Immediate Loading of Tapered Implants Placed in Postextraction Sockets: Retrospective Analysis of the 5-Year Clinical Outcome

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ABSTRACT

Introduction: The use of immediate implant loading protocols delivers obvious benefits to the patient. When applied in healed sites, this has not only been well documented in the totally edentolous mandible but has also been documented and reported to be predictable in the upper jaw, and in cases of partial edentoulism, as well. A further application of immediate loading protocol, although still controversial, especially when replacing single maxillary teeth in the anterior zone, is the immediate implant placement and provisionalization in postextractive sockets. In consideration of the oxidized surface promoting bone healing and the tapered shape of the implant body, the Replace Select Tapered TiUnite implants have been used for many years in our clinic when facing these clinical situations. This article will report about our long-term clinical experience with such implants and the relevant role of a correct surgical and prosthetic treatment planning.

Purpose: The aim of this retrospective study was to report on the 5-year clinical and radiologic outcome of patients treated with Replace Select Tapered TiUnite implants when used according to an immediate loading protocol in postextraction sites.

Method and Materials: In routine practice, 56 consecutive patients were treated with 79 implants. The patients, 23 males and 33 females, had a mean age of 50.9 years, range 21–76 years, at implant placement. Forty-seven implants were placed in the maxilla and 32 implants were placed in the mandible. All implants were placed in postextraction sites and were immediately loaded. Provisional restorations were delivered within 2 hours from surgery and all were in occlusion. Forty-three patients received a single implant while in the remaining 13 patients the implants were splinted. Definitive prosthetic restoration was delivered within 1 to 4 months following implant placement. Evaluations of soft tissue health and marginal bone remodeling were conducted. An independent radiologist performed the radiographic evaluation using the top of the implant as the reference point with negative values indicating a level below the reference point.

Results: Forty-eight patients, accounting for 66 implants, have passed the 5-year follow-up. No implants have failed resulting in a 5-year cumulative implant survival rate of 100%. Three patients, with six implants, withdrew during the course of the follow-up; one patient passed away and two patients moved. Five patients with seven implants did not show up at 5 years recall. At the 5-year follow-up, majority of the implants that were followed demonstrated normal periimplant mucosa and no visible plaque. The mean bone level at 5-year follow-up was −2.45 mm (SD 1.29, $n = 63$) demonstrating a level in line with the first thread. Mean marginal bone loss from implant inserting to 5 years was 0.56 mm (SD 1.98, $n = 63$). In regard with complications, a fracture of the ceramic crown was reported 5 years after implant insertion in a patient who developed bruxism. No other biologic nor mechanical complications were reported.

Conclusion: This retrospective 5-year follow-up study of 56 patients treated with implants immediately placed in postextraction sockets and immediately loaded demonstrates good treatment outcome with regard to implant survival, soft tissue condition, and marginal bone response.

KEY WORDS: immediate loading, postextraction sites, TiUnite

INTRODUCTION

The reduction of treatment time and patient discomfort while maintaining a high level of predictability and an esthetic outcome represents one of the main objectives when developing clinical protocols in modern implant dentistry.

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The two-stage surgical procedure for implant placement with delayed implant loading has been the most documented approach to implant therapy since it was first documented by P.I. Branemark[1] in 1977. Similar results have been reported with the one-stage surgical procedure and transmucosal healing of implants.[2] In the early 1990s, Schnitman et al.[3] first documented the reliability of the immediate loading of implants in the fully edentulous mandible. The one-stage surgical concept has been further documented and reported to also be feasible and predictable in cases of partial edentulism.[4,5] Today, immediate function is a well-documented treatment concept gaining more and more acceptance among dentists. Predictable results are believed to depend on good primary implant stability, controlled loading conditions, and an osseoconductive implant surface.[6]

The adoption of immediate loading protocols delivers obvious benefits to the patient when compared to conventional implant treatment. Among these are the reduction of treatment time and discomfort, no need for a second surgery to uncover implants in case of submerged healing, and no need to use removable prostheses to avoid temporary periods without teeth. A further application of the immediate loading protocol, still controversial with regard to long term predictability and esthetic outcome, especially when replacing single maxillary teeth in the anterior zone, is the immediate implant placement and provisionalization in postextractive sockets.[7] In these clinical cases, the role of a correct surgical and prosthetic treatment planning and meticulous execution, starting with an atraumatic extraction preserving as much of the alveolar bone walls as possible, appears to be more essential for the functional and esthetic result than in healed sites.

In consideration of the oxidized surface promoting bone healing and the tapered shape of the implant body, the Replace Select Tapered TiUnite implants have been used for years in our clinic when applying immediate implant function in both healed sites and postextractive sockets.

The objective of this study was to report on the 5-year clinical and radiologic outcome of patients treated with implants immediately placed in extraction sockets and immediately loaded.

MATERIALS AND METHODS

A total of 79 Replace Select Tapered TiUnite implants (Nobel Biocare, Goteborg, Sweden) were placed in 56 consecutive patients, between November 2002 and November 2004. Patients were of both sexes (23 males and 33 females) and had an average age of 50.9 years (range 21–76). The patients were enrolled and treated consecutively provided that they fulfilled the inclusion criteria and gave their informed consent for the treatment.

TABLE 1 Implant Size in Relation to Location

	Maxilla	Mandible
Replace Select Ø3.5		
13 mm	0	4
16 mm	3	6
Total	3	10
Replace Select Ø4.3		
10 mm	2	1
13 mm	2	4
16 mm	16	2
Total	20	7
Replace Select Ø5		
10 mm	2	0
13 mm	3	4
16 mm	16	9
Total	21	13
Replace Select Ø6		
10 mm	1	1
13 mm	2	1
Total	3	2
Grand Total	47	32

Twenty-nine implants placed in the incisor/canine area, 14 in the premolar, and 4 in the molar area.
Eleven implants placed in the incisor/canine area, 16 in the premolar, and 5 in the molar area.

Forty-seven implants were placed in the maxilla (29 in the incisor/canine area, 14 in the premolar, and 4 in the molar area), and 32 in the mandible (11 in the incisor/canine area, 16 in the premolar, and 5 in the molar area). Implant size in relation to location is reported in Table 1.

All implants were immediately placed in extraction sockets and immediately loaded. Forty-three patients received a single implant while in the remaining 13 patients the implants were splinted.

Selection Criteria

The following inclusion criteria were used: healthy patients, good oral hygiene, absence of interarch discrepancies, clinical and radiologic picture of hopeless

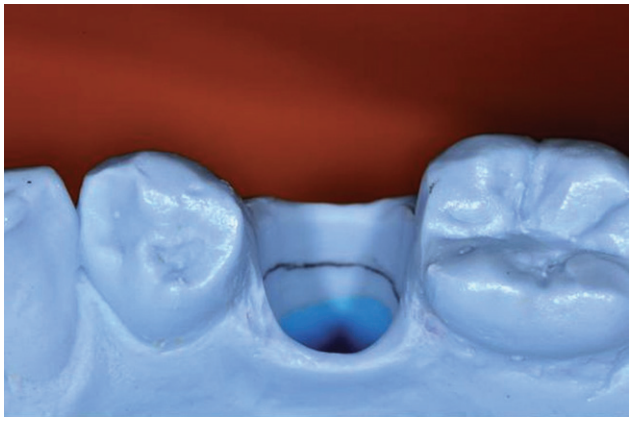

Figure 1 Reference points for depth of implant replica.

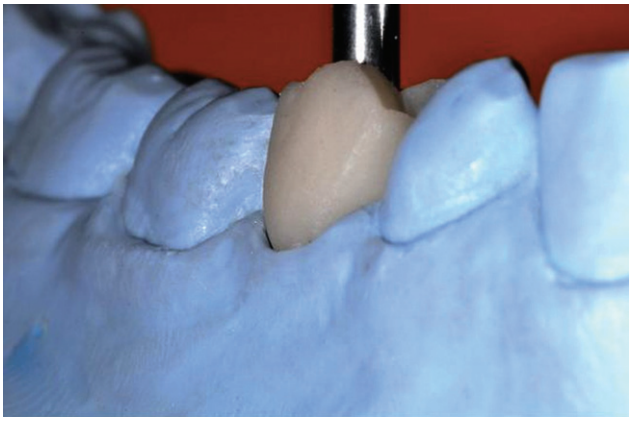

Figure 2 Implant replica angulation: reference point is the inclination of the root as indicated by root prominence on the model.

tooth in case of immediate postextractive implant, and insertion torque of ≥45 Ncm in case of single implant and ≥35 Ncm in case of multiple splinted implants. In addition to exclusion criteria universally accepted in implant surgery,[8] the following exclusion criteria were used: signs of active periodontal disease with bone loss, periapical lesions on adjacent teeth, heavy smokers (more than 10 cigarettes per day), severe bruxism, and/or parafunctional habits. All patients had given their informed written consent to treatment.

Surgical and Prosthetic Treatment Planning

The medical history of the enrolled patients was collected, a clinical and radiologic examination was performed and study models made. When clinical and intraoral radiologic examination showed a hopeless tooth, an immediate-loaded postextraction implant was planned.

In these cases, an impression with vinyl-polysiloxane material (Sky Putty Fast, Sweden & Martina, Italy) was made and poured with an hepoxydic resin (Blue Star, Zeiser Dentalgerate Gmbh, Germany) to form a model; then, in the hepoxydic resin model an implant replica was inserted using the following reference points:

- depth of the implant replica: mesial and distal levels of alveolar bone in contact with the tooth to be extracted were measured by probing and compared with intraoral x-ray (Figure 1);
- implant replica angulation: inclination of the root as indicated by the root prominence on the model (Figure 2);
- implant replica diameter: decided upon mesio-distal and vestibular-lingual measures of the tooth (Figure 3).

Once the replica was inserted into the model, the abutment (Esthetic Abutment, Nobel Biocare, Goteborg, Sweden) was screwed on and mesiodistally modified to fit the shape of the alveolus and the gingival contour.

The abutment was then covered beyond the gingival margin by a thin layer of opaque resin to enhance the adhesiveness with the resin used to reline the provisional crown and avoid that titanium showed through.

In order to make the acrylic provisional a working wax-up was made: for the anterior teeth according to Weimberg's principles of long centric;[9,10] for the posterior, a simplified occlusion according to Wiscott's[11,12] was made. The same occlusion principles were also followed in final prosthesis preparation.

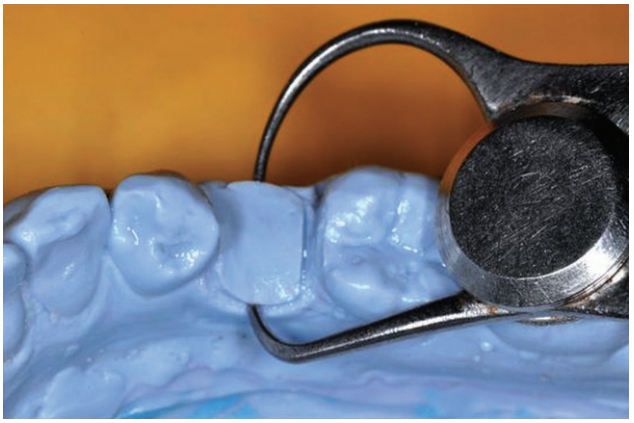

Figure 3 Diameter of implant replica decided upon mesio-distal and vestibular-lingual measures of the tooth.

From the working wax-up, a rigid silicone template was obtained to make the acryilic resin provisional (Anaxdent GmbH, Stuttgart, Germany) at the dental lab located in the same dental office; after relining, in order to be connected to the implant together with the abutment, provisional was then pierced in correspondence with the prosthetic-screw level.

Surgical Procedure

Two hours before surgery, patients were given two tablets of amoxicillin and clavulanic acid (875 + 125 mg) (Augmentin, Glaxo-SmithKline, Verona, Italy).

Local anesthesia was done with articaine 1:100,000 (Septanest, Septodont, Saint Maur des Fosses, France). Teeth were extracted atraumatically with the aid of a periotome. In cases of multi-rooted teeth, a rizotomy was made starting from the center of the tooth followed by extraction of the individual roots with care so as not to damage the alveolar walls. Upon completion of the extraction, the integrity, depth, and inclination of the alveolus were checked with the aid of a periodontal probe.

In all cases, a flapless surgical approach was followed. No punching was performed and burs were used to cut both the mucosa and the bone.

For implant site preparation the inclination of the first drill was always more palatally. In cases of premolars, the use of osteotomes allowed for displacement of the septum toward the vestibular wall for increased strength. When poor bone quality was encountered, the implant site was underprepared. Osteotomes and drills were only used in the final part of the preparation to define the implant diameter and to better exploit the available alveolar bone. Screw tapping was never done.

In order to achieve an appropriate primary stability, implants with as much width and length were used to be compatible with the extraction socket sizes. No grafting, with or without membrane was used in any of the cases. In order to facilitate the closure of the mucosal gap collagen (Condress, Euroresearch, Italy) maintained in situ by some vycril (Ethicon, Johnson & Johnson, New Brunswick, NJ, USA) sutures were used.

After surgery, patients were administered antibiotics (Augmentin, Glaxo-SmithKline, Verona, Italy) 1 g. twice daily for 5 days; patients were also instructed to wash their mouth with chlorhexadine 0.2% (Dentosan, Johnson & Johnson, USA) thrice daily and not to brush the treated area until the next scheduled control, 7–10 days later, for suture removal and medication.

At implant insertion, the following recordings were made: buccal mucosal biotype, bone quality (scored as bone quality 2 in 76 implant sites, quality 3 in 2, and quality 1 in 1 site respectevely) and insertion torque. An intraoral X-ray was taken after provisionalization.

All provisionals were screw-retained acrylic restorations delivered within two hours from surgery and all were placed in occlusion.

For all patients but one, to whom it was delivered 1-month postsurgery, final prosthesis delivery occurred after 2–4 months. Eight final restorations were Procera alumina or zirconia crowns (Nobel Biocare AG, Zurich, Switzerland), while 71 were porcelain-fused-to metal final prostheses. Opposing dentition was represented by natural teeth in most cases (69 implants). For 10 implants, opposing teeth were implant- (8) or teeth- (2) supported prostheses.

Follow-up visits were scheduled at 2–4 months after implant insertion, and at 1, 2, 3, 4, and 5 years time points. Evaluations of soft tissue health (peri-implant mucosa, scored as 0 = normal, 1 = bleeding on superficial probing, 2 = spontaneous bleeding; Jemt's papilla index[13] scoring 0 = when no papilla is present. 1 = less than half of the height of the papilla is present. A convex curvature of the soft tissue contour adjacent to the implant crown and the adjacent tooth is observed. 2 = when half or more of the height of the papilla is present, but does not extend all the way up to contact point between the teeth. 3 = when optimal soft tissue contour is present. 4 = when the papillae are hyperplastic and covers too much of the implant restoration and/or the adjacent tooth; pocket depth on probing) and marginal bone levels/marginal bone remodeling were conducted.

Marginal bone level was evaluated on the basis of the peri-apical radiographs taken perpendicular to the long axis of the implants where the implant platform and threads were clearly visible. Conventional film holders or manual forceps were used to place the films. The radiographs were repeated when quality was poor. An independent radiologist made the bone-height measurements. An image analysis program (National Institutes of Health Scion Image Corporation 4.0.2, Frederick, MD, USA) was used to measure the distance between the implant platform and the most coronal level of the bone deemed to be in contact with the fix-

TABLE 2 Life Table Analysis

Time Period, Implants	Implants	Failed	WD	Missing Info	CSR%
Insertion to 3 months	79	0	0	0	100
3 months to 1 year	79	0	0	0	100
1 to 3 years	79	0	0	0	100
3 to 4 years	79	0	5	1	100
4 to 5 years	73	0	0	7	100
5 years	66	—	—	—	—

WD, withdrawals; CSR, cumulative survival rate.

ture surface. The first bone-to-implant contact at surgery was defined as the baseline. The marginal bone remodeling was calculated as the difference between the reading at the examination and the baseline value. Mesial and distal bone height measurements were averaged for each implant.

Success and Failure Criteria

The success and survival criteria used in this 5-year report are a modification of the success criteria suggested by Van Steenberghe.[14]

According to the above criteria, a "successful implant" is an implant that: (1) Does not cause allergic, toxic, or gross infectious reactions either locally or systematically; (2) Offers anchorage to a functional prosthesis; (3) Does not show any signs of fracture or bending; (4) Does not show any mobility when individually tested by tapping or rocking with an hand instrument; and (5) Does not show any signs of radiolucency on an intraoral radiograph using a paralleling technique strictly perpendicular to the implant-bone interface.

A "surviving implant" is when the implant remains in the jaw and is stable, and when the subject's treatment is functionally successful even though all the individual success criteria are not fulfilled.

A "successful prosthesis" is a prosthetic reconstruction that is stable and in good function.

A "failed implant" is an implant that has been removed, fractured beyond repair, or cannot be classified as a successful or surviving implant.

RESULTS

Forty-eight patients accounting for 66 implants have passed the 5-year follow-up. No implants have failed resulting in a 5-year cumulative implant survival rate of 100% (Table 2). Three patients, with six implants, withdrew during the course of the follow-up; one patient passed away and two patients moved after 4 and 3 years respectively. Five patients with seven implants did not show up at 5 years recall.

At the 5-year follow-up, a majority of the implants demonstrated normal periimplant mucosa (Table 3) (Figure 4) and no visible plaque. Papilla index values and clinical evaluation of pocket depth at the 5-year follow-up are reported on Tables 4 and 5 respectively.

Radiographic Analysis

Marginal bone levels for all sites presented as averages (mesial + distal/2) at different timepoints are shown in Table 6. Radiographic evaluations showed mean bone levels at –1.81 mm (SD = 1.93, $n = 78$) for time of implant insertion while mean bone level at the 5-year follow-up was –2.45 mm (SD 1.29, $n = 63$) demonstrating a level in line with the first thread. Mean marginal bone loss from implant insertion to 5 years was 0.56 mm (SD 1.98, $n = 63$) indicating an overall stability of the periimplant bone (Table 7). The frequency of distribution of implants showing higher than 3 mm bone loss

TABLE 3 Clinical Evaluation of Periimplant Mucosa at 2–4 Months and after 5-Year Follow-Up

	2–4 Months		5 Years	
	N	%	*n*	%
0	51	65	38	47
1	28	35	21	27
Data missing/withdrawn	0	0	20	26
Total	79		79	

0 = normal; 1 = bleeding on superficial probing; 2 = spontaneous bleeding.

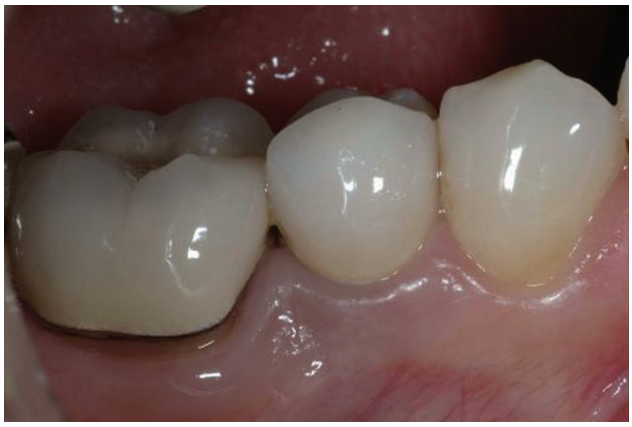

Figure 4 Clinical picture at 5-year follow-up.

after 5 years was 7% while that of implants with a bone gain higher than 2 mm was 6%. No implant site gained bone higher than 3 mm (Figures 5 and 6).

Complications

In one patient who developed bruxism, a fracture of the ceramic crown was reported 5 years after implant insertion. No other biologic nor mechanical complications were reported.

TABLE 4 Papilla Index (Mesial and Distal) at Baseline and after 5-Year Follow-Up

	Mesial		Distal	
	n	%	*n*	%
Implant insertion				
0	0	0	0	0
1	3	3	2	2
2	44	56	52	66
3	32	41	25	32
4	0	0	0	0
Data missing/withdrawn	0	0	0	0
Total	79		79	
5-year follow-up				
0	0	0	0	0
1	0	0	4	5
2	41	52	41	52
3	18	23	12	15
4	0	0	2	2
Data missing/withdrawn	20	25	20	25
Total	79		79	

0 = no papilla is present; 1 = less than half of the height of the papilla is present. A convex curvature of the soft tissue contour adjacent to the implant crown and the adjacent tooth is observed; 2 = half or more of the height of the papilla is present, but does not extend all the way up to contact point between the teeth; 3 = optimal soft tissue contour; 4 = the papillae are hyperplastic and covers too much of the implant restoration and/or the adjacent tooth

TABLE 5 Clinical Evaluation of Pocket Depth at 5-Year Follow-Up

	Buccal						Lingual					
	Mesial		Midline		Distal		Mesial		Midline		Distal	
	n	%	*n*	%	*n*	%	*N*	%	*n*	%	*n*	%
3 mm	5	6	44	57	8	10	5	6	28	35	5	6
4 mm	37	47	17	20	39	49	39	49	29	37	29	37
5 mm	19	24	0	0	13	16	14	18	4	5	27	34
6 mm	0	0	0	0	1	1	3	4	0	0	0	0
Data missing/withdrawn	18	23	18	23	18	23	18	23	18	23	18	23
Total	79		79		79		79		79		79	

TABLE 6 Bone Level All Sites

	Implant Insertion		3-Year Follow-Up		4-Year Follow-Up		5–6-Year Follow-Up	
Mean (mm)	–1.81		–2.33		–2.52		–2.45	
SD (mm)	1.93		1.20		1.21		1.29	
n	78		42		43		63	
	n	%	*n*	%	*n*	%	*n*	%
2.1–3.0	2	3	0	0	0	0	0	0
1.1–2.0	2	3	0	0	0	0	0	0
0.1–1.0	3	4	0	0	0	0	0	0
0.0	6	8	1	3	0	0	1	2
–1.0 to –0.1	14	18	5	12	3	7	9	14
–2.0 to –1.1	20	26	10	24	12	28	13	21
–3.0 to –2.1	13	17	16	38	16	37	26	41
–4.0 to –3.1	9	12	7	17	10	23	6	10
≤–4.0	9	12	3	7	2	5	8	13

Bone levels presented as averages (mesial + distal)/2.

DISCUSSION

With regard to long-term predictability of immediate function protocols in healed sites, even in critical bone areas, general consensus is increasing; several authors, in fact, have found very favorable results with this approach, similar to those documented for delayed loading protocols: Glauser et al.[15] has recently reported the 7-year results of implants with an oxidized surface placed predominantly in soft bone and subjected to immediate occlusal loading. Thirty-eight patients received a total of 102 Branemark System MK IV implants (Nobel Biocare AB, Goteborg Sweden) for support of 51 fixed restorations. Cumulative implant survival rate at 7 years was 97.1%. Calandriello et al.[16] have reported the 5-year follow-up findings of a prospective multicenter study assessing the immediate occlusal loading of single lower molars using Branemark System MK III Wide Platform TiUnite implants. Thirty-three patients with a total of 40 single tooth lower molar implants were followed up to 5 years with a cumulative success rate of 95%.

TABLE 7 Marginal Bone Remodeling, All Sites

	Implant Insertion to 3 Years		Implant Insertion to 4-Year Follow-Up		Implant Insertion to 5–6-Year Follow-Up	
Mean	–0.75		–0.48		–0.56	
SD	1.59		2.13		1.98	
n	41		42		63	
	n	%	*N*	%	*n*	%
>2.1	1	2	3	7	4	6
1.1–2.0	2	5	2	5	3	5
0.1–1.0	10	24	8	19	14	22
0	0	0	0	0	1	2
–1.0 to –0.1	11	27	13	31	19	30
–2.0 to –1.1	11	27	10	24	11	18
–3.0 to –2.1	2	5	3	7	7	11
–4.0 to –3.1	3	7	2	5	3	5
<–4.0	1	2	1	2	1	2

Bone remodeling, presented as averages (mesial + distal)/2.

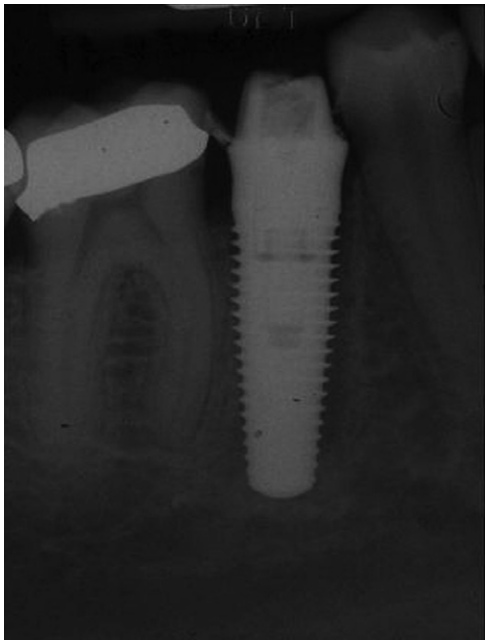

Figure 5 Baseline radiograph after extraction of 45, immediate implant insertion and provisionalization.

With regard to outcomes of implants immediately placed and loaded after tooth extraction, conflicting results have been published by different authors: Esposito et al.,[17] focusing on the effect of timing of implant placement on outcome, using a Cochrane Database Systematic review where evidence was derived from two randomized controlled trial in a limited number of patients, concluded that immediate implants may offer some advantages in terms of patient satisfaction and esthetics, possibly preserving alveolar bone. Botticelli et al.,[18] in a prospective 5-year follow-up study on immediate implants in fresh extraction sockets which were loaded 5–7 months after placement, obtained a very high success rate (no implant was lost) and stable or improved marginal bone levels. On the same topic, Quirynen et al.[19] performed a Medline search to systematically review the current literature on the clinical outcomes and incidence of complications associated with immediate and early-loaded (placed following soft tissue healing) implants. The authors concluded that the question regarding whether the outcomes of immediate or early-loaded implants are comparable with implants in healed sites remained unanswered. The authors also reported a tendency toward higher losses when implants were immediately loaded. De Rouck et al.,[7] in another systematic review addressing single-tooth replacement in the front maxilla by means of immediate implantation and provisionalization, concluded recommending that clinicians be reserved when considering this kind of treatment, adding that a number of guidelines and prerequisites need to be taken into consideration.

On the other hand, recently published articles have reported favorable findings with an immediate or early loading approach. Crespi et al.,[20] in a randomized, controlled clinical trial comparing immediate versus delayed loading of implants (mainly wide and long implants) placed in fresh extraction sockets in the maxillary esthetic zone of 40 patients, reported a cumulative survival rate after 2 years of 100% for all implants with no statistically significant difference between the two

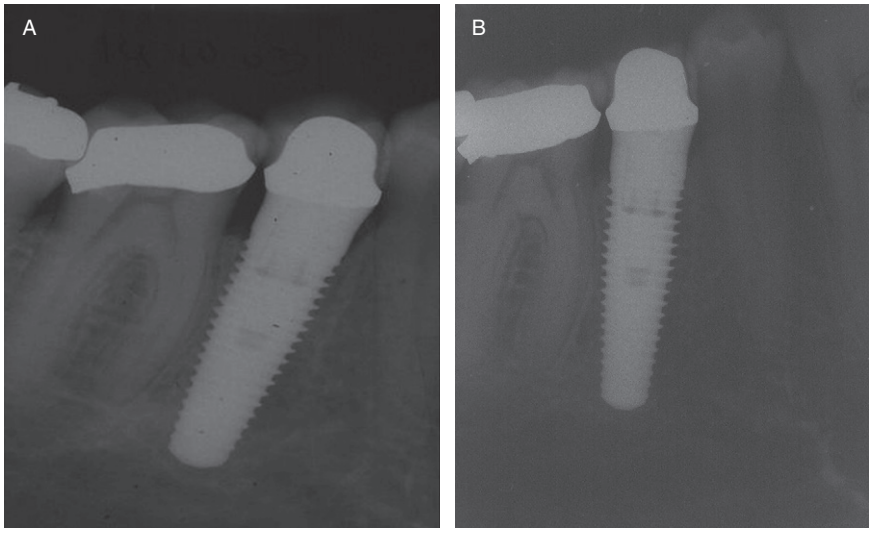

Figure 6 *A*, Five-year radiologic follow-up. *B*, Six-year radiologic follow-up.

groups in terms of radiologic results. Degidi et al.,[21] in 2007, retrospectively compared the immediate loading of a large series of implants (416) in postextractive and healed bone sites (658). They concluded that postimmediate loaded implants have high survival and success rates that are similar to those reported in previous studies of two-stage procedures or in immediate loading implants inserted in healed bone. In another pilot study on immediate and early function of 76 implants placed in extraction sockets of maxillary infected teeth, Villa et al.[22] achieved a 97.4% survival rate at 1 year with very limited bone loss. Finally, positive long term findings, although in a limited number of patients (16) and implants (24), have been published by Mijiretsky et al.[23] After 6 years of follow-up, the authors reported an overall implant survival rate of 95.8% with stable periimplant conditions.

The hetereogeneity of these findings may lie in the number of variables involved in determining the final outcome. The preservation of alveolar bone walls during extraction (in particular, the buccal plate), the reason for extraction, the overall oral health and hygiene conditions, the adopted surgical and prosthetic protocol, the surgical technique with or without membrane and/or bone substitute, the implant location in the socket, and a flapless or flap elevation approach, all are of importance for the outcome.

In the current study, the following reasons may account for the favorable results: (1) the accurate surgical and prosthetic treatment planning allowing the correct implant position and the presurgery preparation of individualized abutment and provisional; (2) the choice of a screw-retained provisional, avoiding cementation, allowing for a better soft tissue healing; and (3) the loading control with axial load in centric and no contacts in lateral movements and protrusion (to optimize axiality of occlusal loads, in the area from canine to canine, Weimberg's principles of long centric were applied,[9,10] while for the posterior teeth a simplified occlusion according to Wiscott[11,12] was followed); (4) the use of implants as wide and long as possible so as to reduce the gap between the bone wall and implant and get a better primary stability; (5) in soft bone quality underpreparation of the site was made; (6) no screwtap; and (7) the benefit of the oxidized surface favoring a faster bone healing without either soft or hard tissue problems over the 5-year observation period.

CONCLUSIONS

Within the limitations of this retrospective 5-year follow-up study, it was found that the immediate loading of Replace Select Tapered TiUnite implants placed in postextraction sockets demonstrates good treatment outcome with regard to implant survival, soft tissue condition, and marginal bone response.

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REFERENCES

1. Branemark P-I, Hansson BO, Adell R, et al. Osseointegrated implants in the treatment of the edentulous jaw. Experience from a 10-year period. Scand Plast Reconstr Surg Suppl 1977; 16:1–32.
2. Buser D, Weber HP, Bragger U, Balsiger C. Tissue integration of one-stage ITI-implants: 3-year results of a longitudinal study with hollow-cylinder and hollow screw implants. Int J Oral Maxillofac Implants 1991; 6:405–412.
3. Schnitman PA, Whorle PS, Rubenstein JE, Da Silva JD, Wang NH. Ten-year results for Branemark implants immediately loaded with fixed prosthesis at implant placement. Int J Oral Maxillofac Implants 1997; 12:495–503.
4. Achilli T, Tura F, Euwe E. Immediate/early function with tapered implants supporting 2–4 units fixed partial dentures in premolar and molar areas of maxillae and mandible: 1-year follow up results of a prospective multicenter study. J Prosthetic Dent 2007; 97(Suppl 1):52–58.
5. Fischer K, Backstrom M, Sennerby L. Immediate and early loading of oxidized tapered implants in the partially edentolous maxilla: a 1-year prospective clinical, radiographic and resonance frequency analysis study. Clin Implant Dent Relat Res 2009; 11(2):69–80.
6. Rocci A, Martignoni M, Gottlow J. Immediate loading of Branemark System Tiunite and machined-surface implants in the posterior mandible : a randomized open-ended clinical trial. Clin Implant Dent Relat Res 2003; 5(Suppl 1):57–63.
7. De Rouck T, Collys K, Cosyn J. Single-tooth replacement in the anterior maxilla by means of immediate implantation and provisionalization : a review. Int J Oral Maxillofac Implants 2008; 23:897–904.
8. Lekholm and Zarb GA. Patient selection and preparation. In: Branemark PI, Zarb GA, Albrektsson T, eds. Tissue – integrated prostheses. Chicago, IL: Quintessence, 1985: 199–209.

9. Weinberg LA. Reduction of implant loading using a modified centric occlusal anatomy. Int J Prosthodont 1998; 11:55–69.
10. Mura P, Vozza I, Pompa G, Quaranta M. The long centric: reduction of occlusal risk factors in implant prostheses. Poster Presentation at Europerio, Geneva, June 8–11, 2000.
11. Wiskott HW, Belser UC. A rationale for a simplified occlusal design in restorative dentistry: historical review and clinical guidelines. J Prosthet Dent 1995; 73:169–183.
12. Wiskott HW. A simplified occlusal design in restorative dentistry. In: Progressi in Protesi. Padova: Piccin Publisher, 1995:119–128.
13. Jemt T. Regeneration of gingival papillae after single-implant treatment. Int J Periodontics Restorative Dent 1997; 17:326–333.
14. Van Steenberghe D. Outcomes and their measurement in clinical trials of endosseous oral implants. Ann Periodontol 1997; 2:291–298.
15. Glauser R, Meier M. Seven-year results of implants with an oxidized surface placed predominantly in soft bone and subjected to immediate occlusal loading. Clin Oral Implants Res 2009; 20:870.
16. Calandriello R, Tomatis M. Immediate occlusal loading of single lower molars using Brånemark System® wide platform TiUnite™ implants: a 5-year follow up report of a prospective clinical multi-center study. Clin Implant Dent Relat Res 2009; August 5. [Epub ahead of print].
17. Esposito MA, Koukoulopoulou A, Coulthard P, Worthington HV. Interventions for replacing missing teeth: dental implants in fresh extraction sockets (immediate, immediate-delayed an delayed implants). Cochrane Database Syst Rev 2006; 4: CD005968. DOI: 10.1002/14651858.CD005968.pub2.
18. Botticelli D, Renzi A, Lindhe J, Berglundh T. Implants in fresh extraction sockets: a prospective 5-year follow up clinical study. Clin Oral Implants Res 2008; 19:1226–1232.
19. Quirynen M, Van Assche N, Botticelli D, Berghlund T. How does the timing of implant placement to extraction affect outcome? Int J Oral Maxillofac Implants 2007; 22(Suppl):203–223.
20. Crespi R, Capparè P, Gherlone E, Romanos GE. Immediate versus delayed loading of dental implants placed in fresh extraction sockets in the maxillary esthetic zone: a clinical comparative study. Int J Oral Maxillofac Implants 2008; 23:753–758.
21. Degidi M, Piattelli A, Carinci F. Immediate loaded dental implants: comparison between fixtures inserted in post-extractive and healed bone sites. J Craniofac Surg 2007; 18:965–971.
22. Villa R, Rangert B. Immediate and early function of implants placed in extraction sockets of maxillary infected teeth: a pilot study. J Prosthet Dent 2007; 97(6 Suppl):S96–S108.
23. Mijiretsky E, Mardinger O, Mazor Z, Chaushu G. Immediate provisonalization of single tooth implants in fresh extraction sites at the maxillary esthetic zone: up to 6 years of follow up. Implant Dent 2009; 18:326–333.