Effect of Deproteinized Bovine Bone Mineral at Implant Dehiscence Defects Grafted by the Sandwich Bone Augmentation Technique

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The aim of this study was to compare the amount of radiographic horizontal buccal bone thickness (BBT) at implant dehiscence defects grafted with the sandwich bone augmentation (SBA) and modified sandwich bone augmentation (MSBA) techniques. Compared to the SBA technique, the MSBA approach involved an additional outer layer of deproteinized bovine bone mineral (DBBM) to maintain the space for bone regeneration for longer periods. A total of 19 patients, each with a buccal implant dehiscence defect, were recruited. The control group was treated with SBA technique (n = 10), while the test group was treated with MSBA technique. Cone beam computed tomography (CBCT) scans, taken at three time points (before and immediately after implant surgery, and 6 months post-treatment) were used to assess the BBT at the implant platform (−1.8 mm), the rough-smooth junction (0 mm), and 2, 4, 6, 8, and 10 mm apical to the rough-smooth junction. At 6 months postsurgery, the mean BBT in control and test groups was 1.69 ± 0.38 mm and 2.55 ± 0.21 mm, respectively. Mean BBT was significantly greater in the test group at 2, 4, 6, and 8 mm apical to the rough-smooth junction. There was no statistical difference in the mean BBT at the implant platform, the rough-smooth junction, and 10 mm apical to the rough-smooth junction between the two groups (P > .05). Within the limitations of this study, it was concluded that the additional layer of DBBM enhanced BBT along the implant, except at the smooth collar. Int J Periodontics Restorative Dent 2018;38:79–85. doi: 10.11607/prd.2931
6.4 mm more vertical bone loss and 0.8 mm more horizontal bone loss compared to a site with a thick buccal plate of > 1 mm. 4 Unfortunately, the majority of the population has thin or missing buccal plates in the anterior region. 5,6 Therefore, in most clinical scenarios tooth loss would result in a mean horizontal bone reduction of 29% to 63% and a mean vertical bone reduction of 11% to 22% at 6 months postextraction. 7 Consequently, the residual ridge would not be adequate to house a dental implant in an ideal prosthetically driven position. Hence, bone augmentation techniques such as guided bone augmentation (GBR), ridge split, block grafts, and distraction osteogenesis could be employed to increase the bone volume in a more advantageous position. GBR is a commonly practiced technique that presents with satisfactory long-term clinical outcomes. 8,9 In recent years, a variation of GBR, termed the sandwich bone augmentation (SBA) technique, 10 has gained popularity in implant dentistry. This technique capitalizes on the healing properties of mineralized cancellous and cortical bone allografts and collagen membrane coverage to mimic the natural structure of pristine bone (cancellous bone covered by cortical bone and protected by the periosteum), thus achieving stable bone augmentation around dental implants with a relatively shorter treatment time. 11 Another technique, termed contour augmentation, 12 has also gained recognition in Europe. It is similar to the SBA technique, except that deproteinized bovine bone mineral (DBBM) is used instead of bone allografts. The use of DBBM is advocated because its slow resorption rate means it is able to maintain space for bone regeneration and maintain bone volume for extended periods. It is hypothesized that adding an outer layer of DBBM to the SBA technique may improve the stability of the regenerated bone. This proposed technique, termed modified sandwich bone augmentation (MSBA) (Fig 1), involves placing autogenous bone, if any, next to the implant surface, followed by the cancellous bone allograft (inner layer), the cortical bone allograft (middle layer), the DBBM (outer layer), and finally a collagen membrane. So far, no human clinical trial is available that has examined the clinical effect of MSBA. Thus, the goal of this study is to compare the radiographic horizontal buccal bone gain at dental implant sites grafted with the SBA or MSBA technique.

Materials and Methods

Study Design and Experimental Population

This case series was conducted from January 2010 to June 2014 in a private practice according to the principles of the Declaration of Helsinki. 13 Prior to patient enrollment, the treatment procedure and potential risks (eg, radiation dose) were discussed and consent was obtained. The study was designed to compare the clinical and radiographic changes in buccal bone thickness at dental implants placed with simultaneous GBR, namely via the SBA 10 and MSBA techniques. The enrolled patients were aged at least 18 years, were systemically healthy, had good oral health, had an edentulous span with a horizontal ridge width of ≤ 7 mm for at least 6 months, and required tooth replacement with dental implants. Patients who were heavy smokers, defined as > 10 cigarettes a day, or with medical contraindications such as history of intravenous bisphosphonates were excluded from the study.
A total of 19 consecutive patients who received one dental implant each were recruited for the study. Alternate dental implants were assigned to the test (MSBA) and control (SBA) groups. The control group had 10 implant dehiscence defects that were augmented with the SBA technique. At these sites, an inner layer of mineralized cancellous bone allograft (Puros Cancellous, Zimmer Dental) was placed over the implant until it was flush with the adjacent bone contours. This was followed by placement of an outer layer of mineralized cortical bone allograft (Puros Cortical, Zimmer Dental) about 1 mm thick. The test group had 9 implant dehiscence defects that were treated with the MSBA technique. These implants received an inner layer of mineralized cancellous bone allograft (Puros Cancellous, Zimmer Dental), which was flush with the adjacent bone contours. Subsequently, a middle layer of mineralized cortical bone allograft (Puros Cortical, Zimmer Dental) and an outer layer of DBBM (Bio-Oss, Geistlich) were placed. The mineralized cortical bone and DBBM layers were each about 1 mm thick. A collagen barrier membrane (Collprotect Membrane, Botiss Biomaterials) without additional fixation was subsequently used to protect the bone substitutes in both groups.

Surgical Procedures

All patients were given 2 g of amoxicillin or 600 mg of clindamycin orally immediately before the surgery and were instructed to rinse with 0.12% chlorohexidine gluconate mouthrinse (Peridex, Zila) for 30 to 60 seconds. All surgical procedures were performed under local anesthesia using 2% Lidocaine (2% lidocaine hydrochloride with 1:80,000 adrenaline) by the same surgeon (S.C.W.).

The mucogingival pouch flap design, which involved a crestal incision placed 2 mm palatal to the midcrest and two vertical releasing incisions leaving behind 1 to 1.5 mm of intact papilla, was used (Figs 2a to 2c). A full-thickness mucoperiosteal flap was elevated and the edentulous ridge was debrided. A dental implant (Zimmer Tapered Screw Vent, Zimmer Dental), 3.7 mm (either 11.5, 13, or 16 mm length) was placed with the rough-smooth junction at 1 to 2 mm apical to the bone crest at an insertion torque of 35 Ncm in an ideal prosthetic position as dictated by the surgical template (Fig 2d). A 10-mm UNC probe was used to measure the height and width of the dehiscence defect. De- cortication was performed around the implant using a half-round diamond bur to stimulate the regional acceleratory phenomenon. The defects were augmented with either the SBA or the MSBA (Fig 2e) techniques according to their groups. The surgical site was passively closed with 4.0 absorbable sutures (Vicryl, Ethicon).

A prescription for 500 mg amoxicillin or 300 mg clindamycin three times a day for 10 days and 600 mg ibuprofen three times a day for 5 days was given to all patients. In addition, patients were instructed to rinse with warm salt water three times a day for 14 days, followed by 0.12% chlorhexidine gluconate mouthrinse (Peridex, Zila) twice a day for 1 month. Sutures were removed 2 weeks after the surgery and reviews were performed at 1, 3, and 6 months postsurgery. The implants were uncovered at the 6-month follow-up (Fig 2f). Stable implants were subsequently restored. Implants with exposed threads were regrafted and restored 6 months later.
CBCT Analysis

All enrolled patients had CBCT scans taken at baseline (Fig 2g), immediately after implant surgery (Fig 2h), and at 6 months postsurgery (Fig 2i). The CBCT scans obtained immediately after implant surgery and at 6 months postsurgery were viewed under ×2 magnification, and the measurements obtained were used for the analysis. The horizontal buccal bone thickness along the implant surface was measured perpendicular to the long axis of the implant, at the implant platform (−1.8 mm), at the rough-smooth junction (0 mm), and 2, 4, 6,
8, and 10 mm apical to the rough-smooth junction using the software in the CBCT machine (KDIS 3D CBCT viewing and planning software version 2.4, Carestream Health).

Clinical Parameters

The clinical parameters measured at implant placement and uncover-ery (Fig 3) were defect width (DW), which was taken as the widest part of the defect; defect height (DH), which was taken as the length of exposed roughened implant surface; and percent defect height reduction (%DHR), which was calculated as [(DH at implant placement – DH at 6 months post implant placement)/DH at implant placement] × 100%.

Statistical Analysis

Descriptive evaluation of all parameters was presented as means with standard deviations. Mann-Whitney \( U \) test analysis with an alpha level set at .05 was used for comparison between the two groups (SPSS version 23.0, IBM).

Results

Of the 19 enrolled patients, 11 were men and 8 were women, with a mean age of 43.3 ± 14.9 years (range: 24 to 70 years). Of the 19 implant sites, 17 were maxillary and 2 were mandibular, with 14 incisors, 3 canines, and 2 premolars. At baseline, the control and test sites had comparable mean ridge widths of 2.69 ± 0.68 mm and 2.74 ± 0.15 mm, respectively (\( P > .05 \)).

A buccal implant dehiscence defect was observed in all sites after implant placement. The control sites had a mean DW of 3.02 ± 0.78 mm and a mean DH of 3.85 ± 1.70 mm. The test sites had a mean DW of 3.64 ± 1.00 mm and a mean DH

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<th>Table 1 Mean Buccal Bone Thickness of Control (SBA) and Test (MSBA) Implants at 6 Months Post-surgery</th>
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*\( P < .05 \).
of 3.80 ± 3.58 mm. There were no significant differences in mean DW (P = .128) and DH (P = .191) between the test and control sites at baseline. All implants were osseointegrated at the 6-month postsurgery follow-up. The mean DW and DH at the control sites were 0.31 ± 0.42 mm and 0.09 ± 0.28 mm, respectively, and that at the test sites were 0.21 ± 0.63 mm and 0.06 ± 0.17 mm, respectively. The mean %DHR at the control and test sites was 97.91 ± 7.00% and 98.32 ± 5.00%, respectively. There were no significance differences in mean DW (P = .247), mean DH (P = 1.000) and %DHR (P = 1.000) between the groups.

At 6 months post–implant placement, the mean BBT in the control and test groups was 1.69 ± 0.38 mm and 2.55 ± 0.21 mm, respectively. The test group appeared to have about 0.8 mm more BBT than the control group. There were no significant differences in mean BBT between the two groups at the implant platform, the rough-smooth junction, and 10 mm apical to the rough-smooth junction (P > .05). The mean BBT at 2, 4, 6, and 8 mm apical to the rough-smooth junction were significantly different between the two groups (P < .05), favoring the test group (Table 1).

Discussion

The SBA technique uses the concept of GBR to effectively increase buccal bone thickness around dental implants.9–11 Cancellous bone allograft is placed on the implant surface to mimic cancellous bone, and the cortical bone allograft over it mimics the protective cortical bone plate. The resorbable collagen membrane acts like the peristeum, serving as a shield to hold the bone grafts in place and exclude ingrowth of epithelial cells. It thus uses the different healing properties of the biomaterials to gain peri-implant bone.9–11 The main advantages of this technique are reduced surgical trauma and shorter treatment time.9–11 However, the ability of the bone allograft to hold space for bone regeneration and the long-term stability of this regenerated bone are questionable. As such, DBBM has been suggested and widely used in Europe to overcome these deficiencies.12 This is because DBBM resorbs slowly and thus can maintain space for bone regeneration and protect the regenerated bone.

The results of this study showed that the addition of a DBBM layer on top of the allogenic bone layers resulted in more buccal bone gain (mean 0.86 mm) compared to sites without the DBBM layer. In addition, the DBBM layer led to significantly greater buccal bone gain at 2, 4, 6, and 8 mm apical to the rough-smooth junction when compared to the SBA approach. Previous clinical trials have also demonstrated good long-term clinical outcomes with the use of DBBM in contour augmentation in the maxillary esthetic zone.12,15–17 In this study, the MSBA approach appeared to have a mean 2.55 mm of BBT, which was about 0.55 mm greater than that observed in previous clinical trials.15,16 The DBBM layer, however, did not prevent peri-implant crestal bone loss around the smooth collar of the implants, which was also observed in other clinical studies.16–20 The peri-implant crestal bone remodels in response to the surgical trauma and subsequent functional loading.21 It can also be adversely affected by factors such as bacterial challenge, occlusal overload, and overlying soft tissue thickness.22 Typically, crestal bone loss ranged from 0.04 to 2.7 mm with different implant macro- and microdesigns,23–25 and most of the bone loss occurred in the first year of function.26

Conclusions

A small sample size of 19 implant dehiscence defects and a relatively short follow-up time of 6 months were the key limitations of this study. It will be interesting to evaluate the long-term stability of the regenerated peri-implant bone obtained through the MSBA and the contour augmentation approach,16 as it will affect the cost effectiveness of the surgical techniques. Within the limitations of this study, it can be concluded that both treatments achieved adequate bone fill in peri-implant dehiscence defects, and the additional layer of DBBM enhanced the treatment outcome when compared to traditional SBA technique along the implant, except at the smooth collar.

Acknowledgments

The authors reported no conflicts of interest related to this study.
References


