Calcium Phosphate Barrier for Augmentation of Bone in noncontained Periodontal Osseous Defects: A Novel Approach

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ABSTRACT

Aim: The aim of this technique is to augment bone in non-contained osseous deformities using a unique self-sustaining calcium phosphate barrier.

Introduction: Bone has the inherent ability to regenerate completely if it is provided with a fracture space or an undisturbed enclosed scaffold. A secluded environment is essential as it provides a secured, sterile and stable wound system that regenerates lost bone by a process of osteopromotion. Reconstructive techniques using bone grafts and barrier membranes utilize this principle for augmentation of deficient bony sites by providing a closed environment that promotes clot stability, graft retention, and facilitates correct cell repopulation. However, in non-contained bone defects like one walled infrabony periodontal defect or sites with horizontal bone loss, regeneration of bone still remains an unrealistic situation since osseous topography at such sites does not favor membrane stability or bone grafts retention. This case report presents a promising technique to augment bone in areas with horizontal loss.

Technique: Augmentation of bone in the interdental area with horizontal bone loss was accomplished by building a contained defect using a unique self-sustaining calcium phosphate cement formulation. The calcium phosphate barrier stimulates the lost cortical plates and promotes graft retention and clot stability. At 6 months, there was a significant bone fill and trabecular formation in the interdental area and reduction in tooth mobility.

Conclusion: This promising technique could prove to be a good alternative to the conventional approaches for treating osseous deformities.

Clinical significance: Calcium phosphate is a promising barrier graft for repair of non-contained periodontal osseous defect.

This technique cues both the clinicians and manufacturers to develop moldable tissue engineered constructs for osseous repair.

Keywords: Bone, Regeneration, Osseous defects, Bone grafts, Calcium phosphate.


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INTRODUCTION

Bone has the inherent ability to regenerate completely if it is provided with a fracture space or an undisturbed enclosed scaffold.1 This is based on Dahlin’s concept of osteopromotion which states that ‘by physically placing a barrier and segregating the sites of osseous deformities from surrounding soft tissues, osteogenesis can be promoted’.2 The secluded space creates a secured, sterile and stable wound system that promotes the rate of osteogenesis extending outward from the surrounding bone to exceed the rate of fibrogenesis progressing from the gingival epithelium by a process known as guided bone regeneration (GBR).3-5

Reconstructive techniques using bone grafts, membranes or mesh utilize these principles for augmentation of deficient bony sites.5 However, apart from tissue/cell exclusion, it is essential that these devices remain stable in their position and maintain adequate space for the healing clot to achieve good regeneration. In osseous topography like shallow osseous craters, one walled infrabony defects and areas of horizontal bone loss, that do not favor membranes stability or graft placement, regeneration of bone still remains a challenging task. The lack of support or pressure from overlying flap causes membranes to collapse into the wound space dislodging the healing clot at such sites.4,6

This clinical report presents a technique to augment bone in such non-contained osseous defects through creation of a unique self-sustaining barrier that would promote graft retention and clot stability for successful bone regeneration (Figs 1 to 4).
A 38 years old female patient presented to Department of Periodontology, Manipal, with the chief complaint of mobility in the upper right lateral incisor and canine for the past 1 month. The teeth were noncarious, vital with grade one mobility and clinical probing depth of 7 mm. The radiographic examination revealed angular bone loss without any associated periapical pathology (Fig. 5). After 2 months of nonsurgical phase one therapy, surgery was planned.

The surgery was performed under local anesthesia of 0.2% lidocaine with 1:80000 adrenaline. A full thickness mucoperiosteal flap was reflected to completely expose the osseous deformities (Fig. 6). After complete debridement of granulation tissue, a template of the lost bone architecture was made using modeling wax (Fig. 7). The powder of CPCs, calcium sulphate and citric acid was then mixed with sodium phosphate liquid to form moldable putty. The putty was placed on the buccal and palatal side of the template (Figs 2 and 8). The height of the built walls should allow tension free primary closure of the overlying flap (Fig. 9). The wax template was carefully removed. A combination of decalcified freeze dried bone allograft (DFDBA) and CPC was placed in the contained space left after the removal of the template after decortication of bone (Figs 3 and 10). The coronal part was subsequently covered with a resorbable membrane (Figs 4 and 11). A primary closure of flap was ensured using nonresorbable 3-0 Ethicon sutures followed by placement of periodontal dressing (Figs 12 and 13). Antibiotic Amoxicillin 500 mg three times a day for 7 days and analgesic Ibuprofen 400 mg three times a day for 5 days was prescribed. The patient was recalled at 15 days for suture removal and subsequently at 1, 3 and 7 months for reevaluation.

The radiograph at 7 months showed significant trabecular formation in the interdental area (Fig. 14). Upon clinical reentry at 12 months, a significant bone fill along...
with reduced clinical probing depth and tooth mobility was observed (Fig. 15).

**DISCUSSION**

The contained space created by the formed CPC walls simulates the lost buccal and palatal cortical plates. This acts like a self-sustaining stable barrier to favor retention of bone graft materials in an area with flat osseous topography (Fig. 3). This is similar to the concept of biomatrix for healing of fractured bones that involves protection of fracture space via artificially placed plates between the two fracture segments.\(^1\) This technique helps to convert a noncontained defect into a contained space that would promote bone graft retention, maintain adequate wound space and ensures isolation from the overlying gingival flap by epithelial cell exclusion.

CPC barrier successfully fulfills all the design criteria for successful GBR devices like cell exclusion, biocompatibility, space maintenance, tissue integration, ease of use and biological activity.\(^4\)\(^-\)\(^6\) CPC is a promising material with excellent bioactive and biological properties.\(^7\)\(^-\)\(^9\) The main advantage of CPC is its ability...
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to be sculpted in vivo according to osseous topography. Moreover, the increased availability of calcium during its nonexothermic setting reaction results in formation of nanocrystalline hydroxyapatite crystals similar in both chemical composition and size to the biological hydroxyapatite of living bone. This initiates rapid osteogenesis by activating mitogenic events, increased mesenchymal cell contact and formation of a complex proteinaceous layer of osteoid. Additionally, as the resorption rate of CPC is parallel with bone formation, there is direct binding with the surrounding bone without any intervening fibrous connective tissue, micro gaps or micro movement between the defect and implanted material. The mechanical properties of CPCs are also similar to cancellous bone. The flexural strength of 8 MPa and elastic modulus of 600 MPa aids CPC barrier to withstand forces of tissue tension from the overlying flaps or those transmitted through the flaps during mastication or other physiological forces. This allows undisturbed healing of wound by preventing reduction of the wound space and soft tissue encroachment. A good porosity in the CPC facilitates rapid revascularization and cells growth resulting in faster and superior healing.

CPC has been used in various craniofacial, orthopedic and oral surgical procedures like reconstructions of the maxilla and mandible bone after trauma or tumor resection, fixation of metallic implants in weakened bone, treatment of spinal fractures and osteoporotic bones, vertebroplasty and orbital reconstructions. However, its use for the treatment of periodontal osseous defects is still an emerging area of research.

CONCLUSION

This approach will open a new area of research where moldable dental materials that simulate bone in both composition and properties along with biomimetic bone healing are warranted. The availability of such smart biomaterials like calcium phosphate has opened a new area of research where, both the clinicians and the manufacturers with the appropriate biomechanical cues could provide tissue engineered constructs for direct use in the skeletal system. However, further studies using this technique are warranted to evaluate its true regenerating potential.
CALINICAL SIGNIFICANCE

CPC is a promising barrier graft for repair of periodontal osseous defects. This technique is a good alternative to conventional membranes or mesh to ensure a stable wound system in horizontal bone loss in interdental areas for successful bone regeneration.

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REFERENCES