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Guided Bone Regeneration of a Seibert Class III Defect with Bioactive Calcium Phosphosilicate Bone Graft (Tent Pole Technique) after Implant Failure: Human Histomorphometry and Clinical Report

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1. Abstract

This clinical case aimed to achieve two main objectives. The first was to determine if the use of only calcium phosphosilicate bone graft as a regeneration material (with no autologous bone added), on a severe vertical and horizontal mandibular defect (created by an implant failure), would allow enough bone to be obtained to enable the placement of a dental implant. The second objective was to determine histologic characteristics of the regenerated site after a healing period of 6 months. Vertical ridge augmentation is one of the greatest challenges for bone regeneration in implant dentistry. Intraoperative and postoperative complications are common [1-3]. Achieving bone regeneration without osseous wall containment is biologically demanding [4, 5]. Covering the grafted area is also a challenge as the increased dimensions necessary for vertical ridge augmentation can make it difficult to achieve tension-free wound closure [6]. Bone blocks (either as onlays or inlays/interpositional grafts) [7, 8] and guided bone regeneration (GBR) are amongst the best options to site development [9,10]. The most suitable approach remains unclear [11]. Block grafts are often described as the “gold standard” for severe atrophies13; however, advances in the field of biomaterials have favoured the use of GBR, a procedure that is significantly less invasive than the first [12, 13]. In the case here presented, GBR for implant placement, in a severe clinical situation was accomplished using only calcium phosphosilicate as a regeneration material. A tentpole technique was performed utilizing a titanium orthognathic plate to sustain, protect and help containing the biomaterial with an acellular dermal matrix on top (Mucoderm®), to further protect the graft and improve the interface of soft tissues-titanium plate.

2. Case Presentation

A 69-year-old female patient with a severe vertical and horizontal defect in the posterior mandible (left side/ third quadrant), a Seibert class III bone defect concerning tooth 36 (or tooth 19) [14], with one fractured and failing dental implant, presented for treatment. The patient had restored the now failing implant 2 years before it fractured.

The patient reported stable cardiac chronic insufficiency with daily intake of the following medication: eliquis, concor and lexotan. To enable a more comprehensive evaluation of the existing conditions and establish a treatment plan, several clinical photographs were taken (Figure 1) and a cone-beam computed tomography (CBCT) examination was done (Figure 2). The defect was severe, 5 to 7mm of the buccal plate had already been lost. A staged approach was suggested: extract the implant and do GBR on the same surgical procedure, wait 6 months to place the implant and then, restore it 4 months after it had been placed. After discussing all treatment steps with the patient, written consent was obtained, not only for the treatment itself, but also for the bone biopsy that would be collected on implant placement. After removing the failing implant (Figure 3), and the bone cleaned from all the granulation

tissue a titanium plate was fixated to the bone to allow for a tent pole (Figure 4) that would be able to sustain, vertically, the graft. The defect was filled with calcium phosphosilicate (NovaBone® Morsels, NovaBone) aggregated by PRGF ENDORET® BTI System. An acellular dermal matrix (Mucoderm®) was used to cover the entire titanium mesh (Figures 5 and 6). Tension-free primary closure of the wound was achieved. Six months later, a CBCT of the area was done (Figure 7). Biopsy of the regenerated area was conducted, taken from the implant's bed preparation (Figure 8). A trephine bur was used to collect the biopsy, which comprised one cylinder of 3.5 mm diameter by 6 mm length. One implant was then placed into the regenerated area. After a 6 months healing period digital impressions with a MEDIT i700® scan were obtained and files sent to the dental technician (Figures 9 and 10). A CAD CAM zirconia crown was designed and milled according to the clinician's indications. Before milling the final crown (Figure 11) a prototype was tried in to test occlusion, tissues adaptation and overall morphology appreciation.

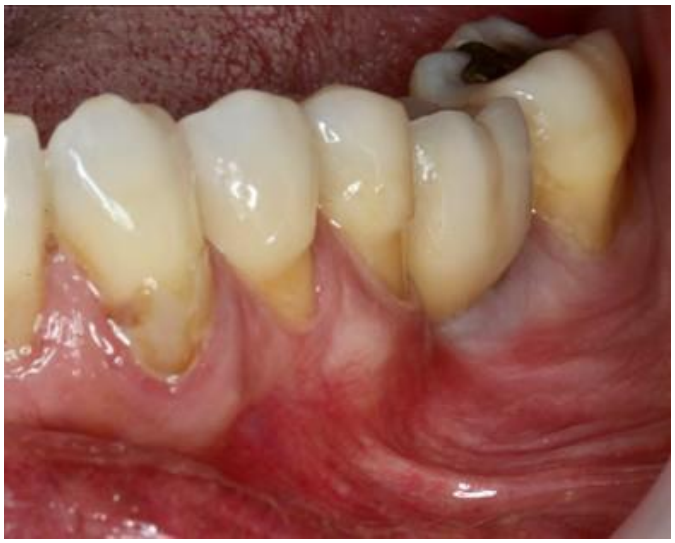


Figure 1: Initial Clinical.

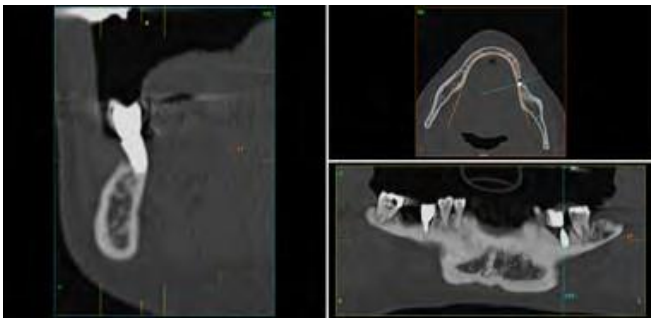


Figure 2: Cbct Initial.

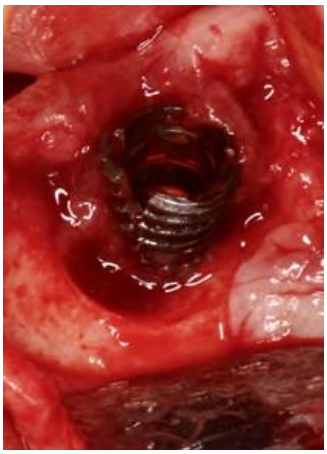


Figure 4: Titanium Plate.

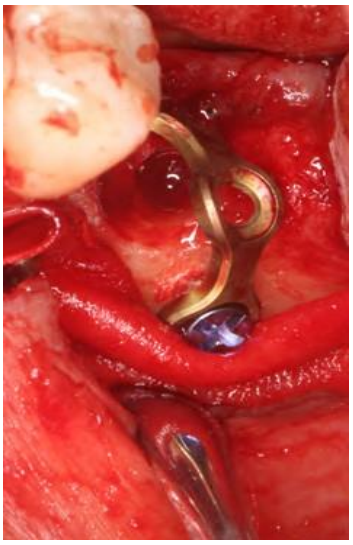


Figure 5: Novabone.

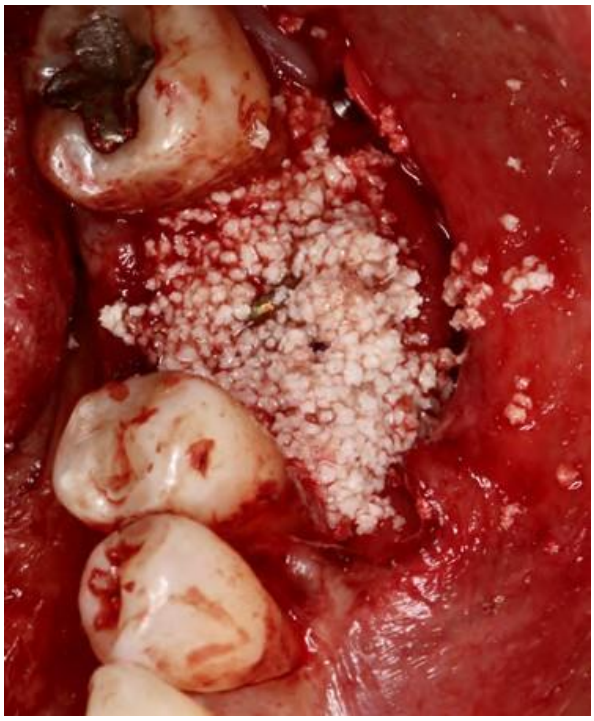


Figure 6: Novabone & Mucoderm.

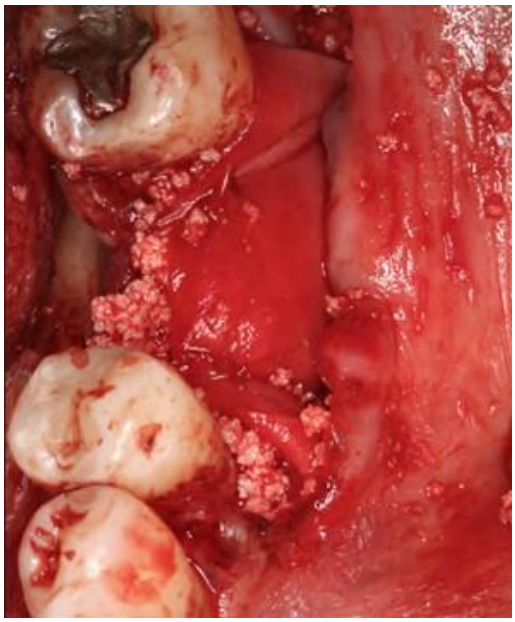


Figure 7: Cbct Final.

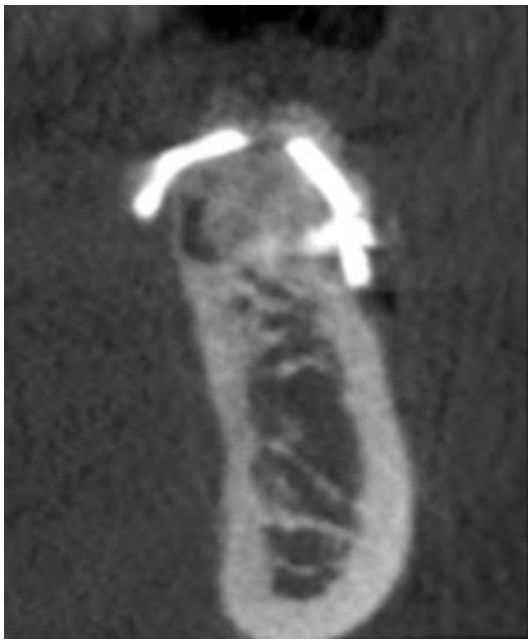


Figure 8: Biopsy.

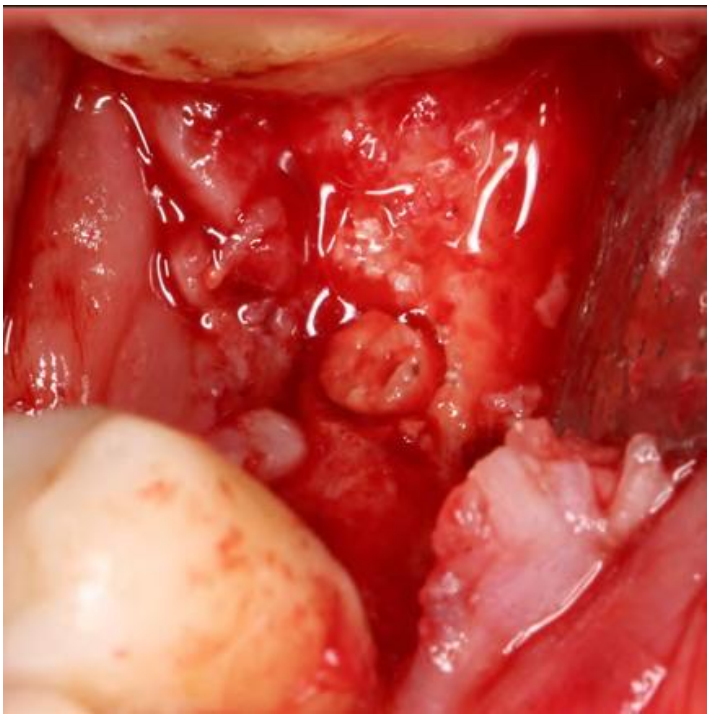


Figure 9: One implant was then placed into the regenerated area. After a 6 months healing period digital impressions with a MEDIT i700® scan were obtained and files sent to the dental technician.

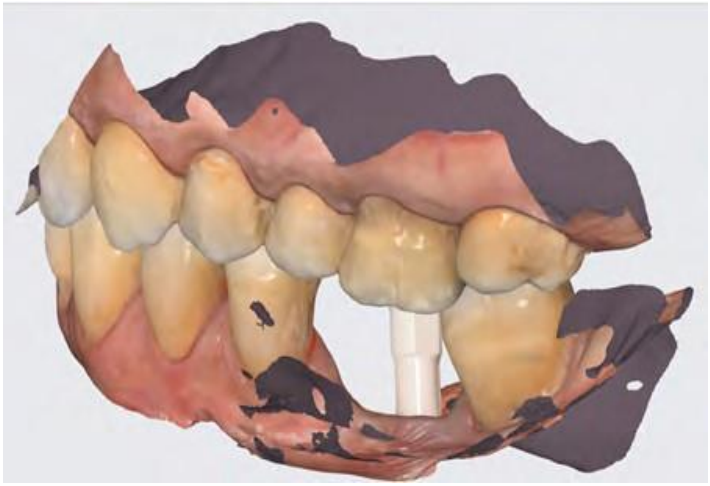


Figure 10: One implant was then placed into the regenerated area. After a 6 months healing period digital impressions with a MEDIT i700® scan were obtained and files sent to the dental technician.

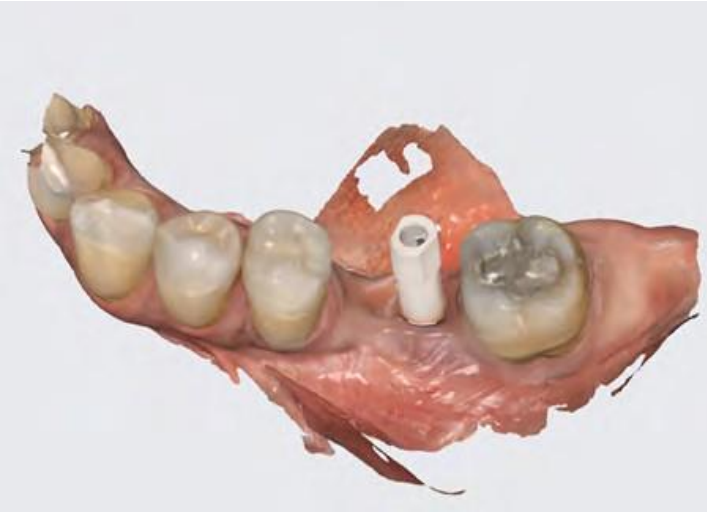


Figure 11: Final Crown.

3. Rationale for Treatment Approach

There were four possible treatment options to consider in treating this severe bone defect, all of which were thoroughly discussed with the patient. The first option was distraction osteogenesis. The patient rejected this option because of the procedure's complexity, and moreover, the clinician had no experience with this technique. The next option discussed with the patient was the use of short implants; however, because both vertical and horizontal bone volume were inadequate, especially in the region from where the failing implant was to be extracted and also soft tissues would never be acceptable to achieve a stable healthy environment, this option was ruled out. The use of bone blocks was also discussed. Although the clinician considered this to be one of the best possible treatment options, the need for a second surgical site (ie, donor site) was a major factor in the patient deciding against it, as she desired a much less invasive procedure. Finally, GBR was deemed the best option for two main reasons: first, it has a lower complication rate when compared to the other viable treatment modalities, and second, it is much less invasive than the first and third options [12, 15, 16]

4. Rationale for the Use of the Primary Products in the Case

The titanium plate was first fixated to the bone in a position that would allow the vertical sustainability of the graft. Only after that was the graft material, calcium phosphosilicate (morsels), put into the defect. In this case, the clinician relied on the general properties of calcium phosphosilicate (morsels); namely, it is osteostimulative, osteoconductive, macroporous, fully resorbable, and radiodense [17]. It was used as the sole bone grafting material; no autologous bone was added. Osteoconductive grafts usually are not bioactive and are just scaffolds without active chemical interaction. This is not the case however, with calcium phosphosilicate. Besides being osteoconductive, it promotes osteostimulation, an active mechanism (bioactive regenerative) stimulating osteoblast proliferation and differentiation due to chemical ion release. The biomaterial acts as a matrix and encourages the differentiation of new bone cells at the site, resulting in faster bone regeneration than exhibited by osteoconduction alone. New bone formation occurs throughout the defect, not just at the defect margins. In the present case, the bone volume obtained and the histological characteristics, as seen from the histomorphometric analysis, of the regenerated area appeared adequate to receive a dental implant, even though no autologous bone was used (Figure 5 and Figure 6). The resulting bone volume was a substantial improvement compared to the initial clinical situation, allowing the placement of one dental implant. Biopsy of the involved areas (Figure 8) and the histomorphometric values obtained from the histology (Figure 12 and 13) showed several interesting results: a large portion of the regenerated area was bone, there were areas of intense remodelling and osteogenic activity, and there were well osseointegrated biomaterial particles; at 6 months 55,5% was new bone and 20,1% was particles. (Figure 14) demonstrates the outcome of the case at 3 months post–implant placement. Implant's position was scanned with Medit Scan i700® (Figures 9 and 10). A PMMA prototype was fabricated in order to approve the design intended for the final crown. Final zirconia crown substructure was delivered to the patient one month after scanning (Figure 14).

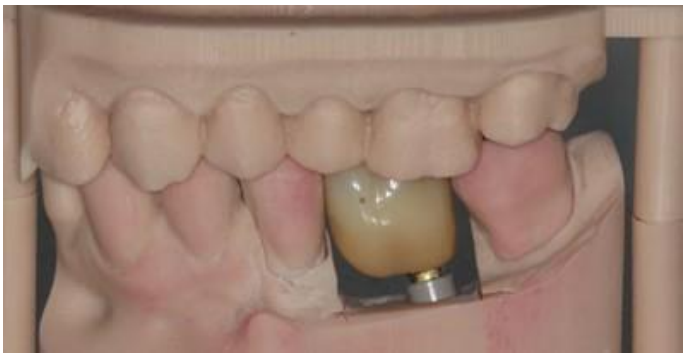


Figure 12: Histology.

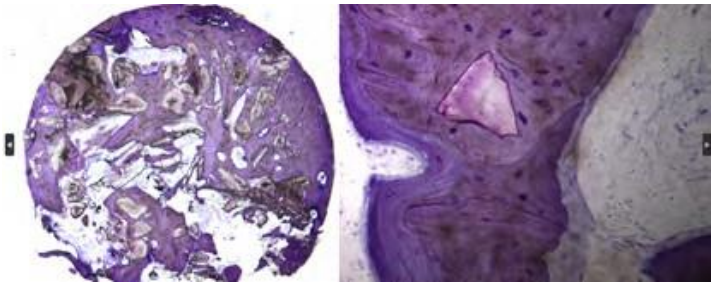


Figure 13: Histology.

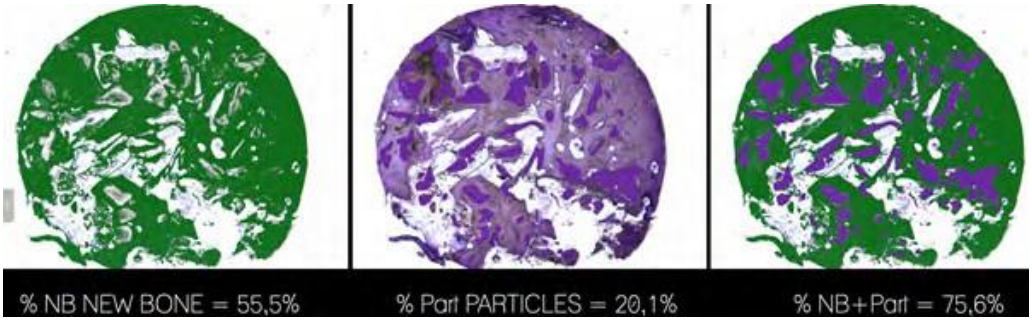
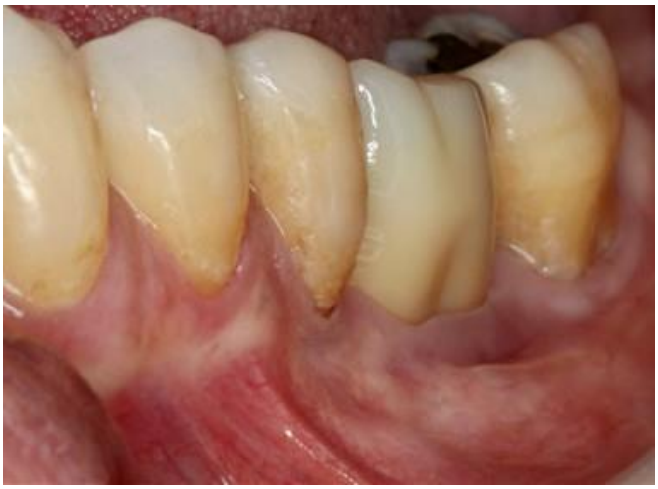


Figure 14: Clinical final.



5. Conclusion

This case report showed that it seems reasonable to consider the use of calcium phosphosilicate alone as an adequate biomaterial to perform GBR of extraosseous defects. Histological analysis and findings are extremely clinically relevant, revealing, in this case, that it appears possible to accomplish the effective bone regeneration of severe 3-dimensional defects without the need to use autologous bone. This approach would equate to less morbidity for the patient, precluding the need for a second surgical site (ie, donor site). It would also enable less complex surgical procedures, making it easier for clinicians to focus only on the defect to be regenerated and having to perform just one surgery, in one place.

6. Acknowledgment

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