

Augmentation of Dental Alveolar Bone by Implanting a Ca/P/S-based Bone Void Filler via Vestibular Tunnel Approach - A Preliminary Cases Report

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Abstract

The conventional procedure of dentoalveolar bone grafting is often costly and time-consuming, therein the crest incision made right on top of the bony defect largely increases dehiscence and infection risks.

The vestibular tunnel approach (VTA) procedure used in the present study utilizes a porous granule/cement delivery tool which can form a granule/cement composite structure in the bony defect. The in-situ hardened Ca/P/S-based Ezechbone® Cement provides a sufficient initial strength to avoid premature collapse of the structure, while the porous Ca/P/S-based Ezechbone® Granule is responsible for a fast resorption/bone healing process. Furthermore, this minimally invasive, low-morbidity method for bone augmentation would not need membrane or bone screw

fixation, thus largely shortening the operation time. The three case reports presented in this study demonstrate a preliminary success of the method combining the present VTA procedure and the Ca/P/S-based composite bone substitute.

Keywords: dentoalveolar bone grafting, dentoalveolar bone augmentation, vestibular tunnel approach (VTA), calcium-based bone substitute

Introduction

Although bone augmentation is often performed prior to or during dental implant procedure, clinically it is a rather hard work, especially in cases of one- or two-walled bony defect. The conventional procedure of dentoalveolar bone grafting is conducted by first creating a substantially rectangular-shaped flap through one crest incision

accompanied with two vertical releasing incisions to expose the bony defect, followed by the placement of a bone graft (powder or block) into the bone defect. To avoid migration of the graft, a barrier membrane or bone screws are often used to fix the implant before the primary closure with tension-free, water-tight suture. The procedures of the placement of membrane and periosteal releasing incision, however, are not only costly and time-consuming, the crest incision made right on top of the bony defect in this conventional procedure largely increases soft tissue swelling, saliva leakage, dehiscence and infection risks [1]. Another often-encountered problem with the conventional flap surgery is in its difficult suture procedure involving cutting through periosteum and dissecting soft tissues to extend flap that would otherwise be difficult to close the wound due to the readily infilled bone graft. This, in turn, can cause more post-operative swelling/pain to the patient.

The concept of subperiosteal tunneling procedure can be traced to 1970s [12], back then such terms as "vestibular", "tunneling", "subperiosteal" and "minimally invasive surgery" were not as popular [2,3,4,5]. Before the mature era of dental implantation, oromaxillofacial surgeons had performed ridge augmentation via subperiosteal tunnel approach using non-resorbable hydroxyapatite (HA) or other types of bone graft for the denture-bearing area [8,10]. Vertical vestibular incision and subperiosteal tunnel preparation for the recipient site were described in the literature [6,7,8,9,10,11,12].

The vestibular tunnel approach (VTA) procedure used in the present study utilized a porous granule/cement delivery tool which was able to deliver a newly-developed resorbable Ca/P/S-based granule/cement composite structure in the bony defect. Presented in this report are three clinical cases which have successfully used this new

Ca/P/S-based bone graft material to reconstruct the atrophic alveolus jaw bone.

Materials and Methods

Ezechbone[®], a series of Taiwan Food and Drug Administration / China National Medical Products Administration-approved synthetic, 100% inorganic and resorbable Ca/P/S-based bone substitute materials [13,14], was developed by a National Cheng Kung University (NCKU)/Joy Medical Devices (JMD) joint research project and manufactured at an ISO 13485/GMP-certified facility in Kaohsiung, Taiwan. The safety and efficacy of the product have been confirmed by a series of chemical/physical characterization and biocompatibility tests such as cytotoxicity, sub-chronic toxicity, intracutaneous reactivity, skin sensitization, genotoxicity and animal implantation. Ezechbone[®] Granule is a highly porous granular product that can be fast resorbed and replaced by new bone, while Ezechbone[®] Cement is not dispersive upon contact with blood/body fluid and can be set therein in less than 10 minutes.

A vertical incision was performed on the movable mucosa of vestibule mesial to the recipient site, followed by a blunt subperiosteal dissection and, if necessary, extending the incision line coronally on the non-movable mucosa. A tunnel was formed by elevating the soft tissues subperiosteally. Ezechbone[®] Cement and Ezechbone[®] Granule were then delivered into the bone defect through the tunnel using a proprietarily-designed minimally invasive instrument (jRidge[™]) without the need of cutting periosteum. A layer of Ezechbone[®] Cement was first minimally-invasively delivered into the bone defect and allowed hardened in-situ to form a barrier to prevent soft tissue ingrowth as well as maintain a space for the later bone growth. When the cement was substantially hardened, a second layer of Ezechbone[®] Granule was inserted into the space between

the hardened cement and the underlying bone. This minimally invasive procedure would neither need any membrane or bone screw, that may cut short the surgery time normally from about 2 hours for the standard flap procedure to 30-60 minutes.

Results

Case 1

A 32 y/o healthy male lost his left lower first premolar 2 months before coming to our clinic due to the failure of a prior endodontic treatment. A depressed buccal plate was noted clinically (Figure 1a) as well as from the preoperative CAT-scans indicated by the arrows in Figure 1b. A vertical vestibular incision was made on the movable mucosa, followed by elevating the soft tissue subperiosteally using a curette to form a tunnel. Pre-implantation bone grafting was then performed by inserting Ezechbone® Cement and Ezechbone® Granule via the aforementioned VTA procedure. Two months after the bone grafting, a radio-opaque volume was noted in the postoperative CAT-scans, as indicated by the arrows in Figure 1c.

Case 2

A 50 y/o healthy male lost his transplanted left lower first molar 2 months before coming to the clinic due to resorption of the root. Crater-like bone defect was noted in the preoperative CAT-scans as indicated by the arrows in Figure 2a. A subperiosteal tunnel was prepared, followed by the insertion of Ezechbone® Cement and Ezechbone® Granule via the same VTA procedure. Six months after bone grafting, a dental implant was placed effortlessly without compromise due to the nicely-developed bone contour. A radio-opaque volume was noted in the postoperative CAT-scans, as indicated by the arrows in Figure 2b.

Case 3

A 63 y/o female patient was a victim of diabetes mellitus

with poor control. She received 4 dental implants at the right side of jaws 7 years before coming to the clinic. 2 years before, under the diagnosis of implantitis accompanied with pain and malodor, 2 of the 4 implants were removed. The patient was suggested to manage blood sugar and referred to an endocrinologist. 3 months following that, her blood sugar became stable (HbA1c lower than 7.5%) and a dental reconstruction plan was made in our clinic. Severe bone resorption was noted on the buccal side of the survived upper implant as demonstrated in the preoperative CAT-scans (Figure 3a). With the same procedure, a subperiosteal tunnel was prepared, followed by the insertion of Ezechbone® Cement and Ezechbone® Granule. Again, a radio-opaque volume was noted in the 3 week and 1 year-postoperative Cat-scans (Figures 3b and 3c).

Discussion

Subperiosteal injection of a bone void filler to reshape the bone surface contour has been widely used by plastic surgeons. In order to increase the stability of a denture, bone substitutes with a low resorption rate and long remodeling time, such as HA particles, have been placed subperiosteally to maintain the dental ridge profile [6,7,8,10,11]. However, it is known that, for a successful dental implantation procedure, the receiving bone quality is as important as the bone shape. A successful bone augmentation technique should maintain the space during the period of bone ingrowth and graft healing. Using membrane and bone screws in the conventional dentoalveolar bone grafting procedure may maintain the space, but at the same time can cause more tissue swelling, pain and risks of wound complication, as well as more patient's budget. An ideal bone graft should be able to be completely replaced by good quality native bone after bone remodeling. The in-situ hardened Ca/P/S-based Ezechbone® Cement provides a sufficient strength to

avoid premature collapse of the structure, while the porous Ca/P/S-based Ezechbone[®] Granule is responsible for a fast resorption/bone healing process.

In an earlier clinical study, Hon et al. (2017) used the same Ezechbone[®] Granule to treat a severely-receded bone for the preparation of a later dental implant. After 6 months, the authors found that the mass drilled out from the implantation site was “good quality bone” [15]. According to this finding, the radio-opaque volume noted in the postoperative Cat-scans should be primarily new, natural bone in case 2 (6 months post-grafting) and case 3 (1 year post-grafting). The volume seen in case 1 (2 months post-grafting) is most likely a mixture of new bone and graft residues.

As mentioned earlier, the conventional procedure of dentoalveolar bone grafting is not only costly and time-consuming, the crest incision made right on top of the bony defect can largely increase dehiscence and infection risks. On the other hand, the VTA procedure used in the present study utilizes a specially-designed delivery tool (jRidgeTM) which can form a particle/cement composite structure in the bony defect. The in-situ hardened cement provides a sufficient initial strength to avoid a premature collapse of the structure, while the porous particles are responsible for a fast resorption/bone healing process. Furthermore, this minimally invasive, low-morbidity method of bone augmentation would not need any membrane or bone screw. This can cut short the surgery time normally from about 2 hours for the conventional flap procedure to only about 30-60 minutes which means very dear to dental surgeons.

Conclusion

The conventional procedure of dentoalveolar bone grafting is often costly and time-consuming, therein the crest incision made right on top of the bony defect largely increases dehiscence and infection risks. The VTA

procedure used in the present study utilizes a minimally invasive system which can deliver a porous granule/cement composite structure in the bony defect. The in-situ hardened Ca/P/S-based Ezechbone[®] Cement provides a sufficient initial strength to avoid premature collapse of the structure, while the porous Ca/P/S-based Ezechbone[®] Granule is responsible for a fast resorption/bone healing process. Furthermore, this minimally invasive, low-morbidity method for bone augmentation would not need a membrane or bone screws, thus largely shortening the operation time. The three case reports presented in this study demonstrate a preliminary success of the method combining the present VTA procedure and Ca/P/S-based Ezechbone[®] Cement/Ezechbone[®] Granule composite bone substitute.

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Legends Figure



Figure 1a: Depressed buccal gum and a vertical vestibular incision made on movable mucosa, followed by elevating the soft tissue subperiosteally using a currette to form a tunnel.

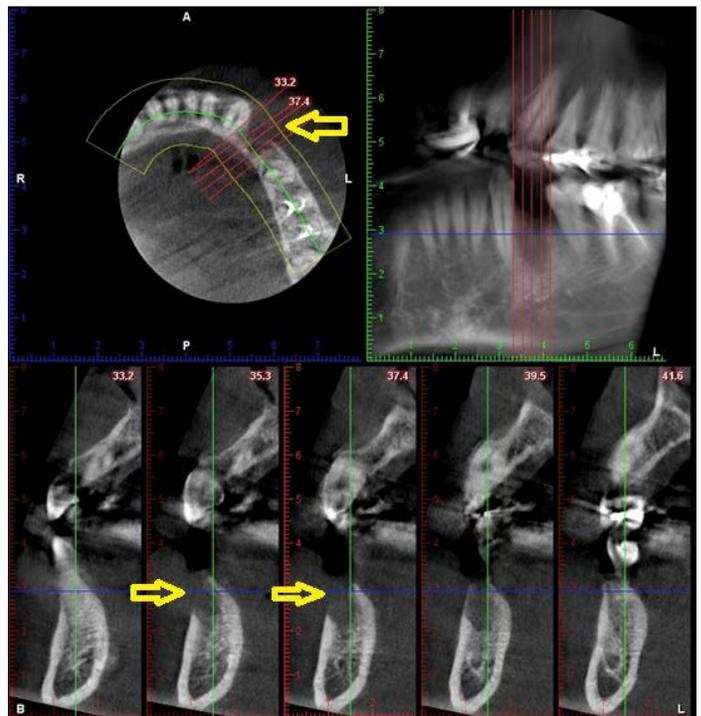


Fig. 1b: Preoperative Cat-scans with a slice distance of 2 mm and slice thickness of 0.5 mm. The buccal bony defect is visible (arrows). Upper left is an axial view coordinated with the blue lines on the panoramic view (upper right).

Lower five are cross-sectional images coordinated with the five red lines on the panoramic and axial views from left to right.

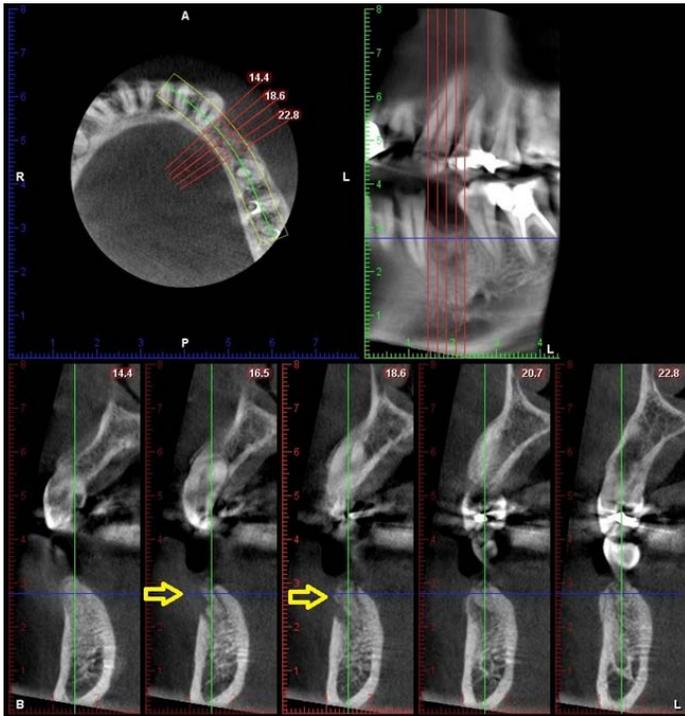


Fig. 1c: 2 month-postoperative Cat-scans with a slice distance of 2 mm and slice thickness of 0.5 mm revealing the socket filled with a radio-opaque volume.

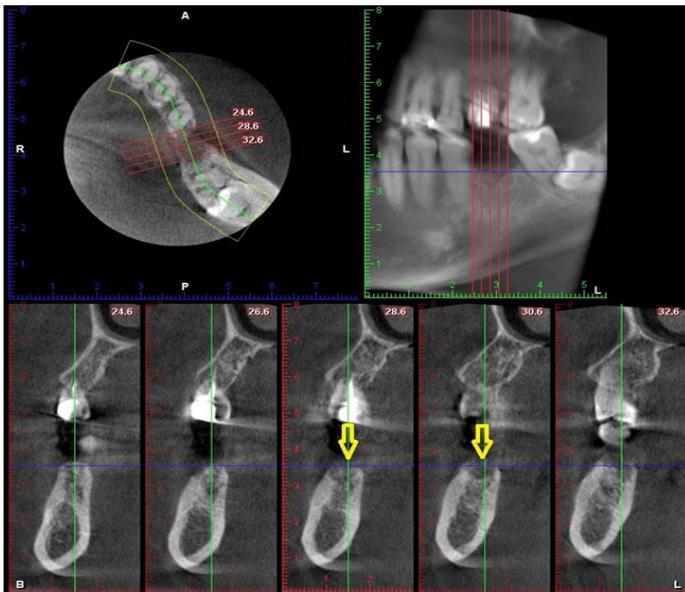


Fig. 2a: Crater-like radiolucent shadow on top of the alveolar bone (arrows) in the preoperative Cat-scans with a slice distance 2 mm and slice thickness 0.5 mm.

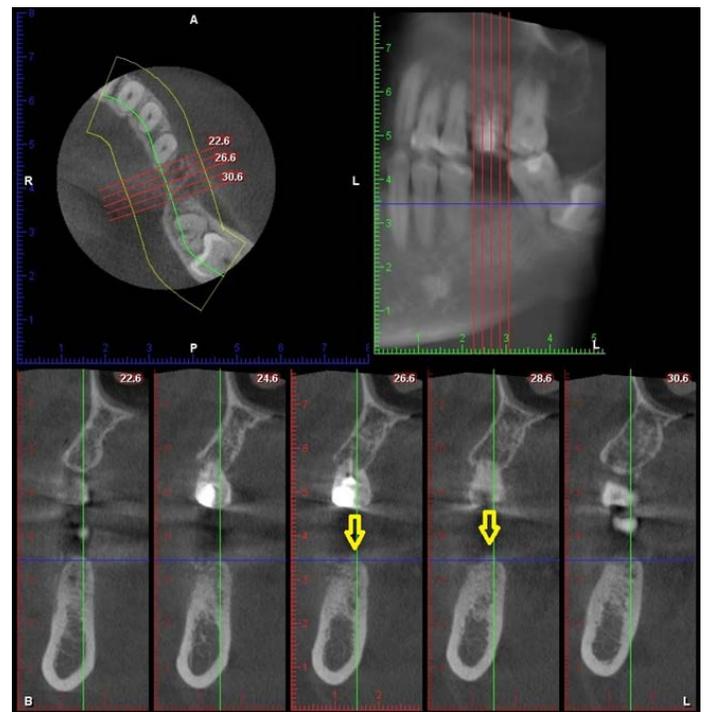


Fig. 2b: 6 month-postoperative Cat-scans with a slice distance of 2 mm and slice thickness of 0.5 mm revealing a well-developed alveolar bone contour and the socket filled with a radio-opaque volume (arrows).

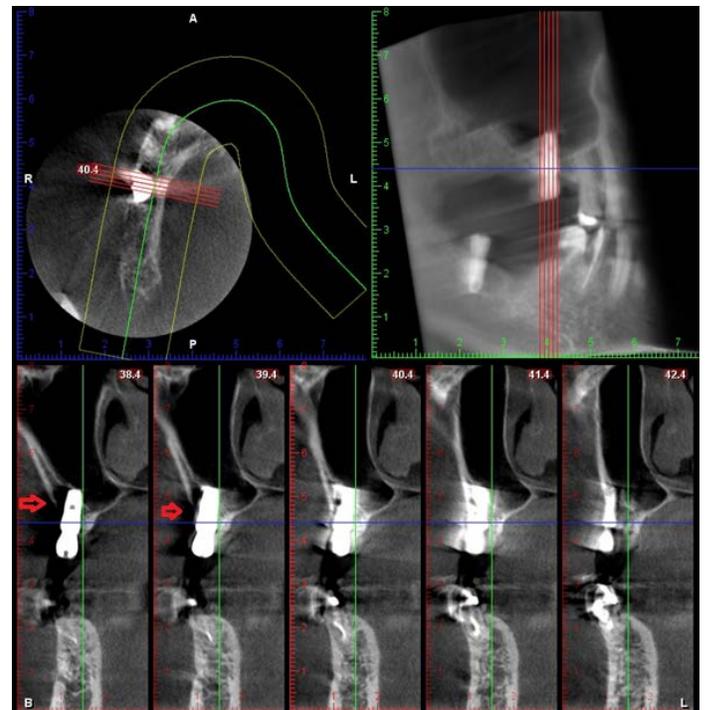


Fig. 3a: Preoperative Cat-scans with a slice distance of 2 mm and slice thickness of 0.5 mm revealing buccal plate resorption of the survived implant (red arrows).

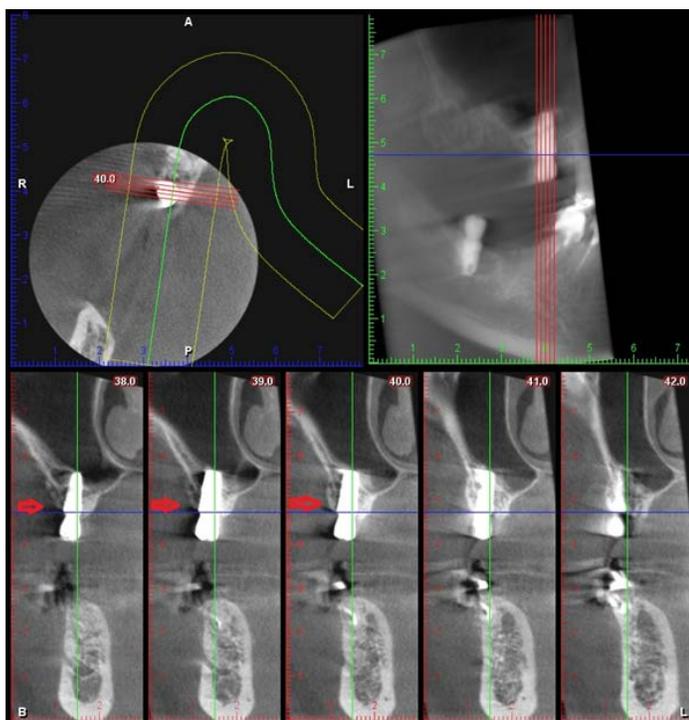


Fig. 3b: 3 week-postoperative Cat-scans with a slice distance of 2 mm and slice thickness of 0.5 mm revealing a radio-opaque volume (red arrows) on the buccal side of the implant.

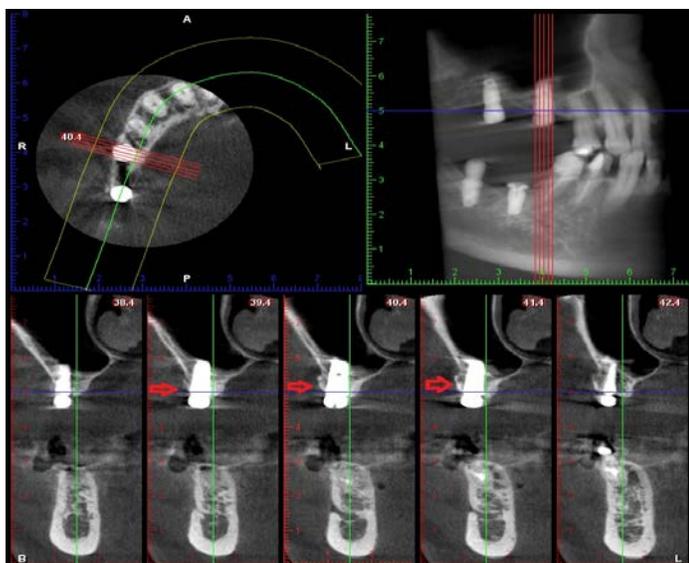


Fig. 3c: 1 year-postoperative Cat-scans with a slice distance of 2 mm and slice thickness of 0.5 mm revealing a radio-opaque volume (red arrows) on the buccal side of the implant.