Buccal Plate Preservation with Immediate Implant Placement and Provisionalization: 5-Year Follow-Up Outcomes

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Abstract

Purpose Despite socket preservation and/or immediate implant placement, resorption of the buccal plate after dental extraction continues to pose esthetic challenges to clinicians. Buccal plate preservation (BPP) is a technique that has been recently proposed with an aim to reduce the incidence of such resorption. This study was conducted to assess the long-term efficacy of BPP in maintaining the thickness of the buccal cortical plate after immediate implant insertion and provisionalization.

Materials and Methods Ten consecutive patients were included in this study. Each patient underwent extraction of a non-restorable tooth, BPPBPP, single immediate implant placement and immediate provisionalization. Cone beam CT scans were taken 3 months after surgery (T1) and 5 years after surgery (T2) to evaluate the effectiveness and longevity of the BPPBPP technique in maintaining the augmented bone width. Two distinct measurements were taken for bone evaluation: (a) R1: 1 mm apical to the implant platform and (b) R2: 5 mm apical to the implant platform. The long axis of the implant was used as a fixed reference. Statistical test analysis was conducted using the SPSS software. Student's *t* test was used to assess statistical significance, and a *p* value of < 0.05 was considered significant.

Results There were six females and four males in the study. The mean age of the sample was 37.6 years (range 23–64 years). At T1, the mean bone thickness of the buccal plate was found to be 2.36 mm at R1 (range: 1.9–3.1), and 2.23 at R2 (range: 1.9–3). At the T2 interval, the mean thickness of the plate was 2.28 mm at R1 (range: 1.7–3) and 2.18 at R2 (range: 1.9–3). The differences in these mean values were not statistically significant.

Conclusions BPPBPP is an effective means for augmentation and maintenance of the buccal cortical plate around an immediately placed and provisionalized dental implant. It is a viable alternative to socket preservation with the added benefit that it allows for immediate implant placement.

Keywords Immediate Implant · Socket Preservation · Buccal Plate Preservation · Socket healing · Post-extraction Implant · Immediate Temporary

Introduction

Following removal of a tooth, the healing socket undergoes an inevitable series of occurrences that have the potential to remodel the adjacent areas of the alveolar ridge. Such remodeling can result in a loss in both bone width and height [1], especially on the facial side [2], which often leads to adversities from both functional and esthetic perspectives during subsequent restoration. Particularly, concerning is the phenomenon of bone resorption, which reduces the amount of available bone required for implant fixture placement and stability [3]. Predictable management of dental extraction sockets in the anterior maxillary, esthetic zone region is a challenging problem that clinicians encounter routinely.

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Many techniques have been proposed in the literature with a common aim to counteract or minimize possible resorption of the alveolus in this region and maintain the three-dimensional topography of the socket. Two common examples include socket preservation with placement of bone graft material into the socket or placing an implant immediately after the extraction [4, 5]. The outcomes following intra-socket grafting are variable and controversial, especially from the biological point of view, due to the fact that placing a graft into the socket always hinders the self-healing response of the site [6]. Buccal plate preservation (BPP) is an alternative technique which has been relatively recently proposed with an aim to maintain the buccal plate similar to socket preservation but via a different mechanism which includes surgical intervention and grafting on the external surface of the labial plate rather than within the socket [7]. The theoretical basis of this procedure is to avoid interference with the natural, physiological healing process of the socket, while at the same time, maintaining its facial contour. BPP has previously been shown to be effective in combination with immediate implant placement and provisionalization [8]. The aim of this study is to present our experience with a long-term, 5-year follow-up of ten patients undergoing BPP and an immediate implant placement and provisionalization.

Materials and Methods

The study sample consisted of 10 consecutive, ASA I, non-smoking patients who were planned for extraction of an anterior maxillary tooth and prosthetic rehabilitation with an implant supported prosthesis. Although the study was considered exempt from institutional review board regulations in accordance with current regulations for research completed in a private practice located in Italy, we obtained approval from the IRB at Boston University.

Surgical Protocol

All patients underwent extraction of the non-restorable tooth (Fig. 1a), immediate implant placement followed by buccal plate preservation (Fig. 1b) and provisionalization. All teeth were extracted under local anesthesia (4% Articaine with 1:100,000 epinephrine); first bicusps were electively sectioned with rotary instrumentation and then extracted in two separate pieces. The sockets were thoroughly debrided with hand instruments to remove any residual granulation tissue. A thin periosteal elevator was used to reflect the soft tissue buccal to the bony buccal plate on the facial aspect of the middle of the socket in a full-thickness manner, following a corono-apical direction, thereby creating a ‘surgical pouch’ (Fig. 1c). Extreme care

was paid to avoiding tearing the soft tissue. The dissection was advanced beyond the mucogingival line to approximately two-thirds the depth of the socket, and the ‘pouch’ was expanded in the mesio-distal direction to stretch the soft tissues away from the underlying bony plate. Granules of bovine xenograft (Endobon Xenograft Granules, BIOMET 3i, Palm Beach Gardens, FL, USA) were hydrated with saline and inserted into the pouch by mean of a small periosteal elevator. Additional graft material was added and compressed until adequate filling of the pouch was achieved without overstretching the soft tissues. Care was taken to avoid the migration of the graft material too far apically, where the mucosa is more flexible and thin (though if this occurred, the graft material was repositioned using manual digital pressure). A total of eight 4 mm diameter and two 3.25 mm diameter tapered implants (BIOMET 3i, Palm Beach Gardens, FL, USA) were placed engaging the palatal wall and the native bone above the alveolus. The gaps between the buccal bone and the implant surface were filled with the same grafting material. At the end of the surgical procedure, a transfer coping was made and a pickup impression made. A standard surgical stent (surgical guide) was fabricated in a dental laboratory using the patients’ dental models with clear acrylic resin. The pickup impression was connected to the surgical stent with self-curing resin to register the position of the implant, which was transferred to a laboratory model. A temporary healing abutment was placed on each implant. Custom abutment and temporary resin crowns were fabricated and delivered to the patients immediately following the surgical procedure. Suturing was not performed in any patient and no attempts were made to obtain primary closure. The patients were maintained on a liquid diet for 1 week postoperatively followed by a soft diet for additional 3 weeks. Chlorhexidine gluconate oral rinse was prescribed for 2 weeks to enhance plaque control. The final restoration was delivered 3 months after surgery [8].

Study Measurements

Cone beam CT scans (CBCT) were taken at two different time intervals: 3 month postoperative (T1) and final 5-year postoperative (T2). The findings on these scans were compared to evaluate whether the BPP technique was successful in maintaining the root eminence appearance counteracting the buccal plate resorption at T2 (Fig. 2). All examinations were made using a 9000 3-D CBCT (Carestream Health, Inc, USA) unit equipped with a flat-panel detector. The exposed volume was 50 mm by 30 mm (Small FOV), to minimize radiation exposure to the patients. Exposure parameters were: 70 kV, 8–10 mA (based on subject size), and a single 360°, 24-s exposure time comprising of approximately 235 projections. Primary

Fig. 1 **a** Preoperative appearance of non-restorable tooth # 9. **b** Schematic representation of the BPPBPP technique showing augmentation of the alveolus with particulate bone graft (blue arrows) outside the extraction socket on its buccal aspect instead of traditional

intra-socket grafting. **c** A periosteal elevator is used to reflect the soft tissue buccal to the bony plate on the facial aspect of the middle of the socket thereby creating a 'surgical pouch,' which will then receive the particulate bone graft

Fig. 2 **a** Frontal view of the same area 3 months after surgery (extraction of # 9, BPPBPP, immediate implant placement and concomitant provisionalization) (T1). **b** Occlusal view at T1. **c** Frontal view 5 years after surgery (T2). **d** Occlusal view at T2

data reconstructions were made using the acquisition software (CS3D Imaging, Carestream Health, Inc, USA), resulting in perpendicular slices in axial, coronal, and sagittal planes of the image volume. Subsequently, a second reconstruction was made to obtain contiguous 0.5-mm-thick slices. The workstation consisted of a ASUS Computer, Intel® i5 CPU, with a graphics card [NVIDIA GeForce 9500 GT Series GPU 32-bit (NVIDIA Corporation, Santa Clara, CA, USA)]. Reformatting and measurements were made on a 19-inch flat-panel monitor (resolution 1600 × 1200 pixels).

Reconstructions were made in a way that for each individual implant that was inclined lingually or labially, the axial slices became perpendicular to its long axis. Image slices, perpendicular to the axial slices, were automatically reconstructed with resultant optimal visualization of the implant within the alveolus in axial, coronal, and sagittal views, as described by Lund on teeth [9]. Using the axial view, one reference line was drawn from the apex of the implant to its platform (long axis); another line, perpendicular to the one at the long axis, was drawn at the apex of the implant. Parallel to this, two lines were drawn, one at 1 mm from the implant collar (R1) and another 5 mm apical to it (R2) measuring the thickness of the bone (at the buccal plate) to the nearest 0.1 mm by a single examiner (Figs. 3, 4). Post-treatment measurements were independently made by the same single examiner without access to previous radiographs or protocols. The difference in measurements between T2 (5-year postoperative) and T1 (3-month postoperative) indicated the change in the

Fig. 3 CBCT showing measurements at reference points R1 and R2 at T1

Fig. 4 CBCT showing measurements at reference points R1 and R2 at T2

alveolar thickness that had occurred from the initial post-operative phase to the long-term time interval. Statistical analysis was performed with the Calculating page of Apache Open Office® 4.1.0 (Copyright © 2014—Apache Software Foundation).

Results

There were six females and four males in the study. The mean age of the sample was 37.6 years (range 23–64 years). The results of the CBCT examinations demonstrated excellent overall stability of the buccal plate contour and shape at both reference points: 1 mm from the implant collar (R1) and 5 mm from the implant collar (R2). At T1, the mean thickness was found to be 2.36 mm at R1

Table 1 Thickness of buccal plate from implant surface; measurement at the 1 mm distance (R1) from the implant platform (abutment connection)

Tooth	3 months	5 years
2.1	2.7	2.5
1.1	2	1.9
1.1	3.1	3
1.2	2.3	2.3
2.2	2.2	2
1.3	1.9	1.7
1.4	1.9	1.9
2.4	2.5	2.4
2.4	2.7	2.7
2.4	2.3	2

Table 2 Thickness of buccal plate from the implant surface; measurement at the 5 mm distance (R2) from the implant platform (abutment connection)

Tooth	3 months	5 years
2.1	2.4	2.2
1.1	0.1	1.9
1.1	3	3
1.2	2.3	2.3
2.2	2.3	2.3
1.3	2	1.9
1.4	1.9	1.9
2.4	2.3	2.2
2.4	2.7	2.7
2.4	2.3	2

(range: 1.9–3.1) and 2.23 at R2 (range: 1.9–3). At T2, the thickness was 2.28 mm at R1 (range: 1.7–3) and 2.18 at R2 (range: 1.9–3). The differences in mean values at T1 and T2 were not statistically significant ($p > 0.05$). Tables 1 and 2 show the results of the study in tabulated form.

Discussion

Clinicians have been placing and provisionalizing single implants immediately in the anterior esthetic areas for many years. Besides patients' demands, another rationale for immediate placement and provisionalization has been the necessity to maintain the osseous and gingival architecture in an attempt to optimize esthetic results. A prerequisite for immediate placement and provisionalization of a single tooth is the presence of ideal hard and soft tissue relationships [10]. There is a compelling need to counteract the remodeling of these tissues after extraction, after implant placement and after provisionalization if one is to assure long-term functional and esthetic stability of the restoration. Placement of an implant into a fresh extraction socket may not prevent buccal plate resorption, as was previously thought!. Araújo [4] demonstrated that placing biomaterial in an extraction socket may not accelerate or ameliorate the rate of bone regeneration, but it may help modify the remodeling and counteract the marginal ridge contraction that occurs following tooth removal. Histologically, it may mean that the original volume may be preserved, but particles of the graft may still be present in the long term. This may be regarded as less than ideal in potential implant-placement sites, but according to several authors, once incorporated in native bone, the particles may actually help prevent resorption of the newly regenerated area in the long term. It has also been suggested that in order to maintain good soft and hard tissue relationships in esthetic areas, a non-resorbable membrane along with bovine xenograft could prevent bone remodeling from taking place. This may be considered a guided bone

regeneration procedure and therefore the total healing time would be expanded, thereby delaying re-entry by 4–6 months after the graft.

BPP has been previously proposed as an effective alternative to socket grafting and has multiple advantages over the latter inclusive but not limited to the following: (1) does not interfere with the natural, physiological healing of the socket healing process; (2) allows for immediate implant placement; and (3) cost savings since augmenting the labial plate externally requires lesser graft material than intra-socket grafting. The rationale behind the use of a slow resorbable grafting material is that slowly resorbing or non-resorbing particles of bovine xenograft are incorporated in the soft tissues, thereby preventing recession and enhancing the soft tissue appearance of the edentulous ridge.

This is the first study in the literature that has shown that the results of BPP are stable long-term and that the technique is effective in resisting remodeling and resorption of the facial cortical plate of the alveolus in the area of dental extraction and implant placement. In this study, the esthetic outcome was not evaluated since this has been reported on previously [7, 8, 11]. Although no definitive conclusions can be made due to the small sample of patients, the results of this pilot study are very encouraging. Multi-center reports with a larger cohort of patients should be conducted to validate the results of this new yet promising technique which has the potential to improve clinical outcomes following implant placement in the anterior esthetic zone.

Compliance with Ethical Standards

Conflict of interest All authors declare that they have no conflict of interest.

Ethical Approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed Consent Informed consent was obtained from all individual participants included in the study.

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