Immediate Postextractive Dental Implant Placement with Immediate Loading on Four Implants for Mandibular-Full-Arch Rehabilitation: A Retrospective Analysis

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ABSTRACT

Background: To date, only few studies have reported on the clinical outcomes of immediate postextraction implant placement and immediate loading.

Purpose: The purpose of this retrospective study was to report the results of immediately loading four implants placed in fresh extraction sockets in the mandible after a follow-up of 24 months.

Materials and Methods: Between January 2001 and January 2009, 50 patients (28 women and 22 men, average age 54 years), had 347 teeth extracted and a total of 200 dental implants placed in the mandible. The patients received a provisional fixed bridge the same day and a permanent one 3 months later. Clinical checkups were performed after 1, 2, 3, 6, 12, and 24 months. Marginal bone measurements were made in intraoral radiographs taken 1 day after surgery and after 1 year. A questionnaire was used to evaluate self-perceived factors related to comfort, aesthetics, and function.

Results: All bridges were stable and no implant failures were recorded during the follow-up, giving a survival rate of 100%, at 2 years. The marginal bone loss amounted to 1.33 ± 0.36 mm after 1 year and 1.48 ± 0.39 mm after 2 years. Ten patients showed prosthetic complications with the provisional bridge, but all the definitive prostheses remained stable throughout the study period without any complications. The patients reported satisfaction with the treatment.

Conclusions: The present retrospective study showed that immediate loading of four implants immediately placed in extraction sockets is a valid treatment modality for the totally edentulous mandible.

KEY WORDS: dental implants, full-arch prosthesis, immediate loading

INTRODUCTION

Because of a better understanding of biological and biomechanical features, together with the notable progress in dental implant morphology and surface characteristics, immediate loading has become an attractive alternative to conventionally loaded implants.[1] Despite the fact that numerous studies on immediate, or early loading have been published,[1–3] over the last few years,[4–7] scientific literature contains several different definitions and evaluation criteria as to the *immediate loading* concept. Indeed, authors refer to immediate loading even when dealing with a 20-[8] or even 30-day period[9] between surgery and actual loading. In the fourth ITI Consensus Conference, *immediate loading* was defined as a prosthesis that is placed in occlusion with the opposing dentition within 48 hours of implant placement.[10]

The concept of immediate loading was first applied to the loading of multiple implants in both the maxilla and mandible[11] for full-arch restorations[11–14] with predictable results. Currently, the survival rates for implants subjected to immediate loading in mature mandible

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bone vary between 80% and 100%.[15–19] However, most of the studies published on immediate loading in the mandible have examined mature bone in edentulous patients.[5,8,17,20–22] As only a few studies, with a limited number of patients,[6,7,23] have described immediate loading of postextractive immediate implants, no definitive evidence has yet been provided on survival rate.

Among these studies, Peñarrocha and colleagues[23] reported a 100% survival rate in eleven patients treated with immediate full-arch implants. Only two randomized controlled clinical trials compared immediate versus delayed implants:[24,25] when prosthesis and implant failures were analyzed, no statistical significant difference was found between the two types of implant loading. Thanks to immediate full-arch loading of the jaw, partially edentulous patients need no longer to wear a conventional removable denture during the osseointegration waiting period (2 to 3 months) and the time required to make their definitive prostheses (2 to 4 months),[26–28] resulting in an improvement in both comfort and function, during the implant healing period.

The purpose of this retrospective study was to report the results of immediately loading of four implants placed in fresh extraction sockets in the mandible after a follow-up of 2 years.

MATERIALS AND METHODS

Patients

The study included 50 patients, 28 females and 22 males, average age of 54.3 years (range 45–65), with partially edentulous mandibles in need of tooth extractions because of severe periodontal disease and/or caries. The patients had been treated by one surgeon between January 2001 and January 2009 according to an immediate loading protocol using four implants and delivery of a fixed bridge the same day. The local ethical committee approved the study protocol. All subjects included in the study gave a written, informed consent to the treatment, and agreed to be available for follow-up clinical visits, including postoperative radiographs, all of which was carefully detailed.

Inclusion Criteria

- Age > 8 years;
- partially edentulous mandible requiring extraction of the remaining teeth;
- minimum bone height of 10 mm in the interforaminal area and 8.5 mm in the distal area with a minimum bone width of 4 mm; and
- insertion torque value of ≥ 30 Ncm.

Exclusion Criteria

- Any systemic or local disease or condition (hematologic diseases, uncontrolled diabetes, serious coagulopathies, history of intravenous therapy with bisphosphonates, and/or diseases of the immune system) that preclude an oral surgical intervention,
- immunosuppression,
- current corticosteroid use,
- pregnancy,
- irradiation to the head or neck region within 12 months before surgery,
- severe parafunctional habits,
- a poor bone quantity (type IV),
- more than 10 cigarettes per day, and
- poor oral hygiene.

Pre- and Postsurgical Preparation

The presurgical evaluation included clinical examinations and orthopantomograms (OPTs) and computed tomography scans. Prior to surgery, the patients underwent debridement and root scaling. The patients received 1 g of amoxicillin and clavulanic acid (Augmentin, Roche S.p.A., Milan, Italy) every 8 hours from the day before surgery to the sixth postsurgical day. Oral rinses with chlorhexidine digluconate 0.2% mouthwash (Curasepts, Curaden HealthCare s.r.l., Saronno, Italy) were prescribed starting 3 days before surgery, followed by seven daily postsurgical sessions.

Surgical Procedure

Surgery was performed under local anesthesia with articaine chlorhydrate at 4% and epinephrine 1:100,000 (Alfacaina N, Weimer Pharma, Rastat, Germany). The tooth extractions were done using a piezoelectric device to preserve bone tissue (Mectron Piezosurgery® Device, Mectron Medical Technology, Carasco, Italy). The extraction sockets were thoroughly and carefully cleaned and left empty. Any granulation tissue present was removed. A periodontal probe was used to verify the integrity of the fresh socket bony walls. A crestal incision was made from the first molar region to the contralateral side. After which, a

full-thickness flap was raised to enhance the visibility of the surgical field. The dental implant sites and depth were identified along with the ideal angulations as dictated by a surgical guide in transparent heat-cured acrylic resin. After mucoperiosteal flap reflection and identification of the mental foramina, of paramount importance for positioning the tilted implant in a distal position, bone remodeling was performed. Postextractive sockets were treated so as to ensure oxygenation by Piezosurgery® during the osteoplasty.[29,30] The length of the mental nerve loop and the shape of the bone were gently assessed by a round-tip probe to determine the ideal angulations of the posterior implants after bone ridge preparation. Implant site preparation was adapted to bone quality to obtain sufficient primary implant stability. Bone density was assessed by the clinician during the early phase of drilling and scored according to the Lekholm and Zarb classification.[31] The implant sites were underprepared to obtain the best possible implant stability. A torque controller (Osseocare®, Nobel Biocare AB) with a torque limit of 50 Ncm was used during implant placement. A manual wrench was also used when incomplete fixture seating occurred.[32] All patients received four implants (Brånemark System® MKIII or NobelSpeedy™ Groovy, Nobel Biocare AB, Göteborg, Sweden). Firstly, the distal tilted fixture was placed. The drill was crestally inserted in correspondence to the first molar and tilted about 30° to the occlusal plane over the alveolar nerve foramen. The mesial fixtures were then inserted. The implants were placed 1 mm under the buccal level of the alveolar crest to improve their primary stability. To facilitate gap closure between implants and the surrounding bone, any bone defects larger than 2 mm were filled with an injectable nanocrystalline paste (Ostim®, Osartis, Obernburg, Germany).[33] The same bone graft material was used to treat any fenestrations resulting from the implant insertion.

Abutments (MUA®, Nobel Biocare AB) were connected to the implants. Abutments with an inclination of 30° relative to the fixture axis were placed onto the distal fixtures to allow for an optimal prosthetic screw access. Standard 1 mm or 2 mm high MUA, or abutments with 17° of inclination when necessary, were placed onto mesial fixtures. A torque controller (Osseocare®, Nobel Biocare AB) was used to tighten tilted abutment screws at 20 Ncm and standard abutment screws at 30 Ncm. Piezosurgery® was used to remodel the bone ridge around the emergence of the implants to allow for the multiunits to be screwed on.

A total of 347 teeth were extracted and 200 implants (20 NobelSpeedy™ Groovy, 4 mm in diameter, 180 Brånemark System® MKIII), 3.75 mm in diameter were placed according to an immediate loading protocol between January 2001 and January 2009 (Figure 1, A–C). Implant lengths ranged from 13 to 18 mm depending on the bone height available and were placed with a torque of ≥30 Ncm (Figure 2A). One hundred twenty-one implants were placed directly in postextraction sockets, while 79 were placed into healed edentulous sites.

After positioning the temporary 15-mm high titanium prosthesis cylinders (Nobel Biocare AB) (Figure 2B), the soft tissues were gently adapted to the abutments and sutured with a 4-0 resorbable suture (Vicryl, Johnson & Johnson Intl., St Stevens, Woluwe, Belgium). Sutures were removed at 14 postoperative days (Figure 2C). An impression of the implant position was made with the aid of a light-curing acrylic resin (Triad® Gel, Dentsply International, New York, USA) following the implant surgery to connect the temporary titanium prosthesis cylinders to the impression tray. Polyether elastomeric material was used to take the soft tissue impression. The occlusion was checked and the impression removed. Lastly, healing caps were placed onto the multiunit abutments and left in place throughout the provisional restoration waiting period.

Prosthetic Procedure

A 12-unit provisional bridge was manufactured in the dental laboratory. The acrylic provisional prostheses were delivered within 3 hours after surgery (Figure 2D). A cast metal bar was included in the resin whenever needed, to prevent fracture of provisional restorations. The cantilevers were eliminated to minimize fracture risk and excessive stress over the distal implants. The prostheses had acrylic occlusal surfaces with narrow platforms and flat cusps; the occlusal contact was light, while centric and lateral contacts were limited to the intercanine zone. The patients were also instructed to eat only soft food for the first month and were given instructions for correct oral hygiene, including the use of toothbrushes and flossing technique. The definitive prostheses were made starting 3 months after surgery (Figure 2, E and F).

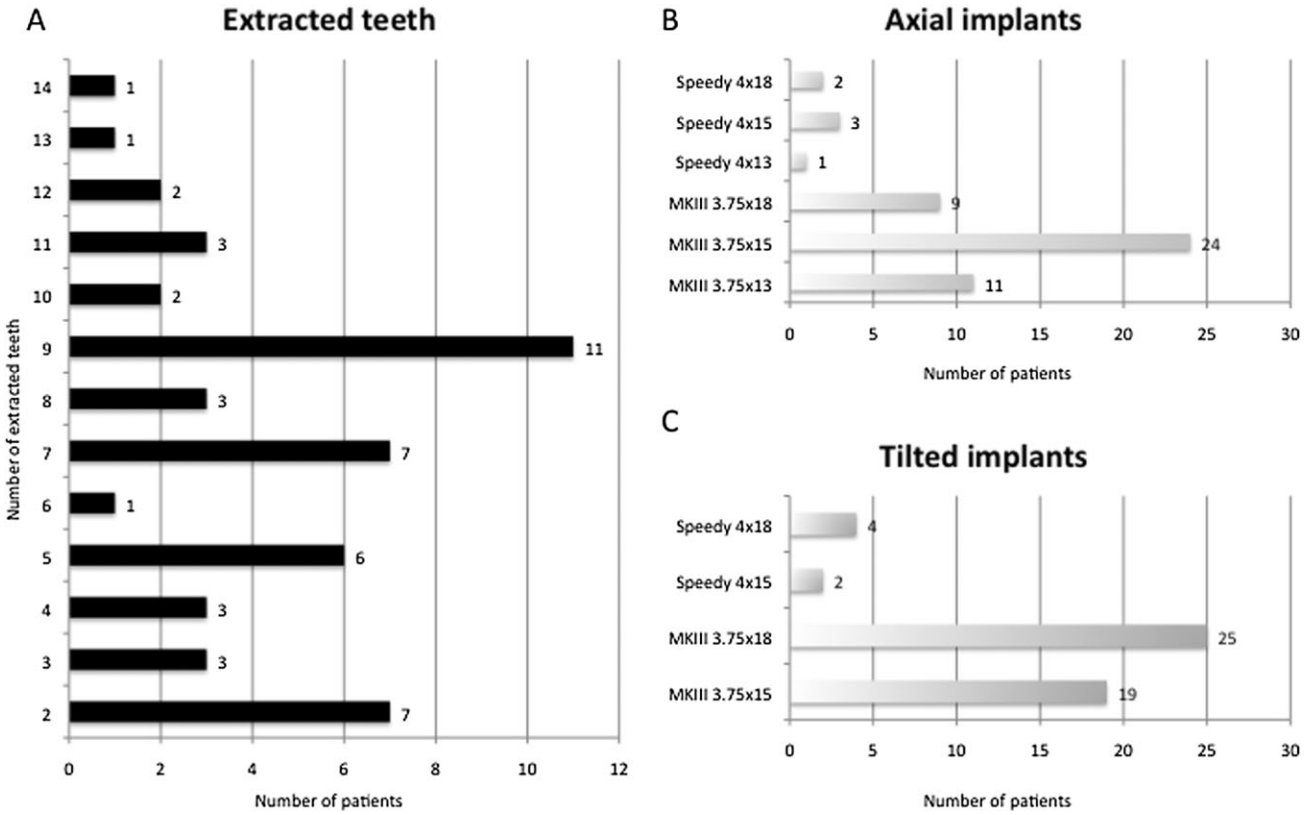

Figure 1 Showing (A) the number of teeth extracted per patient; (B) types of axial implants; and (C) types of tilted implants per patient.

Survival Criteria

Implant and prosthesis survival were evaluated in this study. The definition of implant survival was based on the clinical and radiologic criteria of Albrektsson and collegues:[34]

1. absence of clinically detectable implant mobility;
2. no evidence of peri-implant radiolucency;
3. radiographic vertical bone loss less than 0.2 mm per annum; and
4. absence of pain, infections, neuropathy or paresthesia;

Clinical Follow-Up

Weekly postoperative checkups were made during the first postsurgical month to evaluate tissue healing and prosthesis function; wounds were examined at 14 days and sutures removed. Further visits were scheduled at 1, 2, 3, 6, and 12 months and every 6 months thereafter when implant and prosthesis stability as well as occlusion was checked.

A questionnaire was used to evaluate self-perceived factors related to comfort, aesthetics and function.

Radiographic Follow-Up

OPTs (Orthophos, Sirona, Bensheim, Germany; at 69–71 kV and 15 mA for 14.2 s) and, when necessary, standardized periapical intraoral films (Oralix 65 S, Gendex Dental Systems S.r.l., Milano, Italy) were taken preoperatively, within 1 day after surgery (baseline) and also at 1, 3, and 6 months postsurgery and 1 and 2 years after final prosthesis delivery (Figure 3, A–J). Periapical films were used to evaluate the marginal bone level. Particular attention was paid so as to position the radiographic film parallel to the implant and to align the X-ray beam perpendicular to the implant axis, thus obtaining an optimal, minimally distorted image of the implant threads. The image size was standardized at 750 d.p.i. with a resulting size on average of $1{,}890 \times 1{,}220$ pixels at 8 bytes per plane and 256 values of gray. Two independent examiners (M.M. and G.G.) measured the distance in 0.1 mm increments between

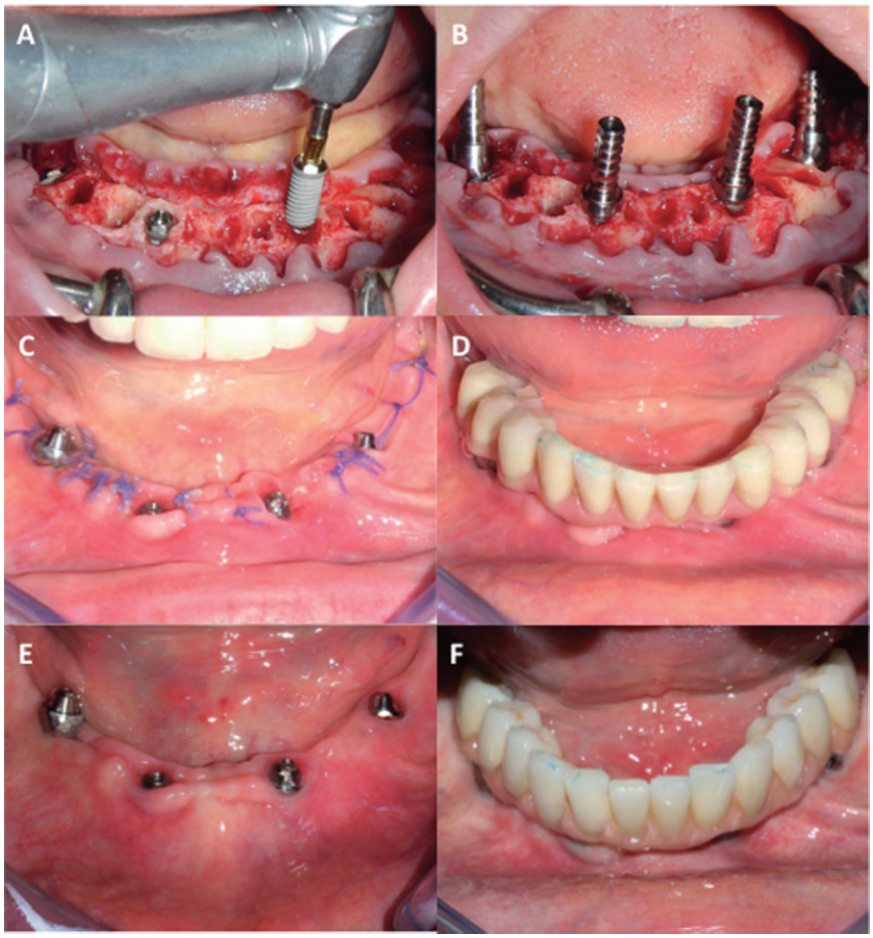

Figure 2 Clinical photograph showing: (A) the placement of an implant in an extraction socket; (B) four implants placed in extraction sockets with abutments and temporary titanium cylinders; (C) sutures about to be removed at 14 postoperative days; (D) the provisional bridge connected to the four implants; (E) the oral mucosa healing at 3 months; and (F) the definitive prosthesis.

the implant shoulder as the reference point and the most coronal bone-to-implant contact mesially and distally of the implants. The known distance between three implant threads was used for calibration purpose and to determine the image magnification. If there was a difference superior to 0.5 mm, then the radiographs were reexamined by both examiners and the results discussed until arriving at a consensus, according to previous protocols.[35]

RESULTS

Apart from expected postoperative swelling and pain, there were no other immediate postsurgical complications. Loosening of the 30° angled multiunits was observed in five patients, most likely because of occlusal overload. Consequently, the abutments were fixed and the prosthesis cylinder reattached directly in the oral cavity with resin. There was a fracture in the provisional screw-retained fixed bridges in another five patients, probably because of the small quantity of acrylic resin. Therefore, a total of 10 patients showed complications while wearing the provisional fixed prostheses.

All permanent bridges and implants remained stable of the 24 months follow-up period, giving a survival rate of 100% for bridges and implants. The marginal bone level measured 0.54 ± 0.28 mm baseline (200 periapical intraoral films, one per implant) and 1.87 ± 0.48 mm after 1 year (200 periapical intraoral films, one per implant). The marginal bone loss (Table 1) after 1 year (Figure 4) amounted to 1.33 ± 0.36 and 1.48 ± 0.39 mm after 2 years. The data from the questionnaire showed high satisfaction with the treatment, in particular, with eating comfort, aesthetics, and phonetics.

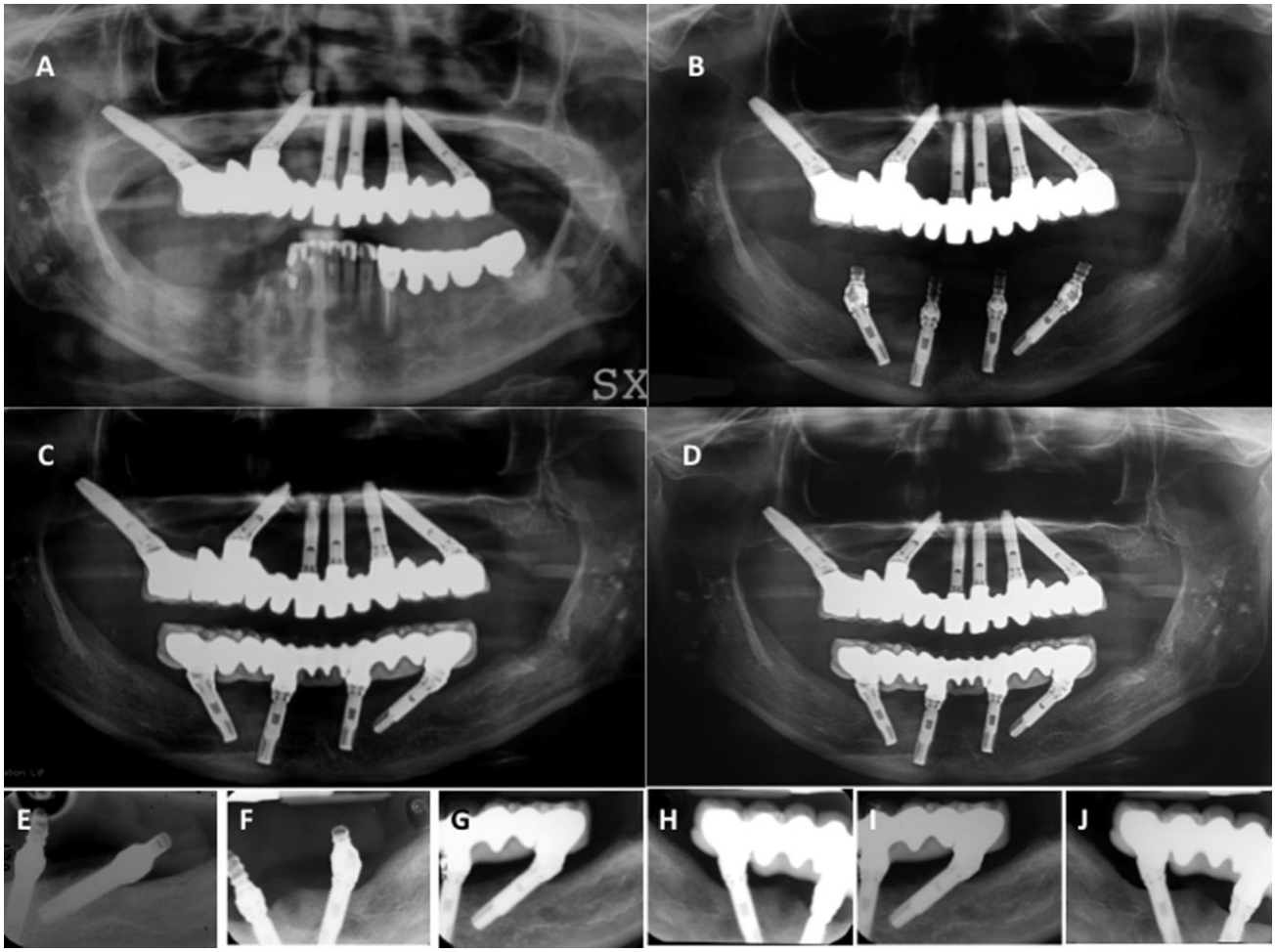

Figure 3 Orthopantomograms showing: (A) the preoperative condition of the patient; (B) the patient at 3 months; (C) the patient at 1 year postoperative; and (D) the follow-up visit at 2 years. Periapical intraoral films showing: the implants placed in the third (E) and fourth quadrant (F) immediately after surgery; the implants placed in the third (G) and fourth quadrant (H) 1 year after surgery; the implants placed in the third (I) and fourth quadrant (J) 2 years after surgery.

DISCUSSION

This retrospective study aimed at evaluating the possibility to rehabilitate completely edentulous mandibles by immediate loading of postextractive immediate implants. As poor bone quality and limited bone quantity often hinder the rehabilitation of the mandibular posterior region with axial implants, tilted implants have frequently been used to improve bone anchorage.[36] Malò and colleagues demonstrated the efficacy of this technique in 2003 by proposing a protocol for edentulous mandibles called "all-on-4".[20] This protocol makes use of four dental implants: two in the anterior part of the mandible and two in the posterior part. The two posterior implants are tilted to reduce the extensions (cantilever) of the fixed prostheses. The mandibles of 44 patients were rehabilitated by a total of 176 immediately loaded dental implants: the survival rate was 98.2% at 12 months.[20]

Our study reported an implant and prostheses survival rate of 100%, which is consistent with previous retrospective[13,20] and prospective single-cohort studies.[37–41] Thus, the survival rate of implants placed in

TABLE 1 Results from Marginal Bone Measurements

	Bone Level mm ± SD	Radiographs Used for Measurements
Marginal bone level, baseline	0.54 ± 0.28	200
Marginal bone level, 1 year	1.87 ± 0.48	200
Marginal bone level, 2 years	2.03 ± 0.51	200
Bone loss baseline to 1 year	1.33 ± 0.36	200
Bone loss baseline to 2 years	1.48 ± 0.39	200

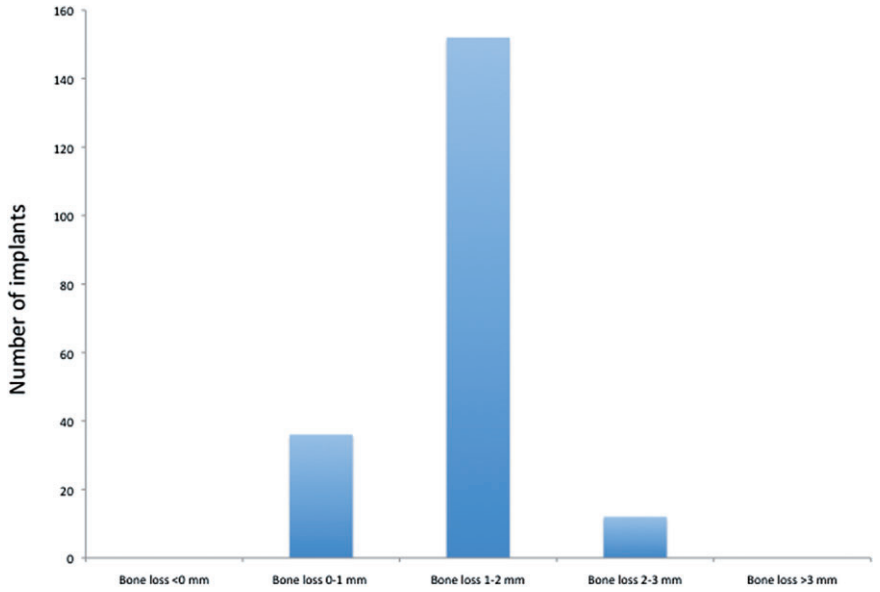

Figure 4 Showing frequency distribution of the bone loss at 1 year.

fresh extraction sites equal to that of implants placed into healed edentulous sites. It should be remarked that one prerequisite for this immediate loading protocol was high initial implant stability, as the implants were placed with an insertion torque of ≥30 Ncm. Indeed, adequate primary implant stability is a fundamental requisite for immediate loading.[42,43] Traditionally, implant stability is achieved by osseointegration during a period of undisturbed healing, while primary stability is achieved immediately via mechanical fixation. Implant surface characteristics are important[44] so as to obtain a successful bone healing, and therefore, long-term implant stability (secondary stability). The use of medium-rough surface implants may have contributed to the favorable results obtained in this study. TiUnite™ is a highly crystalline and phosphate-enriched titanium oxide characterized by a microstructured surface with open pores in the low micrometer range.[45] This implant surface has repeatedly proven to give a more rapid bone formation and greater amount of bone-to-implant contact compared with machined implant surfaces.[46–48] Also, when placed in soft bone and immediately loaded, TiUnite™ surfaces resulted in higher success rates compared with machined implants.[49]

Although the immediate implant loading technique avoids many of the traditional implant surgery drawbacks, that is, healing stages and the use of temporary prostheses, it is prone to other types of possible complications, prosthesis fracture being one of the most common. The fact that the temporary fixed prostheses have to be made and loaded during the surgical session, increases the number of variables that may lead to problems, that is, misfit and fracture. However, if properly handled by careful planning and standardized procedures, problems can be avoided. The incidence of fractures of the acrylic prostheses in the present study (10% of the total cases) is consistent with that reported in literature.[38–40]

CONCLUSIONS

In conclusion, the present study showed successful results when using an immediate loading/immediate postextractive placement protocol for full-arch rehabilitation of completely or partially edentulous mandibles. The technique eliminates the use of a temporary removable prosthesis and reduces treatment times in implant cases where multiple extractions are necessary.

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