contrast, Penarrocha et al[61] and Naert et al[62] found a higher maxillary bone loss.

CONCLUSIONS

First-year bone level changes around immediately restored dental implants in periodontally susceptible patients were found to be slightly higher than most reports in the literature. This indicates a potential influence of periodontal disease on the success rate of dental implants. Additional long-term studies and studies on larger cohorts are necessary to further investigate the relationship between periodontal disease and bone levels around immediately restored dental implants.

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