Immediate Loading of Dental Implants Placed in Periodontally Infected and Non-Infected Sites: A 4-Year Follow-Up Clinical Study

Roberto Crespi,* Paolo Capparè,* and Enrico Gherlone*

**Background:** The aim of the present study is to compare the outcomes of immediate loading of implants in replacing teeth with and without chronic periodontal lesions at 4 years of follow-up.

**Methods:** Thirty-seven patients were included in this study. A total of 275 implants were placed and immediately loaded in extraction sockets, 197 in periodontally infected sites (infected sites group [IG]), and 78 implants in non-infected sites (non-infected sites group [NG]). Marginal bone levels and clinical parameters (plaque accumulation and bleeding index) were evaluated at baseline and 12, 24, and 48 months after implant placement. Comparisons between IG and NG values over time were performed by the Student two-tailed t test.

**Results:** At 48 months of follow-up, the IG presented a survival rate of 98.9% because two implants were lost 1 month after placement; the NG reported a survival rate of 100%. The marginal bone level was 0.79 ± 0.38 mm for the IG and 0.78 ± 0.38 mm for the NG, plaque accumulation was 0.72 ± 0.41 for the IG and 0.71 ± 0.38 for the NG, and the bleeding index was 0.78 ± 0.23 for the IG and 0.75 ± 0.39 for the NG. No statistically significant differences were reported between the IG and NG over time and between time points.

**Conclusion:** At 48 months of follow-up, dental implants that were placed and immediately loaded in periodontally infected sockets showed no significant differences compared to implants placed in uninfected sites. *J Periodontol 2010;81:1140-1146.*

**KEY WORDS**
Dental implants; immediate denture; infection; tooth socket.

To preserve the alveolar bone level from the collapse of healing events,1,2 different authors3-6 placed dental implants into fresh extraction sockets and obtained high success rates. Moreover, immediate loading (an occlusal load applied to temporary crowns positioned immediately to implants) was carried out on implants placed in fresh extraction sockets from premolars to premolars to reduce treatment time.7-10 The survival rate of 100% that was reported in these studies encouraged the use of an immediate-restoration procedure of implants placed in fresh extraction sockets to replace missing teeth. The immediate-function protocol may also be an important measure for achieving improved esthetic outcomes.7,10

Despite the contraindication of placement of fresh-socket implants in infected sites,11,12 more recent clinical studies13-15 reported excellent clinical results of implants placed immediately in periodontally infected sites.

There are also several reports on the use of immediate implants after the extraction of endodontically compromised teeth. Siegenthaler et al.16 and Lindeboom et al.17 reported that the immediate placement of a dental implant in an extraction socket with a periapical infection does not have a higher rate of complication than one placed in an uninfected site. Novaes et al.18 confirmed that

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the presence of periapical lesions may not represent a contraindication if appropriate clinical procedures are followed to clean and decontaminate the surgical site. Rosenquist and Grenthe confirmed that immediate implant placement after the extraction of teeth with a root fracture or resorption has a higher success rate than that of periodontally compromised teeth. However, only a few studies regarding fresh-sOCKET implants in infected sites were published, and, to our knowledge, no prospective randomized studies have been conducted to determine the possibility of this surgical procedure. The purpose of this prospective 4-year study was to compare the outcomes of immediately loaded implants placed for single, partial, and complete rehabilitation immediately after the extraction of teeth with and without chronic periodontal lesions after a flapless procedure.

MATERIALS AND METHODS

Patient Selection
Between February 2005 and October 2005, 37 patients (23 females and 14 males; age range: 32 to 71 years; mean age: 52.5 years) were selected for this prospective study and treated by one oral surgeon (RC) and one prosthetic specialist (EG) at the Department of Dentistry, San Raffaele Hospital. A total of 275 implants in extraction sockets; 197 implants in periodontally infected sites (infected sites group [IG]), and 78 implants were placed in non-infected sites (non-infected sites group [NG]).

The following inclusion criteria were adopted: good general health, no chronic systemic diseases, the presence of hopeless teeth requiring extraction, ≥3 mm of bone beyond the root apex, and the presence of four bony walls of the socket. Immediate loading was performed when an insertion torque ≥35 Ncm was achieved. Exclusion criteria were: the presence of chronic systemic disease, smoking >10 cigarettes/day, bruxism habits, uncontrolled diabetes, coagulation disorders, alcohol or drug abuse, and reduced compliance after oral hygiene sessions.

Surgical Protocol
One hour prior to surgery, the patients received 1 g amoxicillin and 1 g amoxicillin twice a day for a week after the surgical procedure. Surgery was performed under local anesthesia.

A total of 197 teeth were extracted for periodontal reasons, 20 teeth were extracted for endodontic reasons, 39 teeth were extracted because of root decay, and 19 teeth were extracted because of root fracture (Table 1). The procedure was performed without mucogingival flap elevation, and a periodontal probe was used to verify the presence of the four walls of the fresh sockets (Figs. 1A and 1B). Many sockets presented different wall heights, so the buccal height was a little different from mesial or distal heights, but deep dehiscences or fenestrations were excluded in this clinical study. All granulation tissue was carefully removed from the sockets and rinsed using a physiologic solution.

The implant site was prepared with standard drills following the palatal bony walls as guides, and the apical portion of the implant was always placed ≥4 mm beyond the root apex. To ensure primary stability, the drilling protocol included underpreparation of the implant sites without screw tapping or countersinking. The coronal margin of the fixture was located at the buccal level of the bone crest.

A screw-shaped implant with a machined neck for 0.8 mm and a rough-surface body with a progressive-thread design and external hexagon was used for all implant placements. Implant size and insertion positions are presented in Table 1. After surgery, a chlorhexidine mouthwash was prescribed twice daily for the next 15 days.

Prosthetic Protocol
After the surgical procedure, all patients immediately received temporary abutments and prosthetic restorations (Fig. 1C). Prefabricated acrylic-resin crowns were used for single-tooth replacements. For partial or complete temporary prostheses, fixed temporary restorations with a fiber-reinforced framework were custom fit with acrylic resin around the margins or the abutment and affixed with temporary cement. Distal cantilevers were avoided. All temporary crowns were in full contact in centric occlusion. Occlusal surfaces were flattened to reduce horizontal relations. All patients consumed a soft diet (avoiding bread and meat) for 2 months.

Follow-Up
Follow-up visits were performed by a dental hygienist (Elisabetta Polizzi, Department of Dentistry, San Raffaele Scientific Institute, Milan, Italy) every 6 months after implant placement. The following clinical parameters were checked: plaque and bleeding indices at four surfaces around the implants, pain, occlusion, and prosthesis mobility. Success criteria were implant stability and the absence of radiolucency around the implants, mucosal suppuration, and pain.

Radiographs
Intraoral digital radiographs (Fig. 2) were taken at baseline and 12, 24, and 48 months after implant
Periapical radiographs were taken perpendicularly to the long axis of the implant with a long-cone parallel technique using an occlusal template to measure the marginal bone level. A radiologist (PC) twice measured the changes in marginal bone height over time: he marked the reference points and measured lines on the screen interactively (the numeric value of measurements was reported by software*).

The implant height (a known dimension) was used for calibration. The marginal bone level was considered from the reference point represented by the more coronal portion of the implant in contact with the bone to the point where the bone tissue met the implant surface at the mesial and distal sites. Differences of bone level were measured by software** (Fig. 3).

The intraexaminer error was calculated by comparing the first and second measurements with a paired $t$ test at a significant level of 5%. No statistically significant difference was calculated between values ($P > 0.05$).

Placement of the Definitive Prosthesis

Three months after implant placement, temporary crowns and abutments were removed. Transfer copings were inserted into the internal hexes of the implants with a seating instrument and secured with abutment screws. Impressions were made with a polyether material†† using an

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### Table 1.

<table>
<thead>
<tr>
<th>Implant Position</th>
<th>IG</th>
<th>NG</th>
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<tbody>
<tr>
<td>Implant Size (mm)</td>
<td>5.0 × 13</td>
<td>3.75 × 13</td>
</tr>
<tr>
<td>Incisors</td>
<td>67</td>
<td>14</td>
</tr>
<tr>
<td>Canines</td>
<td>24</td>
<td>5</td>
</tr>
<tr>
<td>Premolars</td>
<td>62</td>
<td>25</td>
</tr>
<tr>
<td>Total</td>
<td>153</td>
<td>44</td>
</tr>
</tbody>
</table>

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* Schick Technologies.
** Schick Technologies.
†† Impregum; ESPE, Seefeld, Germany.
individual impression tray. Prepared definitive metal abutments were screwed onto the osseointegrated implants (Fig. 1D).

Five months after implant placement, definitive metal-ceramic restorations were cemented onto the definitive abutments (Fig. 1E). The occlusal contacts were distributed over the arch with anterior guidance (group guidance in lateral excursions), with light contact on the distal cantilevers for full-arch prostheses.

**Statistics**

Dedicated software‡‡ was used for all statistical analyses. Clinical parameters were calculated for each implant and were reported as the mean ± SD at baseline and at 48 months of follow-up. Radiographic bone level values (mesial, distal, and mean bone loss), were calculated for each implant and were reported as the mean ± SD at baseline and at 12, 24, and 48 months (Fig. 3). To compare differences between IG and NG data at every time point, a Student two-tailed t test was adopted; P <0.05 was considered the threshold for statistical significance.

**RESULTS**

**Surgical and Prosthetic Procedure**

After 48 months of follow-up, implants of the NG reported a survival rate of 100%. In the IG, the survival rate was 98.9% because two implants were lost 1 month after placement and were replaced 2 months later, one implant presented peri-implantitis 3 years after placement. No pain or final prosthesis mobility was recorded. There was a suitable wound healing around temporary abutments with a fine adaptation to the temporary crown. Minor swelling of gingival mucosa was present in the first days after surgical procedures; no mucositis or flap dehiscence with suppurative was found. The final ceramic-fused-to-metal restorations were cemented 5 months after implant placement.

**Clinical Parameters**

At baseline, plaque accumulation was 0.48 ± 0.31 for IG and 0.53 ± 0.37 for the NG; at 48 months, it was 0.72 ± 0.41 for IG and 0.71 ± 0.38, respectively. At baseline, the bleeding index was 0.53 ± 0.26 for the IG and 0.49 ± 0.38 for the NG; and at 48 months, it was 0.78 ± 0.23 and 0.75 ± 0.39, respectively. No statistically significant differences between IG and NG values were reported for plaque accumulation (P>0.05; P = 0.55 at 48 months) and the bleeding index (P>0.05; P = 0.32 at 48 months). Moreover, for the IG and NG, no statistically significant differences between time-point values were reported (P >0.05; the most marginal P value was for the bleeding index for the NG: P=0.11). These findings confirmed the maintenance and health over time of peri-implant soft tissues.

**Radiographs**

Radiographic results are reported in Table 2. Baseline marginal bone levels were 1.01 ± 0.37 mm for the IG and 1.03 ± 0.36 mm for the NG. Both the IG and NG showed good maintenance of bone levels, which resulted in a mean bone loss at 48-months of follow-up of 0.79 ± 0.38 mm for the IG and 0.78 ± 0.38 mm for the NG. Non-statistically significant differences between IG and NG values (P = 0.54 at 48 months) were reported. Moreover, for the IG and NG, non-statistically significant differences between time-point values (P = 0.23 for the IG and P = 0.18 for the NG) were reported. These findings confirmed the hard tissue maintenance over time.

**DISCUSSION**

In the present study, the bone-healing process was successful for immediately loaded implants placed in fresh sockets for single, partial, and complete rehabilitations. The implants placed after extraction of teeth with periodontal lesions presented marginal bone levels similar to the implants positioned into

‡‡ SPSS 11.5.0, SPSS, Chicago, IL.
non-infected sites because non-statistically significant differences between IG and NG values ($P > 0.05$) were reported; moreover, an enhancement of the mineralization process of marginal bone around implants over time was observed.

The same results were reported by Villa and Rangert, who evaluated the survival rates of immediate and early loaded implants placed immediately after extraction of teeth with endodontic and periodontal lesions, after socket irrigation with an antibiotic solution. After 1 year, no signs of infection around the implants were detected; furthermore, there was a tendency toward less bone loss with the flapless protocol (mean bone loss: $-0.74 \pm 1.34$ mm) than with the flap protocol (mean bone loss: $-1.02 \pm 1.60$ mm).

These successful results can probably be explained by biologic events during healing process, depending on biomechanical, surgical, and medical principles, the implant stability, load control, and the inflammatory response.

In human studies, implants were immediately placed after extraction of teeth with signs of chronic periapical periodontitis, pain, periapical radiolucency, fistula, and suppuration, the mucoperiosteal flap was elevated for granulation tissue debridement, and the bone-healing process was obtained. It was concluded that for those implants with primary stability, the immediate placement into infected sites did not lead to an increased rate of complications and rendered an equally favorable type of tissue integration of the implants. Extraction of the involved teeth with socket degranulation led to the eradication of the cultured microorganisms, and immediate implant placement may be beneficial in maintaining the integrity of the extraction sockets and contribute to the maintenance of the interdental papillae around implant restorations.

In a prospective study, Kan et al. evaluated 35 threaded, hydroxyapatite-coated implants that were placed and provisionalized immediately after each failing tooth had been removed, and after 12 months, all implants remained osseointegrated with minimal marginal bone-level changes ($-0.26 \pm 0.40$ mm mesially and $-0.22 \pm 0.28$ mm distally). In a similar study, Cornelini et al. reported no implant failure at 12 months; radiographs revealed a mean bone resorption of 0.5 mm after 1 year, and the mean variation of gingival level compared to the neighboring teeth was $-0.75$ mm.

The minimum marginal bone-level change reported in the present study after 48 months may have been due to the flapless implant surgery because flap

### Table 2.

**Radiographic Results (marginal bone levels; mean ± SD) at 48 Months From Implant Placement**

<table>
<thead>
<tr>
<th>Time</th>
<th>IG ($n = 197$ implants)</th>
<th>NG ($n = 78$ implants)</th>
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<tbody>
<tr>
<td></td>
<td>Mesial Bone Loss (mm)</td>
<td>Distal Bone Loss (mm)</td>
</tr>
<tr>
<td>Baseline</td>
<td>0.98 ± 0.32</td>
<td>1.04 ± 0.42</td>
</tr>
<tr>
<td>12 months</td>
<td>0.75 ± 0.42</td>
<td>0.79 ± 0.37</td>
</tr>
<tr>
<td>24 months</td>
<td>0.79 ± 0.45</td>
<td>0.80 ± 0.51</td>
</tr>
<tr>
<td>48 months</td>
<td>0.71 ± 0.45</td>
<td>0.76 ± 0.32</td>
</tr>
<tr>
<td>Baseline</td>
<td>1.00 ± 0.34</td>
<td>1.07 ± 0.38</td>
</tr>
<tr>
<td>12 months</td>
<td>0.84 ± 0.43</td>
<td>0.88 ± 0.51</td>
</tr>
<tr>
<td>24 months</td>
<td>0.83 ± 0.47</td>
<td>0.85 ± 0.46</td>
</tr>
<tr>
<td>48 months</td>
<td>0.75 ± 0.39</td>
<td>0.81 ± 0.38</td>
</tr>
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reflection induces tissue loss, which negatively influences implant esthetic outcomes.\textsuperscript{25,26} Conversely, by using a flapless procedure, a bone regain of 3 mm around exposed threads was reported.\textsuperscript{15,27,28}

**CONCLUSIONS**

The immediate placement of implants in chronically infected sockets may not be necessarily contraindicated if appropriate clinical procedures like antibiotic administration, meticulous cleaning, and alveolar debridement are performed before the implant surgical procedure; and from the data of this present study, for those implants where primary stability was achieved, the immediate implant placement in periodontally infected sockets did not induce an increased rate of complications and rendered an equally favorable soft and hard tissue integration of the implants.

Unfortunately, the data regarding the bone-healing process around implants immediately placed in periodontally infected teeth are limited. Therefore, further studies are mandatory to evaluate clinical and histologic outcomes.

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The authors report no conflicts of interest related to this study.

**REFERENCES**


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