

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

Sanghun Jung. DDS. Maxillofacial surgeon, 21th century implant clinic, Pusan, Korea

---

**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.<sup>1-3</sup> The concept of immediate placement of dental implants is a well-accepted protocol, even after removal of a tooth with periapical pathology.<sup>4-6</sup> However, some studies have questioned whether immediate implant placement can prevent bone resorption.<sup>7,8</sup>

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.<sup>9</sup>

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.<sup>10</sup>

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.<sup>11,12</sup> Resorption prevails during healing when the gap is large and the biotype is thin.<sup>8,13</sup> However, the presence of a thick buccal bone wall does not consistently prevent crestal resorption.<sup>14</sup> It has been suggested that the gap between implant and socket can be filled with a bone graft to preserve the volume.<sup>15</sup> The preservation of bone volume and soft tissue morphology is considered of utmost importance for achieving a highly esthetic result.<sup>16</sup>

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

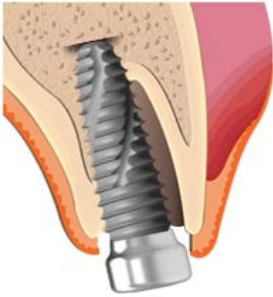
This cohort, controlled clinical trial was performed in 21st Century implant clinic. Treatments were carried out between 2011 and 2013. Patients were recruited according to the following inclusion criteria: 1) need for an immediate postextraction implant of Type I according to the 2004 International Team for Implantology consensus;<sup>18</sup> 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  $\geq 4$  mm (group B), synthetic bone were internal grafting [IG] (Fig. 3)

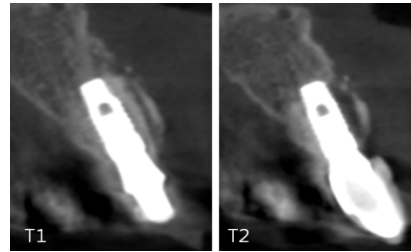


**Figure 1.** The distance between the external implant collar and the bony surface on the buccal plate (I-BP) is indicated by the arrows

The surgical flaps were then sutured around the healing abutment, achieving soft-tissue primary closure. In cases in which an external graft was placed, because of the small amount of graft material added and the length of the horizontal incision (one tooth mesial and one tooth distal to the implant site), no releasing incisions were made to adapt the flap to the abutment. The restorations were placed immediately after bone graft.

Sutures were removed after 1 week, and the patients were seen monthly thereafter. All patients continued to take antibiotics postoperatively (1 g amoxicillin or 300 mg clindamycin, twice daily for 5 days). They also took non-steroidal anti-inflammatory drugs if needed (550 mg naproxen sodium). Chlorhexidine mouthwash twice a day was prescribed for 3 weeks postsurgery.

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.

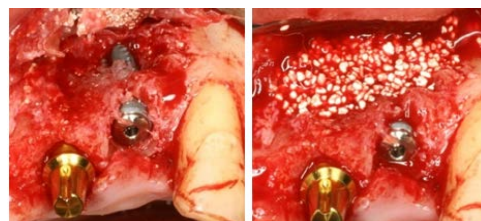


**Figure 2.** CBCT scans immediately after (T1) and 1 year after surgery (T2)

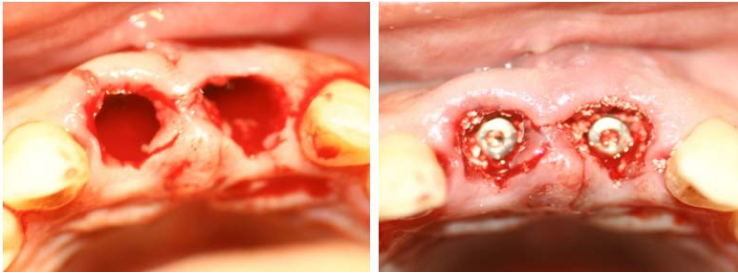
Measurements were recorded and changes between T1 and T2 were calculated (Fig. 2).

## 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)



**Figure 3.** I-BP  $<4$  mm. The graft is placed inside the residual implant gap and outside the buccal bone plate.



**Figure 4.** I-BP  $\geq$  4 mm. The graft is placed inside the peri-implant gap e.

**Table 1.**

Results of Horizontal facial bone thickness change

Procedure and Tooth	Buccal Side Displacement (mm)	Lingual/Palatal Side Displacement (mm)
IEG		
20	-0.35 – 0.54	0.13 – 0.57
6	-0.09 – 0.07	-0.14 – 0.02
5	-1.05 – 0.77	-0.43 – 0.46
7	-0.28 – 0.38	0.19 – 0.15
12	0.04 – 0.23	0.60 – 0.84
7	-0.41 – 1.33	0.31 – 2.48
9	-0.26 – 0.83	-0.09 – 0.23
8	-1.01 – 0.64	-1.31 – 0.88
5	-0.14 – 0.95	-0.50 – 0.40
IG		
11	0.15 – 0.52	0.07 – 0.56
25	0.35 – 0.17	0.18 – 0.18
5	0.06 – 0.27	0.11 – 0.38
7	0.45 – 0.44	0.10 – 0.21
9	0.34 – 0.21	0.04 – 0.14
7	0.12 – 0.27	-0.12 – 0.23
7	-0.90 – 0.5	0.09 – 0.25
12	0.89 – 0.89	0.32 – 0.36
21	0.20 – 0.58	-0.22 – 0.24

Data are mean – SD. The Universal Tooth Numbering System (1 to 32) is used.

## 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.<sup>18,22,23</sup> A recent prospective study, completed during 10 years on 159

implants placed in fresh extraction sockets, confirmed the long-term predictability of this treatment.<sup>24</sup> 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.<sup>25</sup> In fact, some studies have reported the occurrence of buccal recession after immediate implant placement.<sup>26,27</sup> to be of a greater magnitude.<sup>29</sup> The initial thickness of the buccal crestal bone may be a factor in determining the extent of the buccal bone re- sorption during the healing phase.<sup>11,12,30</sup> 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.<sup>31</sup> 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.<sup>32,33</sup> This feature may justify the use of xenografts for filling the gap between an implant and the alveolar walls to reduce bone collapse.<sup>34,35</sup> 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.<sup>36</sup>

Grafting the peri-implant gap may limit the horizontal resorption of the original bone dimension.<sup>27</sup> 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<sup>37</sup> or overlaying the buccal bone externally with the graft.<sup>38</sup> This concept was recently considered in a study where immediate implants in anterior maxilla were frequently associated (87%) with thin buccal walls (<1 mm).<sup>39</sup> 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.<sup>40,41</sup>

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.

## REFERENCES

1. Lazzara RJ. Immediate implant placement into extraction sites: Surgical and restorative



- advances. *Int J Periodontics Restorative Dent* 1989;9:332-343.
2. Schwartz-Arad D, Chaushu G. Immediate implant placement: A procedure without incisions. *J Periodontol* 1998;69:743-750.
  3. Covani U, Barone A, Cornelini R, Crespi R. Soft tissue healing around implants placed immediately after tooth extraction without incision: A clinical report. *Int J Oral Maxillofac Implants* 2004;19:549-553.
  4. Siegenthaler DW, Jung RE, Holderegger C, Roos M, Hämmerle CH. Replacement of teeth exhibiting periapical pathology by immediate implants: A prospective, controlled clinical trial. *Clin Oral Implants Res* 2007;18:727-737.
  5. Lindeboom JA, Tjiook Y, Kroon FH. Immediate placement of implants in periapical infected sites: A prospective randomized study in 50 patients. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 2006;101:705-710.
  6. Del Fabbro M, Boggian C, Taschieri S. Immediate implant placement into fresh extraction sites with chronic periapical pathologic features combined with plasma rich in growth factors: Preliminary results of single-cohort study. *J Oral Maxillofac Surg* 2009;67:2476-2484.
  7. Botticelli D, Berglundh T, Lindhe J. Hard-tissue alterations following immediate implant placement in extraction sites. *J Clin Periodontol* 2004;31:820-828.
  8. Araújo MG, Wennström JL, Lindhe J. Modeling of the buccal and lingual bone walls of fresh extraction sites following implant installation. *Clin Oral Implants Res* 2006;17:606-614.
  9. Pennel BM, King KO, Wilderman MN, Barron JM. Repair of the alveolar process following osseous surgery. *J Periodontol* 1967;38:426-431.
  10. Covani U, Cornelini R, Barone A. Buccal bone augmentation around immediate implants with and without flap elevation: A modified approach. *Int J Oral Maxillofac Implants* 2008;23:841-846.
  11. Covani U, Cornelini R, Barone A. Buccolingual bone remodeling around implants placed into immediate extraction sockets: A case series. *J Periodontol* 2003;74:268-273.
  12. Covani U, Cornelini R, Barone A. Vertical crestal bone changes around implants placed into fresh extraction sockets. *J Periodontol* 2007;78:810-815.
  13. Tomasi C, Sanz M, Cecchinato D, et al. Bone dimensional variations at implants placed in fresh extraction sockets: A multilevel multivariate analysis. *Clin Oral Implants Res* 2010;21:30-36.
  14. Ferrus J, Cecchinato D, Pjetrusson EB, Lang NP, Sanz M, Lindhe J. Factors influencing ridge alterations following immediate implant placement into extraction sockets. *Clin Oral Implants Res* 2010;21:22-29.
  15. Yukna RA, Castellon P, Saenz-Nasr AM, et al. Evaluation of hard tissue replacement composite graft material as a ridge preservation/augmentation material in conjunction with immediate hydroxyapatite-coated dental implants. *J Periodontol* 2003;74:679-686.
  16. Kois JC. Predictable single tooth peri-implant esthetics: Five diagnostic keys. *Compend Contin Educ Dent* 2001;22:199-206.
  18. Hämmerle CH, Chen ST, Wilson TG Jr. Consensus statements and recommended clinical procedures regarding the placement of implants in extraction sockets. *Int J Oral Maxillofac Implants* 2004;19 (Suppl.):26-28.
  21. Morton D, Bornstein MM, Wittneben JG, et al. Early loading after 21 days of healing of nonsubmerged titanium implants with a chemically modified sand-

- blasted and acid-etched surface: Two-year results of a prospective two-center study. *Clin Implant Dent Relat Res* 2010;12:9-17.
22. Quirynen M, Van Assche N, Botticelli D, Berglundh T. How does the timing of implant placement to extraction affect outcome? *Int J Oral Maxillofac Implants* 2007;22 (Suppl.):203-223.
23. Chen ST, Beagle J, Jensen SS, Chiapasco M, Darby I. Consensus statements and recommended clinical procedures regarding surgical techniques. *Int J Oral Maxillofac Implants* 2009;24 (Suppl.):272-278.
24. Covani U, Chiappe G, Bosco M, Orlando B, Quaranta A, Barone A. A 10-year evaluation of implants placed in fresh extraction sockets: A prospective cohort study. *J Periodontol* 2012;83:1226-1234.
25. Avivi-Arber L, Zarb GA. Clinical effectiveness of implant-supported single-tooth replacement: The Toronto Study. *Int J Oral Maxillofac Implants* 1996;11:311-321.
26. Kan JY, Rungcharassaeng K, Lozada L. Immediate placement and provisionalization of maxillary anterior single implants: 1-year prospective study. *Int J Oral Maxillofac Implants* 2003;18:31-39.
27. Evans CD, Chen ST. Esthetic outcomes of immediate implant placements. *Clin Oral Implants Res* 2008;19:73-80.
28. Kan JY, Rungcharassaeng K, Umezumi K, Kois JC. Dimensions of peri-implant mucosa: An evaluation of maxillary single implants in humans. *J Periodontol* 2003;74:557-562.
29. Chen ST, Wilson TG Jr., Hämmerle CH. Immediate or early placement of implants following tooth extraction: Review of biologic basis, clinical procedures, and outcomes. *Int J Oral Maxillofac Implants* 2004;19 (Suppl.):12-25.
30. Araújo MG, Sukekava F, Wennström JL, Lindhe J. Tissue modeling following implant placement in fresh extraction sockets. *Clin Oral Implants Res* 2006;17:615-624.
31. Kan JY, Rungcharassaeng K, Sclar AG, Lozada JL. Effects of the facial osseous defect morphology on gingival dynamics after immediate tooth replacement and guided bone regeneration: 1-year results. *J Oral Maxillofac Surg* 2007; 65;7 (Suppl. 1):13-19.
32. Artzi Z, Tal H, Dayan D. Porous bovine bone mineral in healing of human extraction sockets. Part 1: Histomorphometric evaluations at 9 months. *J Periodontol* 2000;71:1015-1023.
33. Artzi Z, Tal H, Dayan D. Porous bovine bone mineral in healing of human extraction sockets: 2. Histochemical observations at 9 months. *J Periodontol* 2001;72:152-159.
34. Araújo MG, Lindhe J. Ridge alterations following tooth extraction with and without flap elevation: An experimental study in the dog. *Clin Oral Implants Res* 2009;20:545-549.
35. Fickl S, Zuhr O, Wachtel H, Bolz W, Huerzeler M. Tissue alterations after tooth extraction with and without surgical trauma: A volumetric study in the beagle dog. *J Clin Periodontol* 2008;35:356-363.
36. Hämmerle CH, Brägger U, Schmid B, Lang NP. Successful bone formation at immediate transmucosal implants: A clinical report. *Int J Oral Maxillofac Implants* 1998;13:522-530.
37. Iasella JM, Greenwell H, Miller RL, et al. Ridge preservation with freeze-dried bone allograft and a collagen membrane compared to extraction alone for implant site development: A clinical and histologic study in humans. *J Periodontol* 2003;74:990-999.
38. Simon BI, Von Hagen S, Deasy MJ, Faldu M, Resnansky D. Changes in alveolar bone height and width following ridge augmentation using bone graft and membranes. *J Periodontol* 2000;71:1774-1791.

39. Huynh-Ba G, Pjetursson BE, Sanz M, et al. Analysis of the socket bone wall dimensions in the upper maxilla in relation to immediate implant placement. *Clin Oral Implants Res* 2010;21:37-42.
40. Grunder U, Gracis S, Capelli M. Influence of the 3-D bone-to-implant relationship on esthetics. *Int J Periodontics Restorative Dent* 2005;25:113-119.
41. Spray JR, Black CG, Morris HF, Ochi S. The influence of bone thickness on facial marginal bone response: Stage 1 placement through stage 2 uncovering. *Ann Periodontol* 2000;5:119-128.