Implant–Buccal Plate Distance as Diagnostic Parameter: A Prospective Cohort Study on Implant Placement in Fresh Extraction Sockets

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Background: The aim of this study is to investigate contour changes around immediate implants in fresh extraction sockets when different grafting procedures are performed, based on the distance between the external implant surface and the bony surface on the buccal plate (I-BP). This cone beam computed tomography (CBCT) study evaluated horizontal and vertical dimensional changes to the facial bone following maxillary anterior single immediate implant placement and provisionalization.

Methods: This prospective cohort study was performed. Suitable patients to undergo implant placement in fresh extraction sockets were selected. Periodontal biotype, horizontal and vertical periimplant bone defects, and dehiscences were assessed. Depending on the distance between implant surface and buccal bone plate (I-BP), two types of grafting procedures were performed. In group A (I-BP < 4 mm), the peri-implant gap was grafted during the surgical phase with the internal and external grafting [IEG], whereas group B (I-BP ≥ 4 mm) received only internal grafting [IG]. CBCT scans taken immediately after (T1) and 1 year after surgery (T2) were evaluated. The midsagittal cut of each implant was identified, and measurements were made at predetermined levels. Horizontal facial bone thickness was measured at 1 mm apical to the implant platform. Measurements were recorded and changes between T1 and T2 were calculated.

Results: CBCT scans of 20 patients were analyzed. After 1 year of loading, group B showed a slight decrease in mean buccal volume, whereas group A had an increase in volume (P = 0.02).

Conclusions: When implants are placed immediately after tooth extraction, I-BP may represent a useful diagnostic parameter in choosing the most appropriate grafting procedure (IG versus IEG). In clinical cases in which the distance between implant surface and the buccal plate is <4 mm, the combination of internal and external grafting (IEG) is recommended to maintain the volume and the contour of the ridge and achieve a successful esthetic outcome.

Key Words:
Bone regeneration, bone substitutes, cohort studies, dental esthetics, dental implants, tooth extraction.

one of the most challenging objectives of implant treatment is the preservation of hard and soft tissues following the loss of one or more teeth. From a surgical perspective, the current concept is that proper soft-tissue morphology and symmetry can be achieved with correct three
dimensional implant placement that optimizes the emergence profile of the restoration. Immediate implants have been advocated to preserve soft-tissue contour and bone dimension, minimize the period of edentulism, and reduce overall treatment time.\textsuperscript{1-3} The concept of immediate placement of dental implants is a well-accepted protocol, even after removal of a tooth with periapical pathology.\textsuperscript{4-6} However, some studies have questioned whether immediate implant placement can prevent bone resorption.\textsuperscript{7,8} Flapless surgery was proposed to preserve bone vascularization and minimize bone resorption. If a full-thickness flap is elevated, disruption of the blood supply will occur, with subsequent bone loss.\textsuperscript{9} Because of the close relationship between osseous structure and the overlying gingival architecture, the bone resorption resulting from full-thickness flap elevation may result in soft tissue recession. However, a recent clinical study showed that adopting either a full-thickness flap elevation or a flapless approach to immediate implant placement led to similar successful outcomes.\textsuperscript{10} When immediate implants are placed, peri-implant voids are frequently present due to a gap between the alveolar socket and the implant. Healing of the peri-implant bone defect is a process involving both bone apposition and bone resorption, the latter occurring to a larger extent than the former.\textsuperscript{11,12} Resorption prevails during healing when the gap is large and the biotype is thin.\textsuperscript{8,13} However, the presence of a thick buccal bone wall does not consistently prevent crestal resorption.\textsuperscript{14} It has been suggested that the gap between implant and socket can be filled with a bone graft to preserve the volume.\textsuperscript{15} The preservation of bone volume and soft tissue morphology is considered of utmost importance for achieving a highly esthetic result.\textsuperscript{16} The aim of this study is to investigate contour changes around immediate implants in fresh extraction sockets when different grafting procedures are performed, based on the distance between the external implant collar and the bony surface on the buccal plate (I-BP).

**MATERIALS AND METHODS**

This cohort, controlled clinical trial was performed in 21th Century implant clinic. Treatments were carried out between 2011 and 2013. Patients were recruited according to the following inclusion criteria: 1) need for an immediate postextraction implant of Type I according to the 2004 International Team for Implantology consensus;\textsuperscript{18} 2) socket walls intact; and 3) \(>18\) years. The exclusion criteria were: 1) any systemic disease that could interfere with implant therapy; 2) infection at the extraction site; 3) probing depth \(>4\) mm at the adjacent teeth; 4) inadequate oral hygiene; and 5) presence of adjacent implants. All patients received prophylactic antibiotic therapy of 2 g amoxicillin (600 mg clindamycin if allergic to penicillin) 1 hour before the extraction and implant placement procedures. The patients rinsed for 1 minute with 0.2% chlorhexidine mouthwash before surgery. Local anesthesia was induced using lidocaine 2% with adrenaline 1:100,000. The surgical procedure started with a marginal incision extended to one tooth mesial and one tooth distal to the implant site without vertical releasing incisions. This type of flap design allows the surgeon to expose and visualize the buccal bony plate. Care was taken in all these steps to avoid any damage to the buccal bone wall. After tooth extraction, the socket was debrided and the INNO implant was placed in the correct prosthetically driven position, with the implant platform placed 1 mm below the marginal level of the buccal wall. The final insertion torque was measured with a calibrated wrench and taken as an indicator of implant stability right after implant position. A healing abutment was connected, and implants were left to heal according to a one-stage protocol. After implant placement, I-BP was measured. No palatal measurements were taken, since palatal resorption is relatively unimportant from an esthetic point of view (Fig. 1). When the
distance between the implant surface and the outer surface of the alveolar bone wall was <4 mm (group A), synthetic bone was placed in the peri-implant gap both internal (between implant and alveolar bone) and external (on the outer surface of the buccal plate) grafting (IEG) (Fig. 2). When the I-BP was ≥4 mm (group B), synthetic bone were internal grafting [IG] (Fig. 3)

Measurements were recorded and changes between T1 and T2 were calculated(Fig. 2).

RESULTS
A total of 37 patients were screened, but only 20 fulfilled the inclusion criteria (eight males and 12 females; aged 18 to 78 years, mean age: 53.9 years). In this patient data set, 20 implants were placed according to a one-stage protocol in the maxilla and the mandible in the area from second premolar to second premolar. The mean follow-up duration was 12 months (range: 10 to 16 months). The results of the displacement among the optical scans of the 20 cases are summarized in Table 1. One year after prosthesis placement, the treatment group A (IEG) showed a slight increase in mean Horizontal facial bone thickness (0.16 – 0.48 mm), whereas in the control group B (IG), the Horizontal facial bone thickness was reduced by 0.37 – 0.38 mm. The difference was statistically significant (P = 0.02). At the lingual/palatal aspect, no significant difference in mean variation was found (P = 0.19) between the IEG group (0.06–0.28 mm) and the IG group (-0.22 – 0.59 mm)
DISCUSSION
Implant placement in fresh extraction sockets has been thoroughly documented and discussed in the literature. Several consensus statements and clinical recommendations have been drawn up in recent years to guide clinicians toward the best treatment options for such procedures.\(^{18,22,23}\) A recent prospective study, completed during 10 years on 159 implants placed in fresh extraction sockets, confirmed the long-term predictability of this treatment.\(^{24}\)

Socket morphology, on the other hand, may present a disadvantage to the immediate implant procedure because it could lead to compromised implant positioning and initial implant stability. Vertical and horizontal alveolar bone resorption occurring during the healing phase after tooth extraction...
may adversely affect the esthetic results. In fact, some studies have reported the occurrence of buccal recession after immediate implant placement, to be of a greater magnitude. The initial thickness of the buccal crestal bone may be a factor in determining the extent of the buccal bone resorption during the healing phase. Thin buccal bone, mainly located in the most coronal part, is susceptible to interruption of the vascular supply as a consequence of flap elevation.

When the buccal plate is damaged, significant resorption could occur, leading to esthetic issues. In this study, the preoperative thickness of the buccal plate is not considered per se, but it is included in the horizontal facial bone thickness. Scans were performed, so the postoperative buccal bone thickness was not calculated.

Compared to autogenous bone grafts, xenograft volume is rather stable with time because it is slowly resorbed. This feature may justify the use of xenografts for filling the gap between an implant and the alveolar walls to reduce bone collapse. In this context, bone substitutes with a slow resorption rate and the use of a barrier membrane may be a preferred alternative to autogenous bone for the reconstruction of buccal plate dehiscence defects.

Grafting the peri-implant gap may limit the horizontal resorption of the original bone dimension. Other studies investigating preservation of socket dimensions after tooth extraction have reported a gain in vertical bone height of 1 mm by “overbuilding” the marginal defects or overlaying the buccal bone externally with the graft. This concept was recently considered in a study where immediate implants in anterior maxilla were frequently associated (87%) with thin buccal walls (<1 mm). This means that augmentation procedures are needed to achieve adequate bony contours around the implant and optimal esthetic outcomes. However, no clinical indication about the regenerative procedures and actual graft thickness was reported in the study.

To achieve adequate bone contour around the implant and optimal soft tissue contour, a final distance of 4 mm from the implant surface to the external buccal graft side should be obtained at the end of the surgical procedure. A horizontal buccal bone width of at least 2 mm should remain at the end of the resorption phase, allowing for the conical peri-implant bone resorption to remain inside the width of the bone wall.

The tissue volume changes measured in the present investigation demonstrate that the IG group underwent a loss of buccal tissue contours 1 year after prosthesis delivery, whereas the IEG group displayed a slight gain or stability of the buccal tissues. The proposed volume change measurement, with respect to a standard contour distance measurement, takes into account the whole area and is not limited to a single profile. The present results reveal that overbuilding the buccal aspect in combination with immediate implant placement may be a suitable technique to compensate for the physiologic alveolar bone changes occurring after tooth extraction and immediate implant insertion.

CONCLUSIONS

When implants are placed immediately after tooth extraction, I-BP is a critical parameter and could be a useful diagnostic tool to guide the clinician in performing the most appropriate grafting procedure (IG versus IEG). In clinical cases in which I-BP is <4 mm, internal and external grafting should be placed to maintain the ridge contour and achieve a successful esthetic outcome, as validated by the IAS, which showed consistently higher scores for the IEG group. Studies with a larger sample size are needed to confirm the promising outcome of this study.

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