A 10-Year Retrospective Clinical Evaluation of Immediately Loaded Tapered Maxillary Implants

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Purpose: The aim of this study was to compare the effects of immediate loading (IL) and delayed loading (DL) on peri-implant crestal bone loss around maxillary implants after long-term functioning. ***Materials and Methods:*** A retrospective chart review was conducted to assess the outcomes of 110 tapered, multithreaded implants placed for the treatment of one or more missing and/or unsalvageable teeth in the maxilla of 23 patients. Implants were assigned to either the DL or IL database according to loading time. Marginal bone changes were calculated using standardized radiographs taken at implant placement (baseline) and during annual follow-ups. ***Results:*** One implant failed in the DL group. After a mean follow-up of 111 months in the DL group and 119 months in the IL group, cumulative implant survival was 99.09% (DL = 98.11%, IL = 100%). No observable bone loss was evident in 83.49% of the surviving implants. Cumulative success rates were 100% for the IL group and 98.11% for the DL group. ***Conclusions:*** Immediately loaded maxillary implants showed long-term results comparable to delayed loaded maxillary implants. *Int J Prosthodont 2013;26:244–249. doi: 10.11607/ijp.3044*

Immediate loading is defined as an application of functional load to the implant at the time of placement or generally within 48 hours after implantation.[1] This technique's cited advantages include a single surgical intervention with an attendant reduction in patient discomfort, the possibility of an improved soft tissue response and rapid recovery of masticatory function, overall comfort, and esthetics. However, immediate loading increases the risk of an implant's interfacial micromovements leading to osseointegration failure. This occurs because a desired bone-implant interfacial contact that precludes formation of a fibrous tissue barrier depends on limiting microscopic implant micromovements to less than 100 to 150 μm.[2,3]

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Implant placement into fresh extraction sockets has been reviewed extensively, and while its long-term outcome merits remain debatable, it is popularly regarded as offering similar advantages to immediate loading protocols, along with a reduction in number of surgeries and treatment time. Other aspects attributed to immediate placement, such as implant success, esthetic outcome, and preservation of alveolar process, are topics currently debated.[4]

Implant stability has been reported to be enhanced by connecting implants with a bar, reinforcing provisional restorations with metal, using a minimum implant length of 10 mm, and choosing threaded rather than unthreaded implant designs.[5–8] Roughened implant surfaces have also been reported to contribute to the success rate of immediately loaded implants when compared with implants with machined surfaces.[9–11] In a literature review, Avila et al[12] compared outcomes for immediately loaded implants with rough and smooth surfaces and reported success rates of 93.5% to 100% and 80% to 100%, respectively, for splinted prostheses, and 75 to 100% and 85%, respectively, for single-tooth restorations. It should be noted that a well-designed final restoration will also help determine the long-term treatment outcome. Implant location, alignment, and stability optimize function by distributing occlusal loads through larger bone-to-implant interfaces to reduce the risk of overloading.[13] Success rates for splinted implant restorations have been reported to be higher (94.7%)

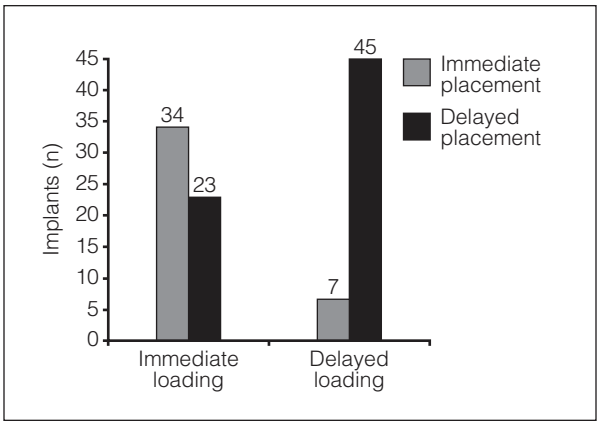

Fig 1 Distribution of implants by placement time and loading time.

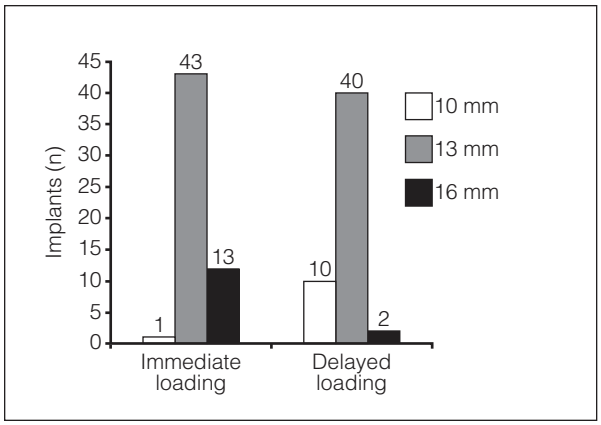

Fig 2 Distribution of implants by length.

than for unsplinted restoration designs (88.8%).[14,15] Occlusal interferences may threaten the outcome of immediate loading. Patients with parafunctional habits should be aware of potential risks and complications that might occur due to excessive forces on implants.[16,17]

Barone et al[18] compared bone density around immediately loaded and unloaded implants using volumetric computed tomography. They observed that bone density, equivalent to bone maturation, was higher for the immediately loaded group. However, their small patient sampling precludes drawing definitive conclusions from their findings.

Immediate loading is regarded as more predictable in the anterior mandible where dense compact bone provides the best conditions for implant stabilization. Consequently, implants placed in defect-free compact bone have a higher probability of achieving initial stability and are more capable of absorbing occlusal loads.[19–21] In a retrospective study, Trisi et al[22] found that only 3% of implants placed in types I to III[23] bone failed, while the failure rate for implants placed in type IV[23] bone climbed to 35%. There is less information about immediate loading in the maxilla, given the presence of more challenging anatomical landmarks and possibe bone quality considerations, such as trabecular bone.

This retrospective study compared the 10-year treatment outcomes for dental implants placed in maxillae using either immediate or delayed loading in a private practice setting.

Materials and Methods

A convenience sample of 46 patients who had been consecutively treated with 173 maxillary implants (tapered, multithreaded with microtextured surfaces) (Tapered Screw-Vent MTX, Zimmer Dental) between

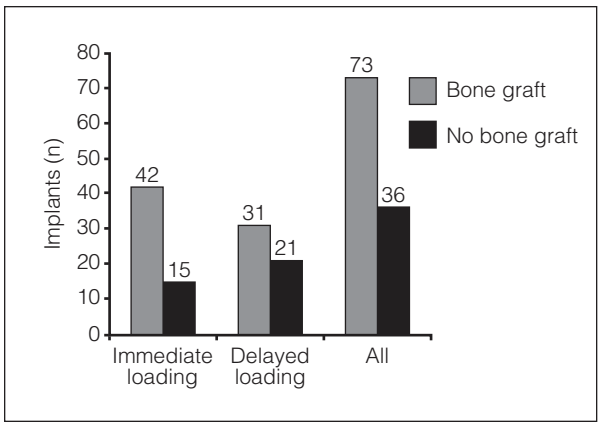

Fig 3 Use of bone graft at implant placement.

March 2000 and June 2002 and who had completed at least one clinical evaluation annually in the authors' private practice was selected and comprised this retrospective study's group. To eliminate variables of implant design and diameter, the final study database consisted of 23 subjects (9 men and 14 women) with a mean age of 54.98 years (range, 25 to 75 years), who were treated exclusively with 110 maxillary implants (3.7 mm diameter) from the same manufactuer and restored with fixed partial dentures (FPDs). Forty-two implants were placed immediately after extraction, and 68 were placed in healed postextraction sites. The distribution of implants by placement time and loading time is summarized in Fig 1, and the distribution of implants by length is summarized in Fig 2. Fifty-seven implants were immediately loaded (IL group) and 53 implants were subjected to delayed loading (DL group). Figure 3 shows the distribution of bone graft used at the time of implant placement. Mean follow-up times were 111.81 months for the DL group and 119.33 months for the IL group.

Table 1 Criteria for Dental Implant Treatment

Inclusion	At least 18 years of age
	Adequate available bone to accommodate an implant
	Systemically and dentally healthy
	Demonstrated ability to maintain oral hygiene
	Willingness and ability to commit to follow-up
	Provided signed informed consent
Exclusion	Lack of skeletal maturity
	Ridges that required significant augmentation for implant site development
	Uncontrolled diseases or conditions that could impede bone healing or soft tissue health
	Mental, emotional, or lifestyle factors that could adversely impact treatment and follow-up

Table 2 Criteria for Implant Evaluation

Clinical survival	Implant is immobile when manually tested
	No peri-implant radiolucency
	No irresolvable clinical symptoms, such as pain, discomfort, numbness, infection
	No irresolvable mechanical problems
	No fractured components
	Implant is fully functioning according to its intended prosthodontic purpose
Clinical success	Meets implant survival criteria
	Absence of fractured components
	Absence of non-failure–related adverse events
	Peri-implant bone loss not exceeding 4.0 mm after 10 years of function*
	Meets the patient's clinical and esthetic needs
	Meets the patient's expectations
	Cumulative implant survival is at least 90% after 5 years

*Based on reported Branemark[1,34,35] bone loss values of 1.5 to 2.0 mm during healing, < 1.0 mm during the first year of functional loading, and < 0.2 mm annually thereafter.

Implants were assigned to either the DL (n = 53) or IL (n = 57) database according to loading time. Patients were treated for one or more missing and/or unsalvageable teeth in the maxilla and met general inclusion criteria for dental implant treatment (Table 1). A retrospective chart review was conducted of all patient records, and data were retrospectively entered into spreadsheets on a personal computer.

In all cases, patients were carefully evaluated for medical and dental histories and subjected to detailed clinical and radiographic examinations, evaluations of oral hygiene, and assessment of their ability to commit to long-term follow-up. Prosthetic wax-ups and surgical templates were fabricated to allow guided placement of the implants relative to the planned prosthesis. The treatment plan and alternative options were dicussed, and signed informed consent was obtained from each patient prior to treatment.

A surgical template was used for osteotomies, and implants were placed in accordance with the manufacturer's protocol. Criteria for immediate placement of implants were initial implant stability, four-walled postextraction sites, and implant-alveolar bone gap of no more than 2 mm. When implants were placed into fresh extraction sites, gaps greater than 1 mm around the neck of the implants were grafted with autogenous bone or β-tricalcium phosphate (Cerasorb, Curasan) mixed with blood and covered with a resorbable barrier membrane (BioMend, Zimmer Dental).

In patients who were reluctant to wear a removable provisional restoration, immediate loading of implants with a fixed provisional restoration was performed if the implants could withstand 20 Ncm of reverse torque immediately after placement. Otherwise, implants were subjected to delayed loading after a conventional submerged healing period. Peri-implant bone changes were calculated from a common landmark in the cervival region of the implant neck to the crestal bone level using nonstandardized periapical radiographs taken at implant placement (baseline) and at the last annual follow-up appointment.

Because of difficulty in measuring slight variations and an inability to control for exact radiologic distortion, mean mesial and distal bone loss were recorded in incremental ranges of 0 to 1 mm, 1 to 2 mm, 2 to 3 mm, 3 mm, or > 4 mm.

At annual prophylaxis appointments, data were recorded on how the implants were performing. Plaque, gingival depth, and probing depth indices were evaluated as references for monitoring the health of the peri-implant mucosa. Implant-related problems were treated, and failed implants were removed and recorded in the database as failures.

Table 2 summarizes the criteria for evaluating implant clinical survival and clinical success.

Statistical Methods

Study variables were summarized by the prosthetic loading time of the dental implants: immediate or delayed. For each group, categorical study endpoints were summarized as frequencies and percentages at each level of the variable, and continuous variables were summarized using descriptive statistics (N, mean, median, standard deviation, minimum, and maximum). Several anaylses were performed, including

mixed model analysis: fixed effects were patient sex, age, health risks, implant length and diameter, time of implant placement, bone graft use, type of restoration, time of implant loading, and follow-up length. The dependent variable was the amount of bone loss. One implant from each patient was randomly chosen by SPSS software for the following two analyses. *(1)* Logistic regression: variables were health risks, loading time, implant length and diameter, bone graft use, and restoration type; *(2)* Crosstabs analysis: the goal was to study the effects of health risks, implant placement time, and loading time on bone loss. All analyses were performed using SPSS software (IBM).

Results

The majority of implants exhibited no discernible bone loss (Fig 4). Statistical analysis revealed no correlation between implant loading protocol and amount of bone loss. However, mixed model analysis found dependency between follow-up time and amount of bone loss (P = .020, 95% confidence interval [CI] 0.008241–0.090669). Logistic regression and crosstabs analysis found implant length, placement time, loading time, loading protocol, and bone graft use had no effect on bone loss. A 50-year-old woman (patient 34) with a history of periodontitis and 11 immediately loaded implants lost 8 mm of bone around a single implant (3.7 × 13 mm) after 124 months of function and was successfully treated with guided bone regeneration procedures. The three patients with 3 to 4 mm of bone loss (one in the IL group and two in the DL group) had a history of controlled periodontal disease. Crestal bone loss is summarized in Fig 4. Apart from the one implant that failed to osseointegrate for unknown reasons and was removed before loading, there were no irresolvable adverse events. Porcelain fracture was the most prevalent prosthesis-related adverse event and involved five restorations in the IL group and four restorations in the DL group. One framework fracture occurred in each study group, and one FPD in the DL group sustained cement failure. Thus, there were no adverse events of any kind associated with 89.47% (51/57) of IL implants and 88.46% (47/53) of DL implants.

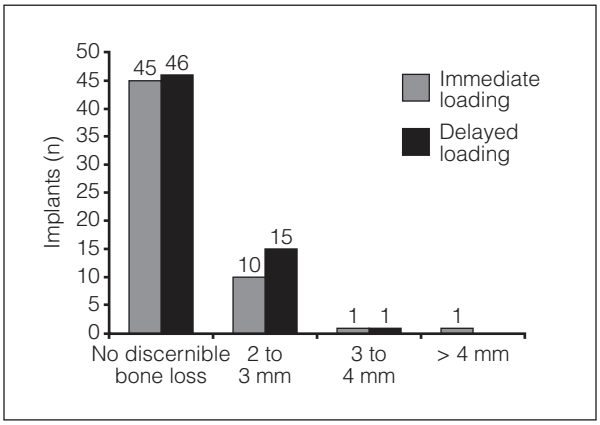

Fig 4 Crestal bone loss.

Discussion

Immediate loading of implants is a common and reliable treatment option, particularly in the mandible[24]; however, there is lack of evidence in the literature regarding the outcome of immediately loaded maxillary implants.[25] In a literature review, Attard and Zarb[26] found reasonable success rates of immediately loaded implants placed in the anterior maxilla. No conclusion was drawn regarding immediately loaded implants placed in the posterior maxilla because of a lack of published studies. Immediate loading of dental implants can be successful if clinical precautions are taken and preoperative assessment is properly done. Reasons for immediately loading implants are to preserve soft tissue esthetics, reduce treatment time and cost, and avoid removable dentures as an intermediate restoration. Implant success is not compromised by immediately placing implants after tooth extraction as long as primary stability is achieved.[26]

Methods of measuring and reporting peri-implant bone loss remain controverisal. At various times, Branemark researchers[27–29] reported that typical bone loss ranged from 1.5 to 2.0 mm during healing, with < 1.0 mm of additional bone loss after the first year of functional loading, followed by < 0.2 mm of bone loss annually thereafter. Based on these figures, the typical amount of peri-implant bone loss should range from a low of < 4.1 mm to a high of < 4.6 mm after 10 years of function. In the present study, 83.49% of the surviving implants exhibited no discernible peri-implant bone loss. The question still remains, however, as to why the remaining 16.51% of implants exhibited any bone loss at all. Causes of crestal bone loss have been associated with surgical trauma, occlusal overload, peri-implantitis, implant-abutment microgap, poor biologic seal, smoking, alcohol use, and many other factors.[30,31] Out of 52 surviving implants in the DL group, 6 implants displayed bone loss that ranged from 2.0 to 4.0 mm. In the IL group, 12 of 57 implants exhibited bone loss. For the majority (n = 11) of immediately loaded implants, bone loss ranged from 2.0 to 4.0 mm; only one implant exhibited bone loss > 4.0 mm. There was no statistically significant difference between the two loading groups.

The implants used in this study featured a 1.0-mm turned (machined) cervical collar above their microtextured surfaces. While short-term clinical studies have demonstrated increased bone attachment to roughened surfaces as compared with machined surfaces,[23,32] no studies were identified that clinically demonstrated the ability of roughened surfaces to prevent crestal bone resorption. Conversely, implants with fully roughened cervical collars[33] have demonstrated short- and long-term peri-implant bone loss rates comparable to conventional machined titanium implants: approximately 1 to 2 mm from placement to the first year of clinical loading followed by approximately 0.2 mm of bone loss thereafter until a steady state is achieved.[34] Based on these findings, it is doubtful that the 1-mm machined cervical collar contributed to the observed crestal bone loss in the present study. Other research has shown that roughened surfaces had no influence on crestal bone loss.[35]

In a comprehensive literature review of English-language dental implant studies published from 1981 to 2001, Goodacre et al[36] reported a 6% failure rate for maxillary fixed partial restorations. In the presence of type IV bone, the implant failure rate rose to 16% regardless of restoration type.[36] Out of the 110 implants placed in the present study, one implant failed for unknown causes, which resulted in a failure rate of 1%. Numerous causes of implant failure are reported in the dental literature, such as infection, impaired healing from surgical trauma, micromotion, and occlusal overload.[37]

Conclusion

The present clinical and radiologic findings suggest that there is no difference between immediately loaded implants and those loaded after a conventional healing period when used to restore fully edentulous or partially edentulous maxillae.

Acknowledgment

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

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Literature Abstract

Position of the Academy of Nutrition and Dietetics: The impact of fluoride on health

The primary role of fluoride in dental health is to prevent caries. Fluoride enhances remineralization of teeth and can decrease and reverse tooth demineralization. It also inhibits the metabolism of acid-producing bacteria that cause dental caries. Fluoride is found in small amounts in various foods that we eat and is a normal component of our diets. Pre-eruptively, fluoride is incorporated into the developing tooth and helps increase its resistance to acid demineralization. After eruption, ingested fluoride is secreted in saliva and provides topical protection. Systemic fluoride benefits teeth from birth until all teeth have erupted, while the protective effects via saliva are life long. Posteruptively, topical application is the primary means by which fluoride provides protection to teeth. The frequency of fluoride exposure is the most important factor for maintaining a high fluoride concentration on enamel surfaces, which will in turn prevent caries and enhance the remineralization of early carious lesions. The use of topical fluoride should be based on the level of caries risk rather than age or other factors. The American Dental Association Council on Scientific Affairs has determined a system for caries risk assessment and categorizes risk into low, moderate, and high. All individuals are encouraged to drink fluoridated water and brush with a fluoride-containing dentifrice. Children younger than 6 with moderate and high caries risk should have topical fluoride varnish application twice a year. Children aged 6 to 18 with moderate caries risk should have either a fluoride varnish or gel twice a year at the discretion of the clinician. Children in this age group with high caries risk should have topical fluoride two to four times a year. There are no clinical trials to support recommending professional topical fluoride to adults, but it is believed that topical fluoride applied two to four times a year can be effective at preventing caries. Fluoride is safe and effective at the levels used for water fluoridation (0.7 to 1.2 mg/L). Excessive fluoride places children at an increased risk for fluorosis which can appear clinically, ranging from white spots to severe pitting and discoloration of the teeth. In conclusion, the Academy of Nutrition and Dietetics supports optimal systemic and topical fluoride use throughout life to maintain good oral and overall health.

Palmer CA, Gilbert JA. *J Acad Nutr Diet* 2012;112:1443–1453. **References:** 86. **Reprints:** The Academy of Nutrition and Dietetics. Phone: 1-800-877-1600, ext 4835. Email: ppapers@eatright.org—*Clarisse Ng, Singapore*