Immediate Loading of Single Post-Extractive Implants in the Anterior Maxilla: 12-Month Results From a Multicenter Clinical Study

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The purpose of the study was to evaluate survival and peri-implant bone levels of single, immediately loaded post-extractive implants in the anterior maxilla 12 months after implant placement. Thirty-six consecutive patients from 3 study centers were included in the study. The concerned sites were upper premolars, canines, and incisors. For each patient the following data were recorded: reason for tooth extraction, bone quality, implant size, and final insertion torque. Implants were placed using a flapless technique and immediately loaded with a nonoccluding temporary restoration. Final restorations were provided 4 months later. Peri-implant bone resorption was evaluated radiographically after 6 and 12 months. The average final insertion torque was 70.55 Ncm. One implant inserted in D3 quality bone with a 35-Ncm seating torque was lost. All other implants had a final insertion torque ranging between 50 and 80 Ncm. The average peri-implant bone loss was 0.437 and 0.507 mm at 6 and 12 months, respectively. All the sites maintained excellent papillae and peri-implant soft-tissue conditions. The resulting 1-year success rate was 97.2%. Immediate nonfunctional loading of single post-extractive implants in the anterior maxilla is a predictable treatment. And it seems that achieving high insertion torques by placing self-tapping/self-condensing implants in an underprepared osteotomy is favorable.

\textbf{Key Words: immediate loading, single post-extractive implants, anterior maxilla, survival rate, bone resorption, insertion torque}

\section*{INTRODUCTION}

In the past two decades some of the original prerequisites for successful osseointegration are being redefined to meet patients' demands to reduce treatment time and increase comfort. Immediate loading and immediate implantation concepts have been proposed to shorten treatment time and to allow the patient to quickly recover function and esthetics.\textsuperscript{1}

Immediate loading is gaining popularity among clinicians, and the outcome of immediately loaded dental implants is being investigated more and more in clinical trials and animal studies.\textsuperscript{2–4} Even though the results are sometimes conflicting, there is an increasing corpus of evidence to support the application of immediate loading.\textsuperscript{1} However, most of the clinical studies on immediate loading have been performed in the totally edentulous maxilla and mandible. Few studies have investigated immediate loading of implants for single tooth replacement,\textsuperscript{5,6} and fewer still have examined immediate loading of implants placed in fresh extraction sockets.\textsuperscript{7,8}

The current state of knowledge suggests that
Immediate loading per se does not prevent successful osseointegration, provided that micromovement at the bone-implant interface is closely monitored. It has been shown that micromovement does not hinder the healing process if it is within a range of 50 to 150 \( \mu \)m.\(^9\) To contain micromovement within this range, it has been suggested that implants should be splinted together and/or that implant fixtures should have a high level of primary stability.\(^{10,12}\) Rigid splinting is possible in multiple-unit restorations, and various authors have demonstrated the long-term success of immediately loaded implants rigidly splinted together.\(^{10,12,13}\) However, in single tooth restorations, rigid splinting is not possible, and application of an immediate loading protocol could result in a higher risk of failure. More challenging is the situation of an immediately loaded single post-extractive implant where parts of the fixture are not engaging the bone. In this situation, achieving a high level of primary stability is probably more vital to ensure a successful outcome.

Immediate loading/temporization of post-extractive implants finds its main indication in the anterior maxilla, where the demand is dictated by the patient’s esthetic and psychological needs. The purpose of this study was to evaluate the success rate at the end of the first year and the peri-implant bone level changes of immediately loaded single post-extractive implants placed in the anterior maxilla.

**Materials and Methods**

Thirty-six patients scheduled for a single post-extractive implant were included in the study. The cases included were non-restorable teeth in the anterior maxilla (from the right second bicuspid to the left one) with a well-preserved alveolar contour. The reasons for tooth extraction are illustrated in Table 1. The study protocol was explained in detail to all patients, and they subsequently signed an informed consent form. Patient recruitment, implant placement, and follow-up were conducted by a single expert operator in 3 study centers in the north of Italy.

Patients were included in the study on the basis of the following criteria:

1. Good oral hygiene
2. Absence of systemic disease that could compromise osseointegration
3. Need for a single tooth replacement in the maxilla from the right second bicuspid to the left one
4. Residual alveolar bone walls and, in particular, the facial socket wall were not damaged after extraction
5. Adjacent teeth were in place

During the first visit, the patient’s oral hygiene and periodontal health were evaluated. In particular, periodontal screening and recording (PSR) was performed. Patients with a PSR score up to 3 were treated by a dental hygienist and reviewed after 30 days to evaluate plaque index.\(^{14}\) Where Plaque Index was up to 2, patients were excluded from the study.

**Surgical Protocol**

Flapless tooth extraction was performed with a particular concern for preserving the integrity of the alveolar bone walls. Where present, all granulation tissues were removed. The alveolar bone walls were carefully sounded with a probe to confirm the absence of bone dehiscences. Implants were placed using a flapless technique. The implant site was prepared according to the manufacturer’s instructions (JDentalCare, Modena, Italy). The implant platform was positioned 3 mm apical to the cementoenamel junction of the adjacent teeth. Remaining gaps between the implant and the surrounding bone were filled with Bio-Oss granules (Geistlich AG, Wolhusen, Switzerland). During the initial osteotomy, bone quality was gauged by resistance to drilling with a 2-mm twist drill. Bone was classified as D1, D2, D3, or D4.\(^{15}\) Tapered, self-tapping/self condensing implants were used (JDEvolution, JDentalCare). Final insertion torque was measured using a calibrated torque wrench (JDTorque, JDentalCare) that can reliably perform torque measurements from 15 to 80 Ncm (Figure 1). Implants to be seated that did not achieve an insertion torque above 30 Ncm were excluded from the study.

All patients were instructed to use 0.2% chlorhexidine mouthrinse twice daily, commencing 3 days before the intervention and continuing thereafter for a 2-week period. Antimicrobial prophylaxis was obtained with the use of 1 g \( \beta \)-lactam antibiotic (amoxicillin, Pfizer Manufacturing, Puurs, Belgium) twice daily for 6 days, starting 1 hour before
surgery. A soft diet was recommended during the healing period.

**Prosthetic Treatment**

A preparable titanium abutment was connected to the implant. The occlusion was checked and, if necessary, the abutment was cut and modified on an implant analog. A temporary restoration was relined in situ with acrylic resin, refined, polished, and cemented (Temp Bond, Kerr, GmbH, Karlsruhe, Germany). Care was taken not to have contact in centric occlusion and in lateral excursions. The provisional restorations were not removed during the healing period to prevent any manipulation that could jeopardize osseointegration (Figures 2 through 6). The definitive metal ceramic crown was delivered 4 months after surgery. An impression was made with a pick-up impression coping and the use of addition silicon (Elite Implant Impression Material; Zhermack, Badia Polesine, Rovigo, Italy). Based on restorative preferences, the definitive crown was either cemented or screw retained (Figures 7 and 8).

**Follow-up**

Patients were recalled at 10 days and at 3, 6, and 12 months after surgery to assess implant failure (any mobility or infection that required implant removal), peri-implant marginal bone level, and biologic or prosthetic complications. Criteria used to assess the outcome are those of Albrektsson and colleagues.16 Standardized bitewing X rays were taken subsequent to implant insertion and postoperatively at 6 and 12 months. Standardization was made with an individual rigid index made of polyether rubber (Impregum, ESPE, Germany) placed between the film holder and the opposing occlusal surfaces. Radiographs were scanned, digitized in JPEG,
converted to TIFF format with a 600-dpi resolution, and stored in a personal computer. The peri-implant marginal bone levels were measured using Image J 1.42 software (National Institute of Mental Health, Rockville, Md). Each image was calibrated twice, the first time using the known length of the radiograph’s side (40 mm × 30 mm) and the second time using the known diameter of the fixture. Readings of mesial and distal bone levels adjacent to each implant were made to the nearest 0.01 mm. The vertical distance was measured between the coronal margin of the implant collar (taken as the reference point) and the most coronal bone-to-implant contact. An increase in the vertical distance between the reference point and the most coronal bone-to-implant contact for consecutive radiographs was considered indicative of peri-implant marginal bone resorption. Each measurement was performed twice, on 2 different days and by the same operator, and the average of the 2 readings was taken as the final value.

**Statistical Analysis**

A descriptive statistical analysis was conducted. The t test was used to compare mean values. The mesial and the distal measurements on each implant were averaged and used as a statistical element. Statistical analysis was performed using the statistical package StatView (version 5.01.98, SAS Institute Inc, Cary, NC). Significance was set at $P < .05$.

**RESULTS**

Thirty-six implants were placed in 36 patients (20 female, 16 male) with an average age of 37.4 (see Table 2). Table 3 shows the dimensions (diameter and length) of the inserted implants.

Most of the sites were classified as D2 bone density, and no sites were D4 (Table 4). Seating torque values varied from 35 to 80 Ncm with a mean of 70.55 Ncm (Table 4).

Healing was, in general, uneventful, and there was little pain and swelling. One implant was lost, resulting in a survival rate of 97.2% after 1 year. The lost implant was inserted in D3 quality bone with a 35-Ncm final insertion torque. Implant mobility increased progressively during the first 3 weeks, and the implant was subsequently removed. All other sites maintained excellent papillae and peri-implant soft-tissue conditions. No patients complained of pain or discomfort during chewing, function, or percussion. No implant mobility was detected during the follow-up. All implants, except the one that failed, were inserted with a final insertion torque ranging from 50 to 80 Ncm.

In the radiographic analysis, the average value at baseline was $-0.132$ mm, which means that the implants were positioned at the level of the osseous crest or slightly coronal to it. The bone level found apically to the implant platform was $-0.437$ mm at 6 months after fixture placement and $-0.507$ mm at the 12-month follow-up period (Table 5). Bone resorption between 0 and 6 months, between 6 and 12 months, and between 0 and 12 months was statistically significant ($P < .0001$).

The definitive restoration was cemented in 22 patients and screw retained in 14 patients. The type of the final prosthesis, whether cemented or screw...
retained, had no influence on the marginal bone resorption \((P = .974)\).

**Discussion**

The results of this study showed that immediate implantation and temporization in the anterior maxilla afterward is a successful treatment. The immediate loading of single post-extractive implants is not a well-established procedure, and this approach may be at higher risk for implant failure and complications than delayed implants.\(^{17}\) However, a limited number of clinical papers report on this concept, and the achieved insertion torque is sometimes not mentioned.\(^{18}\)

In a prospective cohort study, immediate loading of single tooth implants in fresh extraction sockets in the maxilla was compared with immediate loading of single tooth implants in healed sites.\(^{19}\) The survival rate was 82.4% for the test group and 100% for the control group.

In a more recent study, 84 rough-surfaced implants were placed (50 in the maxilla and 34 in the mandible).\(^{20}\) Of these, 32 were placed in fresh extraction sockets. Four implants in 3 patients failed within the first 6 months, resulting in an implant survival rate of 95.2%. All of the failed implants had been placed in fresh maxillary extraction sockets.

Other findings are more encouraging. Polizzi et al\(^{21}\) presented the 5-year results of a multicenter study in which 264 implants were placed either immediately after tooth extraction or after a short soft-tissue healing period (3–5 weeks). The 5-year cumulative implant survival rate was 92.4% in the maxilla and 94.7% in the mandible. No difference in failure rates was observed between implants placed immediately and implants place conventionally.

The difference in success rates reported by several studies probably depends on differences in implant macro-geometry, implant surface, surgical technique, and loading protocol, but general conclusions cannot be drawn from a few underpowered trials.\(^{22}\) Well-designed, prospective studies are required to more thoroughly evaluate this treatment approach.

During the current study, 1 implant failed and was removed 3 weeks after placement because of progressive mobility. The failed implant had a final insertion torque of 35 Ncm, whereas all the successful implants had a final insertion torque ranging between 50 and 80 Ncm. The implant was inserted in D3 quality bone and, probably, the presence of micromovements at the implant-bone interface led to the formation of a soft-tissue encapsulation around the fixture, causing its failure.

When performing immediate loading, it is important to reach a sufficient primary implant stability. However, the threshold for sufficient primary stability has not been uniformly adopted in studies on immediate single implant loading. Besides, different methods have been used to
assess primary implant stability, and primary stability has sometimes not been reported at all. As it has been reported that insertion torque is related to the amount of micromotion, we used final insertion torque measurements to assess primary implant stability. It is possible to measure implant stability by means of the resonance frequency analysis, but the values were not collected in this study because its purpose was not to longitudinally assess implant stability. In our study, the implants were installed with a high insertion torque (mean = 70.55 Ncm). This was possible because tapered self-tapping/self-condensing implants were placed in underprepared osteotomies. The implants used also featured a progressive increase in the thickness of the threads to help stabilize the implant inside the osteotomy. Using this approach, high insertion torque was predictably achieved, and the fact that the patients were consecutively treated reflects the high degree of predictability in achieving high insertion torque using the described protocol. In this study, high insertion torque implant placement was apparently beneficial because the overall success rate was high (97.2% at 1 year), and all the implants that succeeded were inserted with a seating torque ranging between 50 and 80 Ncm. In support of this explanation is one study that demonstrated that increasing peak insertion torque may significantly improve the survival rates of immediately loaded single implants. Nevertheless, a minimum torque value of 35 Ncm has been successfully adopted in other studies on single implants inserted into fresh extraction sites and immediately loaded.

If there is no consensus on the minimal insertion torque required for this treatment concept, there is no consensus on the maximal insertion torque allowed either. Traditionally, implants were preferably placed with a torque not exceeding the empirically set limit of 45 Ncm because excessive strain on the surrounding bone was thought to negatively affect osseointegration. Excessive tightening creates important compression forces in the surrounding bone. This has been theorized to disturb microcirculation and lead to bone resorption, but the theory has never been scientifically investigated. In a recent study, the clinical outcome of 42 implants placed with an insertion torque ≥70 Ncm was reported. The use of high insertion torques (up to 176 Ncm) did not prevent osseointegration. The implants were followed for 1 year, and no signs of pressure necrosis, crestal bone change, or untoward healing were noted compared with the control group.

The mean final insertion torque of 70.55 Ncm achieved in this study is well above the conventional set limit, and it was seemingly beneficial. The only implant that failed was below this limit, and the implants that succeeded were above it. So, reducing the osteotomy diameter and placing self-tapping/self-condensing implants for the purpose of increasing the level of initial fixation seems to improve success rate. And it seems that bone deformity and heat arising from implant placement in narrower bone sites is not deleterious for osseointegration.

Based on the aforementioned literature, we can conclude that primary implant stability and lack of micromovement at the bone-implant interface is a determining factor in achieving high success rates. However, minimal and maximal insertion torque values have to be set for the immediate loading of single post-extractive implants.

The values of marginal bone loss found in this study (0.43 mm at 6 months and 0.5 mm at 12 months) were consistent with what has been reported in other studies on immediate single tooth implants in the anterior maxilla. Lorenzoni and colleagues found that mean coronal bone level changes at 6 and 12 months were 0.45 and 0.75 mm, respectively, in post-extractive implants in the anterior maxilla. Mura found 0.56 mm of bone resorption in his study group composed of immediately loaded tapered implants placed in post-extraction sockets after a 5-year evaluation period. Measurement of marginal bone on intraoral radiographs is generally accepted as a reliable instrument to measure the true bone level at least at the proximal side of the implant, and it offers fixed reference points from the moment of implant placement to years thereafter.

This study evaluated survival rates up to 12 months from implant placement. This follow-up period is brief but takes into account the fact that implant failure due to mechanical overloading occurs early in the healing period.

Esthetic outcome was not objectively measured in this study. Soft-tissue contours are a major factor for rating treatment success, particularly in esthetically delicate areas. We considered peri-implant marginal bone level as a determining factor for the
quality of implant survival and thus as our primary outcome measure. The level of the peri-implant marginal bone has been suggested to determine the level of the peri-implant mucosa and thus the esthetic outcome.\textsuperscript{31,32} Marginal bone loss may induce pocket formation, which could be unfavorable for the long-term health of the peri-implant tissues.

We realize that the sample size of our study is too small to demonstrate whether the immediate loading of single post-extractive implants in the anterior maxilla is an effective and safe treatment option. Additional (long-term) studies would be helpful to draw firm conclusions regarding to the fact that immediate loading is not inferior to conventional loading with respect to implant survival and bone resorption in single tooth restorations.

Technically, immediate temporization of post-extractive implants seems to be more demanding than the delayed approach. Surgical and prosthetic treatment must be meticulously planned and executed. Atraumatic extraction is a must, where care is taken to preserve the alveolar bone walls. Good primary stability is mandatory, and the immediate temporary crown fabrication is an integral part of the procedure. This makes biologic and esthetic success in this type of clinical protocol very technique sensitive and dependent on the meticulousness of the surgical and prosthetic processes.

**CONCLUSION**

Within the limits of this study, it was found that immediately loaded single post-extractive implants placed in the anterior maxilla with high insertion torque is a favorable treatment.

**ABBREVIATION**

PSR: periodontal screening and recording

**REFERENCES**


