Immediate Versus Delayed Loading of Dental Implants Placed in Fresh Extraction Sockets in the Maxillary Esthetic Zone: A Clinical Comparative Study

Roberto Crespi, MD, MS[1]/Paolo Capparé, MD[2]/
Enrico Gherlone, MD, DDS, PhD[3]/George E. Romanos, DDS, Dr Med Dent, PhD[4]

Purpose: *The aim of this study was to report a clinical comparative assessment of crestal bone level change around single implants in fresh extraction sockets in the esthetic zone of the maxilla either immediately loaded or loaded after a delay.* ***Materials and Methods:*** *Forty patients were included in a prospective, randomized study. All patients required 1 tooth extraction (ie, 1 tooth with a hopeless prognosis) and were randomized into either the test group or the control group. Implants were positioned immediately after tooth extraction and were loaded immediately in the test group (20 implants) and after 3 months in the control group (20 implants). The implant site was prepared, with at least 4 mm of sound apical bone below the implant apex, and the coronal margin of the implant was placed at the buccal level of the bone crest. All implants were 13 mm long; 30 implants had a diameter of 5 mm, and 10 had a diameter of 3.75 mm. Radiographic examinations were made at baseline, at 6 months, and at 24 months. To compare the mean values between test and control group, a paired* t *test was performed (considered statistically significant at* $P < .05$*).* ***Results:*** *After a 24-month follow-up period, a cumulative survival rate of 100% was reported for all implants. The control group resulted in a mean mesial bone loss of 1.16 ± 0.32 mm and a mean distal bone loss of 1.17 ± 0.41 (mean bone loss, 1.16 ± 0.51 mm). The test group resulted in a mesial bone loss of 0.93 ± 0.51 mm and a distal bone loss of 1.1 ± 0.27 mm (mean bone loss, 1.02 ± 0.53 mm). No statistically significant difference between control and test groups (*$P > .05$*) was found.* ***Conclusion:*** *The success rate and radiographic results of immediate restorations of dental implants placed in fresh extraction sockets were comparable to those obtained in delayed loading group.* Int J Oral Maxillofac Implants 2008;23:753–758

Key words: *dental implants, immediate loading, postextraction sockets*

Titanium dental implants have provided a suitable treatment for tooth replacement[1,2] following the conventional 2-stage implant placement procedure (delayed loading) to ensure implant stabilization during early stages of bone healing.[3–5] However, several authors[6–8] have shown high success rates for immediate loading in osseointegrated implant treatment. Tarnow et al[9] obtained encouraging results with multiple implants placed and splinted into a full-arch arrangement and immediately loaded. Brånemark et al[10] reported a method to place multiple implants into the mandibular anterior region to perform immediate loading. Similar results have been obtained by Buser et al[11] in a clinical study of 271 implants placed with a 1-stage surgical procedure. The results included increased patient satisfaction and avoidance of the use of a conventional denture during the healing phase.[12–18]

Since Lekovic et al[19,20] reported a decrease in vertical socket height after tooth extraction of 50% and a decrease in horizontal width of approximately two thirds of the original, several authors[21–23] have placed dental implants into fresh extraction sockets to maintain the alveolar bone level from the

[1]Visiting Professor, Department of Dentistry, "Vita Salute" University, San Raffaele Hospital, Milan, Italy.
[2]Medical Doctor, Department of Dentistry, "Vita Salute" University, San Raffaele Hospital, Milan, Italy.
[3]Full Professor and Chair, Department of Dentistry, "Vita Salute" University, San Raffaele Hospital, Milan, Italy.
[4]Professor of Clinical Dentistry, Department of Periodontology, Eastman Dental Center, Rochester, New York.

Correspondence to: Dr Roberto Crespi, Department of Dentistry, "Vita Salute" University, San Raffaele Hospital, Via Olgettina N.48, 20132 Milano, Italy.

collapse of healing events. Covani et al[24] analyzed bone healing and bone remodeling around 15 implants placed immediately after tooth removal. The mean ± SD buccolingual distance reported was 10.5 mm (± 1.52) at the time of implant placement and 6.8 mm (± 1.33 at second-stage surgery). They observed a horizontal width reduction of the bone ridge, with new bone apposition around the neck of the implants.

Aires and Berger[7] compared the results of implants immediately loaded in edentulous sites with implants loaded immediately in extraction sites. Seventy-five implants were placed in 9 jaws of 7 patients. Twenty-nine of these implants were placed in immediate extraction sites and were loaded in less than 3 weeks. The authors provided comparable success rates extraction and edentulous sites.

In a multicenter study of immediate and early loading, Malo et al[22] placed 116 titanium implants, 22 in fresh extraction sites. After 1 year, the survival rates were 93.7% for single-tooth restorations and 98.1% for splinted implants. Fresh-socket implants had a 100% success rate and providing a shorter treatment time, reduction of surgical appointments, and better esthetic results.[25,26]

In contrast with other authors, Chaushu et al,[27] studying a group of 28 immediately restored cylindric, press-fit hydroxyapatite-coated implants, found a cumulative survival rate of 82.4% for implants placed in fresh extraction sockets and 100% for implants placed in healed ridges.

There are few comparative clinical studies of immediate versus delayed loading of dental implants placed in fresh sockets in the maxillary esthetic zone. Consequently, the aim of this study was to clinically compare marginal bone levels around single implants in fresh extraction sockets for immediate versus delayed loading in the maxillary esthetic region.

MATERIALS AND METHODS

Patient Selection

Forty patients, 24 women and 16 men with a mean age of 47.21 years (range, 24 to 68 years), were included in the prospective randomized study. All patients required a single-tooth extraction for root fractures, caries or endodontic lesions, or periodontal disease and were randomly assigned to the test or control group. Implants were positioned immediately after tooth extraction and were loaded immediately in the test group and after 3 months in the control group. The control group included 20 patients, 14 women and 6 men, with a mean age of 48.83 years (range, 27 to 68 years). The test group included 20 patients, 10 women and 10 men, with a mean age of 45.59 years (range, 24 to 62 years).

The patients included in this clinical study were treated by 1 oral surgeon (RC) and 1 prosthetic specialist (EG) in the Department of Dentistry, San Raffaele Hospital.

Inclusion criteria for patient selection were the presence of 4 bony walls of the alveolus, presence of at least 4 mm of bone beyond the root apex, and the presence of adjacent teeth. All patients were in good health, with no chronic systemic disease, and all patients and control subjects gave their informed consent for immediate implant loading. Immediate loading of the implants was performed with an implant stability quotient (ISQ > 60) and implant insertion torque (> 25 Ncm).

Exclusion criteria were the presence of dehiscence or fenestration of the residual bony walls, uncontrolled diabetes, coagulation disorders, signs of acute infection around the alveolar bone at the surgical site, heavy smoking (more than 10 cigarettes per day), alcohol or drug abuse, and bruxism.

Surgical Protocol

The patients received 1 g amoxicillin 1 hour prior to surgery and 1 g twice a day for a week after surgical procedure. Surgery was performed under local anesthesia (optocaine 20 mg/mL with adrenaline 1:80,000).

Forty maxillary teeth in incisor, canine, and premolar regions were extracted. Care was taken to maintain the integrity of the socket, and buccal flaps were avoided. A periodontal probe was used to verify the integrity of the 4 walls of the fresh sockets.

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 always placed at least 4 mm beyond the root apex; no countersinking was used. The coronal margin of the implant was located at the buccal level of the bone crest. The quality of alveolar bone was determined during surgery for each site and was predominantly classified as type 2 or 3, according to Lekholm and Zarb classification.[19]

Forty titanium implants (Outlink; Sweden & Martina, Padova, Italy) were placed immediately after extraction (Table 1). The implant had a machined neck for 0.8 mm and a rough-surface (titanium plasma-sprayed) body with a progressive thread design. Thirty implants had a diameter of 5 mm and 10 implants had a diameter of 3.75 mm; all were 13 mm long. Twenty were immediately loaded (test group), and 20 were delayed loaded (control group; Table 1).

All implants were placed with a minimum insertion torque of 25 Ncm assessed by a device for measuring force resistance (Sweden & Martina). In the test group, an oval cross-sectional temporary abutment (Sweden & Martina) was placed. The junction between the abutment and the implant was located at the level of buccal bone margin in all cases. In the test group, sutures were used to close the gap between the temporary abutment and gingival margin, while in the control group, after implant placement, the flap was coronally repositioned to obtain primary wound closure and then sutured. Chlorhexidine mouthwash was prescribed twice daily for 15 days following surgery.

Prosthetic Protocol

In the test group, immediately after surgical procedure, single-tooth, temporary prefabricated acrylic resin crowns were performed, adapted with acrylic resin along margins of the temporary abutment and fit with temporary cement (Temp Bond; Kerr Manufacturing, Romulus, MI). All temporary crowns were in full contact in centric occlusion. The occlusal surfaces were made flat, and horizontal relations were avoided. All patients followed a soft diet for 2 months.

Follow-up

The following clinical parameters were checked: pain, occlusion, prosthesis mobility, and plaque and bleeding indicies. Success criteria for implant survival were *(1)* presence of implant stability, *(2)* absence of radiolucent zone around the implants, *(3)* no mucosal suppuration, and *(4)* no pain.

Radiographic Examination

Intraoral digital radiographic examinations (Schick; CDR Schick Technologies, Long Island City, NY) were made at baseline, 6 months, and 24 months (Figs 1 to 4) after implant placement. The periapical radiographs were made 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 measured the changes in marginal bone height over time. The marginal bone level was measured from the reference point (the most 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 by included software (Schick Technologies).

Placement of the Definitive Prosthesis

Three months after implant placement, in the control group, a second-surgical stage procedure was performed, and in the test group, the temporary restoration was removed. 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 silicone material using an individual impression tray. Prepared definitive metal abutments were screwed onto osseointegrated implants, and temporary crowns were positioned.

Six months later, definitive metal-ceramic restorations were cemented on abutments.

Table 1 Implant Positions and Dimensions for Implants Placed in Fresh Extraction Sockets

Implant position	Implant size		Total
	5.0 × 13	3.75 × 13	
Control group			
Maxillary incisor	6	2	8
Maxillary canine	4	0	4
Maxillary premolar	5	3	8
Total	15	5	20
Test group			
Maxillary incisor	5	2	7
Maxillary canine	5	0	5
Maxillary premolar	5	3	8
Total	15	5	20

Statistical Analysis

The marginal bone loss was evaluated at 24 months of healing. Mesial, distal, and mean bone loss were calculated in the maxilla, and the resulting data were presented as mean values and standard deviations. To compare the mean values of each group, a paired *t* test was performed, with $P < .05$ considered statistically significant.

RESULTS

Surgical and Prosthetic Procedures

After a 24-month follow-up period, a survival rate of 100% was reported for all implants. There was no patient withdrawal in either group. Suitable wound healing was observed around the temporary abutments, with good adaptation to the temporary crown. Minor swelling of gingival mucosa was present in the first days after surgical procedures, although no mucositis or flap dehiscences with suppuration were observed. Four occlusal screws became unscrewed in provisional plastic abutments. The definitive ceramic-fused-to-metal restorations were cemented 6 months after implant placement.

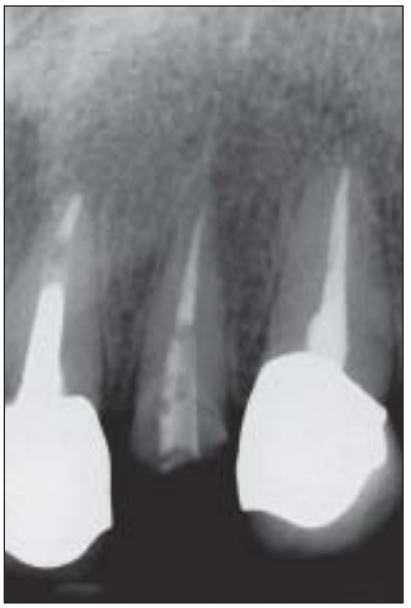

Fig 1 Preoperative radiograph of a maxillary left lateral incisor. Vertical radicular fracture was observed.

Fig 2 Postoperative periapical radiograph showing an implant placed into a fresh extraction socket.

Fig 3 Six-month follow-up.

Fig 4 Two-year follow-up.

Clinical Parameters

Plaque accumulation at the baseline was 4% and 7% after 24 months. The bleeding index was 5% at baseline and 7% 24 months later No pain or mobility of the definitive prosthesis was registered.

Radiographic Evaluation

Radiographic results at 24 months from implant placement are reported (Table 2).

The control (delayed loading) group had a mean mesial bone loss of 1.16 ± 0.32 mm and a mean distal bone loss of 1.17 ± 0.41 mm (mean bone loss 1.16 ± 0.51 mm). The test (immediate loading) group resulted in a mesial bone loss of 0.93 ± 0.51 mm and a distal bone loss of 1.10 ± 0.27 mm (mean bone loss 1.02 ± 0.53 mm). No statistically significant differences between the control and test groups for mesial bone loss were found ($P > .05$). Moreover, no statistically significant differences between the control and test groups for distal bone loss were found ($P > .05$).

Table 2 Radiographic Results at 24 Months from Implant Placement

Group	Patients (n)	Mesial bone loss (mm)		Distal bone loss (mm)		Mean bone loss (mm)		Survival rate (%)
		Mean	SD	Mean	SD	Mean	SD	
Delayed loading (control group)	20	1.16	0.32	1.17	0.41	1.16	0.51	100
Immediate loading (test group)	20	0.93	0.51	1.10	0.27	1.02	0.53	100

DISCUSSION

The results showed no statistically significant differences ($P > .05$) in either mesial or distal crestal bone loss in delayed versus immediate loading group. Less bone loss was reported for the immediate loading group, perhaps due to peri-implant bone response to immediate loading, since several authors[28,29] have reported that immediately loaded implants had significantly more bone-implant contact as compared with implants placed using 2-stage protocol.

Different prospective studies[30,31] have evaluated the clinical outcome of immediately loaded implants versus delayed loaded implants in the anterior and premolar regions of the maxilla. Lindeboom et al[30] reported no significant differences for radiographic bone loss or gingival esthetics between immediate unloaded and immediately loaded implants. No significant differences between delayed and immediate loading implants in restorations of partially edentulous patients were reported by Cannizzaro et al.[31] In that study, the authors evaluated 92 dental implants and demonstrated a 100% success rate in the immediate loading group against 92.9% in the control group.

The mean bone loss reported in the present study confirms the marginal bone level changes measured by Yoo et al,[32] since, in a retrospective study of 347 immediately loaded implants, the authors measured bone levels with a mean value of –1.0 mm and –0.8 mm on the mesial and distal surfaces at 12 months.

In fresh extraction socket implants, the width of the gap between the implant surface and the bone walls at the time of implant placement represents a critical point for bone healing, since as the gap widens, the amount of bone-implant contact decreases, and the point of the highest bone-implant contact shifts apically.[33] Botticelli et al,[34] studying the healing of marginal defects that occurred at implants placed in fresh extraction sockets in dogs, showed that at sites where teeth with an intact periodontium are present mesially and distally of the extraction socket, the height of the proximal socket walls may be retained, since the reduction of the crestal bone will be limited to the buccal walls of the recipient site.

The difference in the success rates reported by several studies probably depends on differences in clinical parameters, implant surfaces, and morphology, since short implants with machined surfaces placed in sites with poor bone density are associated with an increased failure rate.[35]

To reduce marginal bone loss, Shin et al[36] suggested a rough surface and microthreads at the implant neck not only to reduce crestal bone loss but also to improve early biomechanical adaptation to immediate loading.

In addition to bone loss, soft tissue management around implant represents a biological and esthetic concern. In the present study, plaque accumulation at the baseline was 4% and 7% after 24 months. The bleeding index at baseline was 5%, and 24 months later a value of 7% was registered.

Cornelini et al[37] reported similar clinical results. They evaluated the placement of 22 transmucosal implants into fresh extraction sockets and their immediate restoration with temporary crowns. At 12 months, no implant had failed, radiographic examination revealed a mean bone loss of 0.5 mm compared to baseline, and the clinical parameters reported good conditions in comparison with baseline levels.

Within the limits of this study, the results showed that immediate and delayed loading of implants placed in fresh extraction sockets showed no significant clinical or radiographic differences after 2 years of follow-up. Immediate restoration of single-tooth implants placed in fresh extraction sockets may be considered a predictable procedure that improves patient satisfaction. However, further studies are required to improve the parameters of surgical procedure and soft tissue management and to study the macro- and microtextures of the dental implants.

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