Case Report

Immediate Placement and Loading of Dental Implants: A Human Histologic Case Report

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Background: *The possibility of immediately loading postextraction implants was proposed recently. However, histologic evidence of osteointegration in such cases is still lacking. In this case report, two implants placed into fresh extraction sites, one immediately loaded and the other one unloaded, were compared clinically and histologically.*

Methods: *Two teeth in need of extraction and localized in two symmetric quadrants of one patient were extracted, and dental implants were placed immediately into fresh extraction sites. One of them was connected with a healing abutment (control), whereas the other one was loaded immediately (test) with a resin crown in occlusion with the antagonist teeth. Clinical examinations were made, and radiographs were taken at follow-up visits. After 6 months, control and test implants were removed, together with the peri-implant bone, and a histomorphometric analysis was made.*

Results: *Both implants appeared radiographically osseointegrated and clinically stable at retrieval. Mineralized tissue was found at the implant interface. The percentage of bone-to-implant contact in the control and test implants was 58% ± 4.0% and 52% ± 3.2%, respectively. In the loaded implant, a more compact, mature, well-organized peri-implant bone was found with many areas of remodeling and some osteons, whereas the bone tissue surrounding the unloaded implant was constituted of only thin bone trabeculae.*

Conclusions: *Immediate loading did not seem to impair osseointegration of an immediate postextraction implant compared to an unloaded postextraction one. Further studies with a larger number of samples are needed to confirm these preliminary results.* J Periodontol 2008;79:575-581.

KEY WORDS

Case report; dental implants; histologic techniques; osseointegration; tooth extraction.

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Implant practice has grown dramatically in the last decade, providing ever more reliable and accessible opportunities for clinicians. Innovative operative protocols, including implant placement into fresh extraction sites[1,2] and early/immediate implant loading,[3] have been proposed, with the aim to preserve hard and soft peri-implant tissues and significantly reduce the treatment time of traditionally staged protocols.

Although it was shown recently that implant placement into a fresh extraction socket failed to preserve the alveolar bone dimensions,[4,5] the advantages of such an approach in terms of reduction in treatment times and patient satisfaction are undeniable. The efficacy of immediate implant placement is predictable, with high survival rates if reasonable guidelines are followed.[1,2] Histologic studies[6,7] support the clinical results, showing valid osseointegration and bone-to-implant contact (BIC) rates for postextraction implants that are comparable to those achieved with implants placed into healed, mature bone.

The constant pursuit of time-saving clinical procedures has led researchers to investigate the possibility of loading dental implants before the traditionally staged protocol. The term "immediate loading" refers to a situation in which the superstructure is attached to the implants in occlusion with the opposing dentition within 48 hours.[3] Immediate "restoration" refers to the connection of a provisional crown upon implants left free from occlusal loading.[3] Animal[8-10] and human[11-14] experimental studies support immediate-loading protocols, showing high BIC rates that are comparable to, and sometimes even greater than, conventional loading.

The possibility of immediately connecting a provisional restoration to implants placed into fresh extraction sites was recently investigated.[15-22] In particular, some case reports[15-17] noted the immediate, non-functional restoration in single-tooth postextraction implants obtaining a 100% survival rate at 12 months, favorable peri-implant tissue responses, and results

doi: 10.1902/jop.2008.070188

that were clinically and radiographically comparable to those achieved following the standard protocol. A number of non-controlled prospective studies also investigated the immediate functional loading of postextraction implants in edentulous mandibles[18,20] or partially edentulous sites.[19] Also, in these cases, a 100% survival rate with a follow-up from 6 to 44 months was reported.[18-20] The only controlled clinical trial that dealt with this combined approach was performed by Chaushu et al.,[21] who compared 19 single-tooth postextraction and immediately loaded implants to nine single-tooth immediately loaded implants placed into healed sites. They reported an 82.4% survival rate (versus 100% at healed sites) at 6 to 24 months of follow-up. In a recent retrospective study,[22] 1,074 immediately loaded implants (416 were inserted in postextraction sites and 658 were placed in healed sites) were followed for a mean of 3 years. Only eight implants (survival rate 99.3%), four of which were in the postextraction group (survival rate = 99.04%), were lost.

Because of the heterogeneity of all of these studies and the low number of cases examined, no conclusive data exist about the reproducibility and clinical efficacy of combining immediate implant placement and loading. Furthermore, neither animal nor human histologic evidence is available concerning the response of peri-implant bone under these conditions.

In this case report, two immediate postextraction implants, one loaded immediately (test) and the other unloaded (control), were retrieved after 6 months and compared histologically.

CASE DESCRIPTION AND RESULTS

A 63-year-old female patient was scheduled in May 2005 to receive an implant-supported prosthetic rehabilitation at the Department of Odontostomatological, Orthodontic, and Surgical Disciplines, Second University of Naples. In addition, the patient consented 1) to the simultaneous extraction of teeth in sites where the prosthetic rehabilitation was not requested (maxillary third molars), which already were scheduled to be extracted because they were malpositioned and traumatizing the buccal mucosa; 2) to the immediate insertion in the extraction sites of two implants, one of which was loaded immediately (test implant) and the other one was unloaded (control implant); and 3) to their removal after 6 months exclusively for research purposes. Informed consent was obtained after explaining the nature of the investigation being conducted. Approval was obtained from the Ethical Committee of the Second University of Naples.

The patient showed good oral hygiene and no systemic disease and/or medication that contraindicated implant surgery. A complete clinical examination and radiographs were carried out to plan the future rehabilitation of the preexisting edentulous sites and to evaluate the anatomic characteristics of the test and control sites.

Edentulous sites scheduled for implant-supported rehabilitation were treated conventionally. In addition, in the same surgical session, the maxillary third molars were extracted, and two implants were inserted into fresh extraction sites. Both implants[‡] were titanium tapered screws with a 3.5-mm high smooth collar and a titanium plasma–sprayed surface covering the rest of the implant body. Both sites received an implant that was 5 mm wide and 13 mm long. After local anesthesia, teeth were extracted with a minimally invasive technique to preserve the alveolar bone walls. Intrasulcular incisions were made, and mucoperiosteal flaps were elevated; implant sites were prepared by calibrated burs on the bottom of the extraction socket to obtain an adequate primary stability. Maximum care was exercised to minimize bone injury during the preparation of the implant sites. Implant dimensions were chosen among those available so that the bone–implant gap was <2 mm. The limit between the smooth and rough surface was placed at the level of the crestal ridge in both sites. One of the two implants was covered by a healing abutment (control implant), whereas the other one was covered by a provisional abutment (test implant). Flaps were adapted around the implant neck to allow a non-submerged healing at the control and test sites and were sutured using a #3.0 silk multifilament material.[§] The test implant was loaded within 24 hours with a resin crown in occlusion with the antagonist tooth and was not splinted with any adjacent element. Amoxicillin,[‖] 2 g/day for 6 days, was prescribed, and a chlorhexidine mouthwash was suggested for 4 weeks. The patient underwent clinical controls once a week for the first month and then each month until implant removal. Sutures were removed after 1 week, and oral hygiene instructions were given and reinforced at each visit.

After 6 months, the control and test implants were examined clinically and radiographically and then removed together with the peri-implant bone in a single surgical session to be examined histologically. Implant removal was performed with a piezoelectric device[¶] and manual scalpels. Care was exercised to preserve the integrity of the interface between the implants and the surrounding bone. Antibiotic and local antiseptic therapy was prescribed.

The dimensions of the biopsies were 18×9 mm for the test implant and 16×8 mm for the control implant. Each specimen was stored immediately in 10% buffered formalin and processed to obtain thin ground

‡ P.H.I., San Vittore Olona, Milan, Italy.
§ Perma-Hand Silk Suture, Ethicon, Cornelia, GA.
‖ Augmentin, GlaxoSmithKline, Milan, Italy.
¶ Piezosurgery, Mectron, Carasco, Genova, Italy.

sections with an automated system.[#23] The specimens were dehydrated in an ascending series of alcohol rinses and embedded in a glycolmethacrylate resin.** After polymerization, the specimens were sectioned longitudinally along the major axis of the implant with a high-precision diamond disk at ~150 μm and ground down to ~30 μm. Three slides were obtained. The slides were stained with acid fuchsin and toluidine blue. A double staining with von Kossa and acid fuchsin was done to evaluate the degree of bone mineralization, and one slide per implant, after polishing, was immersed in $AgNO_3$ for 30 minutes and exposed to sunlight; the slides were washed under tap water, dried, and immersed in acid fuchsin for 5 minutes and washed and mounted. Histomorphometry of the bone surrounding the implant was carried out using a light microscope†† connected to a high-resolution video camera‡‡ and interfaced to a monitor and personal computer.§§ This optical system was associated with a digitizing pad‖‖ and a histometry software package with image-capturing capabilities.¶¶ The collar of the implant was excluded from the evaluation of BIC, which was carried out on the whole perimeter of both implants, including the apex.

At 6 months, comparable clinical and radiographic conditions were found between the control and test sites. In particular, implants were clinically stable, and neither pain to percussion nor signs of inflammation were found; modified plaque index and modified sulcus bleeding index[24] were negative, and the peri-implant probing depth was <3 mm around the control and test sites. Both implants appeared radiographically osseointegrated. No sign of bone resorption was evident around either implant.

Minor differences between the control and test implants were observed at the histologic analysis.

Figure 1.
Test implant (postextraction/immediately loaded implant): the fixture–abutment junction (black arrow) and the limit between the smooth and the rough implant surface (white arrow) are seen. At low magnification, bone is found all around the implant surface. Connective tissue in contact with the polished collar of the implant also is evident. (Acid fuchsin and toluidine blue; original magnification ×6.)

Postextraction/Immediately Loaded Implant (test)

At low-power magnification, bone tissue was observed starting from the inferior third of the polished collar of the implant up to the apical region of the implant (Fig. 1). The peri-implant bone was compact, mature, and well organized with many areas of remodeling and osteons. In the coronal portion, there was connective tissue in contact with the polished collar of the implant; no acute or chronic inflammatory infiltrate was present in this tissue. At higher magnification, it was possible to see the bone covering the middle third of the implant surface. Marrow spaces also were present at this level in contact with the titanium surface (Fig. 2). In the apical part of the implant, newly formed bone more strongly stained with acid fuchsin was found in close contact with the implant surface. No acute or chronic inflammatory cell infiltrate was present in the peri-implant bone or in the marrow spaces. Epithelial downgrowth, gaps, or connective, fibrous tissue was not present at the bone–implant interface. The BIC percentage was 52% ± 3.2%.

Postextraction/Unloaded Implant (control)

At low-power magnification, it was possible to observe bone tissue around the implant (Fig. 3). Connective tissue was found at the most coronal portion of the polished collar, with no acute or chronic inflammatory infiltrate. The first BIC occurred in the most apical part of the implant collar. At higher magnification, it was possible to see thin, newly formed bone

\# Precise 1 Automated System, Assing, Rome, Italy.
** Technovit 7200 VLC, Kulzer, Wehrheim, Germany.
†† Laborlux S, Leitz, Wetzlar, Germany.
‡‡ 3CCD, JVC KY-F55B, JVC, Yokohama, Japan.
§§ JVC.
‖‖ Matrix Vision, Oppenweiler, Germany.
¶¶ Image-Pro Plus 4.5, Media Cybernetics, Bethesda, MD and Immagini & Computer, Milan, Italy.

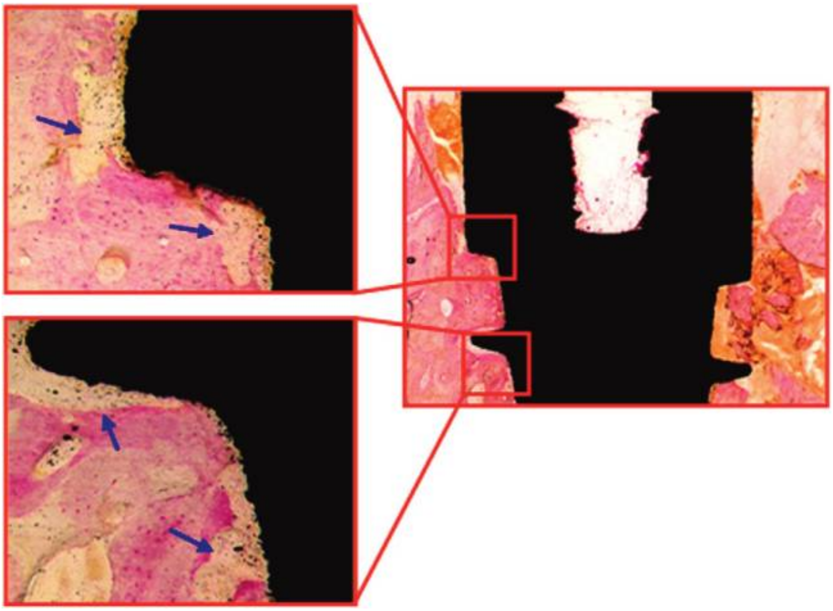

Figure 2.
Test implant (postextraction/immediately loaded implant): at higher magnification, it is possible to see the bone covering the middle third of the implant surface. Marrow spaces also are present at this level in contact with the titanium surface (dark blue arrows). (Acid fuchsin and toluidine blue; original magnification ×100.)

trabeculae all along the implant surface (Fig. 4). Marrow spaces also were present on the titanium surface at this level. Some active osteoblasts were found in the apical region of the implant; the bone trabeculae in this area showed wide osteocyte lacunae. The bone was undergoing remodeling in some portions of the interface. No acute or chronic inflammatory cell infiltrate was present at the bone–implant interface or in the marrow spaces. No epithelial downgrowth was present. No gaps or connective, fibrous tissue was present at the bone–implant interface. The BIC percentage was 58% ± 4%.

DISCUSSION

From a clinical point of view according to the implant success criteria reported by Albrektsson et al.,[25] both implants could be considered successfully osseointegrated after a period of 6 months. In this sense, the importance of respecting some prerequisites, as indicated by international clinical guidelines[2,3] for postextraction and immediately loaded implants must be emphasized. In our case, an adequate primary stability was found in the control and test sites thanks to a sufficient amount of bone surrounding the extraction socket; to the drilling technique, aimed to engage the bottom of the socket; and to the unique implant characteristics. The rough titanium plasma–sprayed surface, the tapered form, and the wide threads in the middle third and the narrow threads in the apical third of the implant could, all together, contribute to explain our results and account for the selection of this type of fixture.

Both implants in our study were placed in fresh extraction pockets. The placement of implants in these sites was shown in the literature to allow clinical outcomes and a degree of osseointegration comparable to implants placed into healed sites.[7] From a clinical and histologic point of view, the favorable results obtained in this case report further confirm the reliability of this technique.

The importance of histologic studies in supporting new implant protocols and procedures is crucial and must be emphasized adequately because only histologic studies can provide direct evidence of osseointegration. The main parts of these studies were performed on animal models,[8-10,13,26] and one must proceed with caution with the possibility of transferring the histologic results obtained in animal experimentations to humans. To the best of our knowledge, no histologic study on a combined approach of postextraction and immediately loaded implants is available in the literature. In our case, we observed newly formed and well-organized bone that covered the implant surfaces in the control and test sites. This type of bone apposition was similar to that reported by Testori et al.,[27] who histologically compared submerged versus immediately loaded implants retrieved 2 months after their placement. They found that the rough surfaces of the implants were covered by an almost continuous thin bone layer. This type of bone formation, comparable to that observed in the present histologic specimens, has been referred to commonly as "contact osteogenesis,"[28] i.e., the formation of new bone first on the implant surface, and it generally is believed to be promoted by the osteoconductive properties of implant surfaces.

There is an absence of information about how much bone is needed at the interface of loaded dental implants,[14] and different values have been reported in the literature from 18% to 25%[29] to 50%.[30] In the present study, both implants showed a high BIC percentage (>50%) with slight quantitative and qualitative differences.

At the control site, some of the bone tissue was lost during implant retrieval; apparently, this did not affect the percentage of BIC because bone was present at the apical portion of the implant at higher magnification (Fig. 4). Furthermore, it must be emphasized

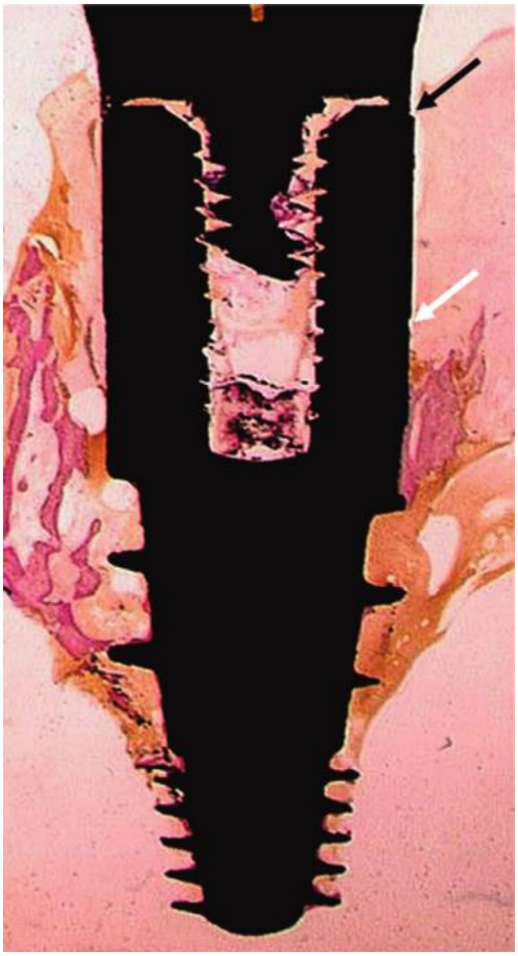

Figure 3.
Control implant (postextraction/unloaded implant): the junction between the healing abutment (black arrow) and the limit between the smooth and the rough implant surface (white arrow) are seen. At low magnification, it is possible to observe the presence of trabecular bone around the implant. Connective tissue at the most coronal portion of the polished collar also is present. (Acid fuchsin and toluidine blue; original magnification ×6.)

that, for ethical reasons, only the smallest amount of peri-implant bone should be retrieved in humans; moreover, the clinical and anatomical situations can be different for the different retrieved implants. This fact clearly can affect the quality of the biopsies for the histologic evaluation.

The loaded implant showed a lower BIC percentage than the unloaded one (52% versus 58%) although the quality of the peri-implant bone appeared to be greater. Bone tissue was more mature and well organized around the loaded implant with many areas of remodeling and well-defined osteons, whereas the bone surrounding the unloaded implant was constituted only of thin trabeculae.

The reason for the differences could be related, in part, to the hypothesis that functional loading affects bone apposition. According to Frost,[31,32] bone tissue adapts its strength to the applied load by a continuous remodeling, so maintaining its mechanical competence. Bone cells respond to local deformations and mechanical stresses by adapting, to a certain extent, the bone structure to the new conditions and recovering a state of equilibrium. When a mild overload occurs, mechanical fatigue microdamages are repaired, and the bone even may strengthen itself to reduce future functional strain. However, if the strains go beyond a certain threshold, repair mechanisms can be overwhelmed, and fatigue fracture can occur. Conversely, if minimum physiologic strains are not achieved, bone loss due to disuse may occur.[31] The stimulatory effect of load on peri-implant bone was demonstrated well in a histomorphometric analysis in monkeys.[26] In that work, the investigators showed the formation of cancellous bone with loose connective tissue at the interface of unloaded implants, whereas a thick cortical plate with extensive bone trabeculae formation was present around loaded implants. These results are in line with other studies conducted in monkeys[8] and humans[27,33] that reported bone conditions that were quantitatively and qualitatively better in immediately loaded oral implants compared to unloaded ones. Also, a radiologic study in man[34] obtained similar results with denser peri-implant bone around immediately loaded implants compared to unloaded implants. Furthermore, some investigators[13] suggest that immediate loading could lead to a peri-implant bone quality even better than conventional loading. In a histomorphometric analysis in monkeys, Romanos et al.[13] compared immediately loaded implants retrieved 3 months after their placement with conventionally loaded implants retrieved 3 months after loading. The investigators reported a hard tissue peri-implant response around immediately loaded implants similar to that of delayed-loaded implants but with a significantly higher density of bone between the threads of immediately loaded implants.

Taken together, all of these results suggest that a slight immediate load might not impair bone healing and even may accelerate it. Conversely, to avoid a failure due to occlusal overload in immediately loaded implants, proper load calibration must be emphasized. However, it is still difficult to clinically quantify the magnitude and direction of naturally occurring occlusal forces.[35]

CONCLUSIONS

Placement of implants into fresh extraction sites is a reliable and successful technique if reasonable guidelines are followed. Furthermore, immediate loading did not seem to impair osseointegration.

Although encouraging, the results cannot be used to draw any conclusion about the influence of immediate

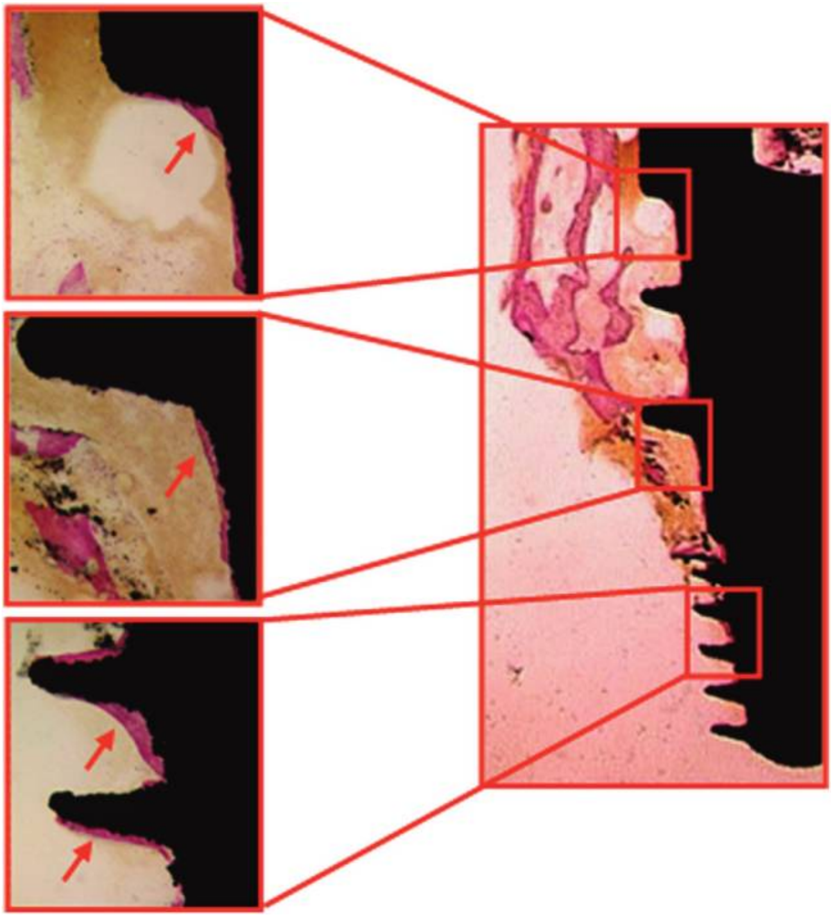

Figure 4.
Control implant (postextraction/unloaded implant): at higher magnification, very thin lamellae (red arrows) were visible along the implant surface from the coronal to the apical region. (Acid fuchsin and toluidine blue; original magnification ×100.)

loading on the peri-implant bone response around immediate postextraction implants. Additional studies with a larger number of samples are needed to determine whether the histologic similarities and differences found in the present case report may be considered significant.

ACKNOWLEDGMENTS

The authors thank Prof. Antonello Crisci, Department of Legal Medicine, Second University of Naples, for support in preparing and submitting the informed consent and the experimental protocol to the Ethical Committee. P.H.I., San Vittore Olona, Milan, Italy, provided the implant components used in the study. The authors report no conflicts of interest related to this case report.

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Submitted April 6, 2007; accepted for publication July 31, 2007.