Fresh-Socket Implants in Periapical Infected Sites in Humans

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Background: The aim of the present study is to compare the outcome of the immediate placement of implants when used in the replacement of teeth with and without chronic periapical lesions.

Methods: Thirty patients requiring a single-tooth extraction of a monoradicular or premolar tooth were selected. The control group (CG) included 15 patients without periapical lesions but with root caries and root fractures. The test group (TG) included 15 patients with periapical lesions, periapical radiolucencies, and no signs of pain, fistulas, or suppuration. Thirty teeth were extracted, and implants were immediately positioned in fresh sockets and loaded after 3 months in both groups. Clinical parameters (probing depth [PD], modified plaque index, modified bleeding index [mBI], marginal gingiva level [MGL], and keratinized mucosa [KM]) and marginal bone levels were evaluated at baseline and 12 and 24 months after implant placement. Comparisons between CG and TG values over time were performed by the Student two-tailed *t* test.

Results: At the 24-month follow-up, a survival rate of 100% was reported for all implants. The mean bone loss was 0.82 ± 0.52 mm for the CG and 0.86 ± 0.54 for the TG. Plaque accumulation was 0.74 ± 0.29 for the CG and 0.69 ± 0.29 for the TG. The mBI was 0.77 ± 0.33 for the CG and 0.72 ± 0.36 for the TG. The soft tissue profile MGL and KM remained stable for up to 24 months for the CG and TG. The mean PD was 2.05 ± 0.66 mm for the CG and 1.99 ± 0.57 mm for the TG. Differences that were not statistically significant were reported between the CG and TG over time and between time points.

Conclusion: At the 24-month follow-up, endosseous implants placed immediately in extraction sites affected by periapical infection rendered an equally favorable soft and hard tissue integration of the implants, revealing a predictable outcome. *J Periodontol 2010;81:378-383.*

KEY WORDS

Dental implants; infection; periodontitis; tooth socket.

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Tooth extraction induces bone crest resorption of ~23% after a 6-month period, severely modifying the architecture of hard and soft tissues.[1,2]

To preserve the alveolar bone level from the collapse of healing events, a number of authors[3-6] placed dental implants into fresh extraction sockets and obtained a high success rate.

Analyzing bone remodeling around 15 implants placed immediately after tooth removal, Covani et al.[7] observed a healing pattern of coronal bone around immediate implants with new bone apposition around the neck of the implants and, at the same time, bone resorption with a horizontal width reduction of the bone ridge.

It has been stated that fresh-socket implants are contraindicated in the presence of periapical and periodontal lesions because of the risk of microbial interference with the healing process.[8,9] However, in an attempt to overcome this limitation, other clinical studies[10-13] reported good results with implants placed immediately in periodontally infected sites.

There are also several reports on the immediate placement of implants after the extraction of endodontically compromised teeth. Siegenthaler et al.[14] and Lindeboom et al.[15] reported that the immediate placement of a dental implant in an extraction socket with a periradicular infection does not have a higher rate of complication than one placed in an uninfected site. Novaes et al.[16] confirmed that the presence of periapical lesions may

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Table 1.

Implant Positions and Dimensions for the CG and TG

	CG			TG		
	Implant Size (mm)			Implant Size (mm)		
Implant Position	5.0 × 13	3.75 × 13	Total	5.0 × 13	3.75 × 13	Total
Incisor	6	1	7	3	2	5
Canine	2	0	2	1	0	1
Premolar	4	2	6	7	2	9
Total	12	3	15	11	4	15

not represent a contraindication if appropriate clinical procedures to clean and decontaminate the surgical site are taken. Rosenquist and Grenthe[9] reported that implants placed immediately after the extraction of teeth with root fractures or resorption have a higher success rate than periodontally compromised teeth. Only a few studies[9,14-16] regarding immediate implant placement in fresh sockets with periapical lesions were published, and to our knowledge, no prospective randomized studies have been conducted to determine the feasibility of this surgical procedure. The purpose of this prospective randomized study was to compare the outcome of the immediate placement of implants when used in the replacement of teeth with and without chronic periapical lesions.

MATERIALS AND METHODS

Patient Selection

Between February 2007 and May 2007, 30 patients (18 females and 12 males; age range: 34 to 71 years; mean age: 51.2 years) were included in this study at the Department of Dentistry, Vita Salute University, San Raffaele Hospital.

All patients required a single-tooth extraction of a monoradicular or premolar tooth and were randomly placed into a test group (TG) or control group (CG) (Table 1). Implants were positioned immediately after tooth extraction and loaded after 3 months in both groups. All patients needed teeth to be replaced by immediate implants. The CG included 15 patients without periapical pathology, with root caries and root fractures, and without acute or chronic periapical lesions. The TG included 15 patients with periapical pathology and periapical radiolucencies and no signs of pain, fistulas, or suppuration.

The patients included in this clinical study were treated by one oral surgeon (RC) and one prosthetic specialist (EG).

Inclusion criteria for patient selection were: the presence of adjacent teeth, presence of four bony walls of the alveolus, presence of ≥4 mm of bone beyond the root apex, periapical lesions present on all bony walls, good health, and no chronic systemic diseases. Exclusion criteria were: the presence of a dehiscence or fenestration of the residual bony walls, presence of signs of acute infection around alveolar bone at the surgical site, uncontrolled diabetes, coagulation disorders, being a heavy smoker (>10 cigarettes per day), and alcohol or drug abuse. The local ethical committee at the San Raffaele Scientific Institute approved the study, and all patients gave their written informed consent for immediate implant placement into fresh sockets.

Surgical Protocol

One hour prior to surgery, the patients received 1 g amoxicillin and 1 g twice a day for a week after the surgical procedure. Surgery was performed under local anesthesia (octocaine,† 20 mg/ml, with adrenaline, 1:80.000).

Thirty teeth (Table 1), including incisors, canines, and premolars, were extracted, maintaining the integrity of the socket. Avoiding buccal mucogingival flaps, a periodontal probe‡ was used to verify the integrity of the four walls of the fresh sockets. All granulation tissue was carefully removed from the area of the periapical lesion and rinsed with a physiologic solution.

The implant site was prepared with a standard drill following the palatal bony walls as a guide, and the apical portion of the implant was placed ≥4 mm beyond the root apex; no countersinking was used. The coronal margin of the fixture was located at the buccal level of the bone crest.

In the two groups, 30 titanium implants§ were immediately placed after extraction (Table 1). The implant had a 0.8-mm machined neck and a rough-surface‖ body with a progressive-thread design. Twenty-three

† Molteni Dental, Scandicci, Italy.
‡ Hu-Friedy PGF-GFS, Hu-Friedy, Chicago, IL.
§ Seven, Sweden-Martina, Padova, Italy.
‖ Titanium Plasma Spray, Sweden-Martina, Padova, Italy.

implants had a diameter of 5 mm, and seven implants had a diameter of 3.75 mm, with a 13-mm length (Table 1).

All implants were placed with a minimum insertion torque of 25 Ncm that was assessed by a device¶ for measuring force resistance. After implant placement, a partial-thickness flap was coronally repositioned to obtain primary wound closure and sutured. A chlorhexidine mouthwash was prescribed twice daily for the next 15 days.

Follow-Up

The following clinical parameters were checked: pain, occlusion, and prosthesis mobility. Success criteria for implant survival were accepted as the presence of implant stability, absence of a radiolucent zone around the implants, no mucosal suppuration, and no pain.[17] Follow-up examinations were performed at baseline and 12 and 24 months. The probing depth (PD), modified plaque index (mPI), and modified bleeding index (mBI) were determined on the mesial, distal, buccal, and palatal surfaces of the implants[18] with a periodontal probe.# The distance between the platform of the implant and the marginal gingiva level (MGL) was measured at four sites per implant as the same surfaces as for the mPI. The width of the keratinized mucosa (KM) was recorded at the mid-buccal sites.

Radiographs

Intraoral digital radiographs** were made at baseline and 12 and 24 months (Figs. 1 and 2) after implant placement. Periapical radiographs were taken perpendicular 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 measured the changes in marginal bone height over time. 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. The difference in bone level was measured using software.††

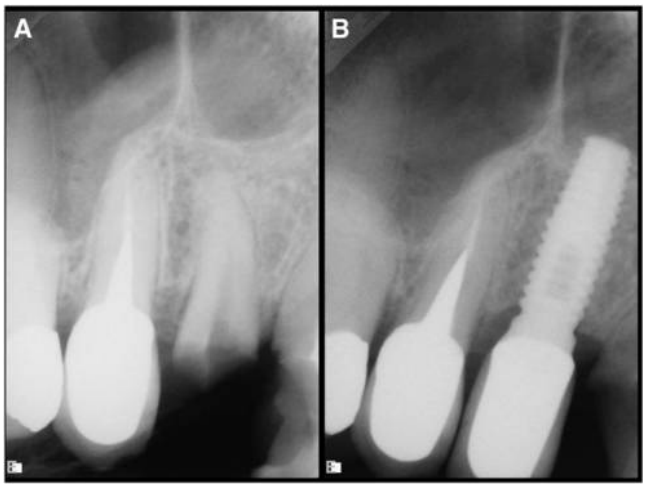

Figure 1.
A) *Preoperative radiograph of tooth #5 in CG. Deep root decay was present.* ***B)*** *Postoperative periapical radiograph of implant after 2 years.*

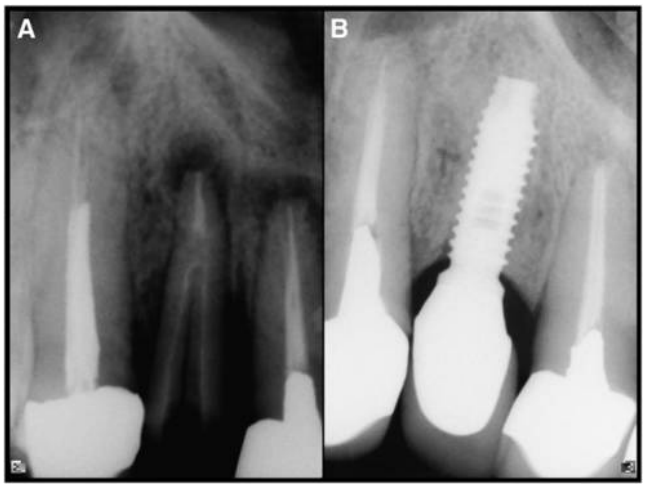

Figure 2.
A) *Preoperative radiograph of tooth #12 in TG. A periapical lesion was present.* ***B)*** *Postoperative periapical radiograph of implant after 2 years.*

Placement of the Definitive Prosthesis

Three months after implant placement, a second surgical-stage procedure was performed. In both groups, transfer copings were inserted into the internal hex of the implant with a seating instrument and secured with abutment screws. Impressions were taken with a silicon material using an individual impression tray. Prepared final metal abutments were screwed onto osseointegrated implants, and temporary crowns were positioned. Six months later, final metal ceramic restorations were cemented on the abutments.

Statistical Analyses

Dedicated software‡‡ was used for all statistical analyses. For clinical parameters and radiographic bone levels (mesial, distal, and mean bone loss), data were calculated for each implant and reported as the mean ± SD at baseline and 12 and 24 months. To compare the differences between TG and CG data at every time point, a Student two-tailed *t* test was adopted. $P<0.05$ was considered the threshold for statistical significance.

¶ Sweden-Martina.
# Hu-Friedy PGF-GFS, Hu-Friedy.
** Schick CDR, Schick Technologies, Long Island City, NY.
†† Schick Technologies.
‡‡ SPSS 11.5.0, SPSS, Chicago, IL.

RESULTS

Surgical and Prosthetic Procedure

After 24 months of follow-up, a survival rate of 100% was reported for all implants. No pain or final prosthesis mobility were registered. There was 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 dehiscences with suppuration were found. The final ceramic-fused-to-metal restorations were cemented 6 months after implant placement.

Clinical Parameters

Clinical parameter values are reported in Table 2. At the 24-month follow-up, plaque accumulation was 0.74 ± 0.29 for the CG and 0.69 ± 0.29 for the TG, whereas the mBI was 0.77 ± 0.33 for the CG and 0.72 ± 0.36 for the TG. The soft tissue profile MGL and KM remained stable for up to 24 months for the CG and TG (Table 2).

The mean values of MGL at 24 months were 0.25 ± 0.18 mm for the CG and 0.20 ± 0.13 for the TG. No significant changes occurred in the MGL from baseline to 24 months in the CG and TG. The mean values of KM remained stable from baseline to 24 months for the CG and TG (Table 2). The mean PD was obtained from averaging PD measurements on the mesial, distal, buccal, and palatal surfaces of the implants; the mean values at 24 months were 2.05 ± 0.66 mm for the CG and 1.99 ± 0.57 mm for the TG.

Differences between CG and TG values that were not statistically significant (NS) were reported (P = NS). Moreover, for all parameters for the CG and TG, NS differences among time points (P = NS) were reported.

These findings confirmed the maintenance and health of the peri-implant soft tissues over time.

Radiographic Evaluation

Radiographic results are reported in Table 3. The CG and TG showed good maintenance of bone levels, resulting in a mean bone loss at the 24-month follow-up of 0.82 ± 0.52 mm for the CG and 0.86 ± 0.54 mm for the TG.

NS differences between CG and TG values (P = NS) were reported. Moreover, for the CG and TG, NS differences among time-point values (P = NS) were reported.

These findings confirmed the maintenance of hard tissues over time.

Table 2.

Clinical Parameters at the 24-Month Follow-Up (N = 30 implants)

	CG			TG		
Parameter	Baseline	12 Months	24 Months	Baseline	12 Months	24 Months
mPI	0.53 ± 0.20	0.71 ± 0.27	0.74 ± 0.29	0.49 ± 0.19	0.66 ± 0.28	0.69 ± 0.29
mBI	0.49 ± 0.29	0.68 ± 0.34	0.77 ± 0.33	0.46 ± 0.23	0.69 ± 0.30	0.72 ± 0.36
MGL (mm)	0.18 ± 0.11	0.21 ± 0.13	0.25 ± 0.18	0.15 ± 0.08	0.16 ± 0.13	0.20 ± 0.13
KM (mm)	3.83 ± 0.81	3.68 ± 0.72	3.67 ± 0.61	3.79 ± 0.77	3.64 ± 0.68	3.62 ± 0.65
PD (mm)	1.46 ± 0.45	1.85 ± 0.68	2.05 ± 0.66	1.42 ± 0.41	1.80 ± 0.64	1.99 ± 0.57

Table 3.

Radiographic Results (marginal bone levels) at 24 Months After Implant Placement (N = 30 implants)

	CG			TG		
Time Point	Mesial Bone Loss (mm)	Distal Bone Loss (mm)	Mean Bone Loss (mm)	Mesial Bone Loss (mm)	Distal Bone Loss (mm)	Mean Bone Loss (mm)
Baseline	0.96 ± 0.25	1.02 ± 0.29	0.99 ± 0.27	0.99 ± 0.30	1.05 ± 0.36	1.02 ± 0.33
12 months	0.77 ± 0.40	0.82 ± 0.55	0.80 ± 0.47	0.81 ± 0.44	0.85 ± 0.58	0.83 ± 0.51
24 months	0.78 ± 0.47	0.86 ± 0.57	0.82 ± 0.52	0.82 ± 0.51	0.89 ± 0.57	0.86 ± 0.54

DISCUSSION

In the present study, there was no biologic damage in the bone-healing process associated with the immediate implant placement into extraction sockets of teeth that exhibited a periapical pathology. The implant survival rate at 24 months was 100%, and hard and soft tissue integration was similar and favorable in the TG and CG.

In an animal experiment,[16] implants were immediately placed in fresh sockets with periapical infections. Twelve weeks later, all implants were successfully osseointegrated, and no signs of inflammation or exudation were observed during the healing period. Histomorphometric analysis revealed no significant difference in the percentage of bone-to-implant contact (BIC) at the periapically infected sites compared to healthy sites.

Another animal study[19] compared the osseointegration of immediate implants in infection-free sites and in sites with periradicular lesions; after 12 weeks, the control and the experimental implants were clinically acceptable, and despite the lower BIC of the experimental group, the study showed the possibility that immediate implant placement might be successful in extraction sockets with periradicular lesions.

In a human study,[15] implants were immediately placed after extraction of teeth with signs of chronic periapical periodontitis, pain, periapical radiolucency, fistula, and suppuration,[14] obtaining a bone-regeneration process.

For those implants with primary stability, the immediate placement into the extraction sockets affected by periapical pathology did not lead to an increased rate of complications and rendered an equally favorable type of tissue integration of the implants. In both studies,[14,15] acute periapical infections and buccal periapical bone loss were included, and during the surgical procedure, the mucoperiosteal flap was elevated for granulation tissue debridement and the bone-regeneration procedure. In the present study, which had the same success rate as those reported in previous articles,[14,15] the implants were positioned in chronic apical lesions with the integrity of bone walls, and granulation tissue was removed without gingival flap elevation.

The high success rate of fresh-socket implants placed in chronic and acute lesions may be explained by the behavior of endodontic infections because they are mixed infections dominated by anaerobic bacteria (*Fusobacterium*, *Prevotella*, *Porphyromonas*, *Actinomyces*, *Streptococcus*, and *Peptostreptococcus*) commonly restricted in the infected root canal.[20,21]

Extraction of the involved tooth with socket degranulation led to the eradication of the cultured microorganisms,[15] and immediate implant placement may be beneficial in maintaining the integrity of extraction sockets and contribute to the maintenance of the interdental papillae around implant restorations.[22]

The minimum marginal bone-level change and the moderate recession of the gingival margin observed after 24 months in this study may be due to partial-thickness-flap implant surgery[23] because full-thickness-flap reflection induced tissue loss, which negatively affected the implant esthetic outcomes.[7]

As studied by Novaes et al.,[11] the immediate placement of implants in chronically infected sites may not necessarily be contraindicated if appropriate clinical procedures like antibiotic administration, meticulous cleaning, and alveolar debridement are performed before the implant surgical procedure. For those implants where primary stability was achieved, the data of the present study shows that immediate implant placement in extraction sockets of teeth that exhibited chronic periapical pathology did not induce an increased rate of complications and rendered an equally favorable soft and hard tissue integration of the implants.

CONCLUSIONS

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

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