CLINICAL AND HISTOLOGICAL EVALUATION OF CALCIUM SULFATE BONE GRAFT BARRIER (CAPSET) IN THE MANAGEMENT OF ANGULAR DEFECTS IN ADULT PERIODONTITIS BONE

Fatma Amin*, Azza Zaki** and Hisham Osman***

ABSTRACT
This study was conducted to provide a clinical and histological evaluation of calcium sulfate (Ca S) bone graft barrier (Capset) associated with naturally bovine derived hydroxyapatite (BHA) compared to bovine hydroxyapatite (BHA) alone in management of angular defects in adult periodontitis. A total of 16 defects were chosen from 10 patients for this study. All patients were subjected to thorough clinical examination in selected sites including plaque index, papillary bleeding index, probing depth and probing attachment level. All these clinical parameters were taken prior to surgery and at 3 and 6 months postsurgically. The angular defects were divided into two groups; the first group comprised 8 angular defects, which were treated with full thickness mucoperiosteal flap and filled with naturally derived bovine hydroxyapatite, which was covered with calcium sulfate. The second group comprised 8 angular defects, which were treated with flap surgery and filled with BHA only. An experimental study on 5 dogs was also included in this study. 10 surgically induced angular defects were created in the 5 dogs. Two defects in premolar region in each dog. One defect was filled with Ca S + BHA while the other was filled with BHA only. The dogs were sacrificed at 3 months and tissue sections were prepared and stained for histological examination. It had been found that, clinically, both surgical treatment modalities were effective in management of angular defects in adult periodontitis. The adjunctive use of bovine hydroxyapatite and calcium sulfate is a valuable mode of treatment of angular defects in adult periodontitis as it offered a more favorable clinical result and also demonstrated histologically better regenerative potential than bovine hydroxyapatite only.

INTRODUCTION
The primary goal of periodontal therapy is to maintain the health and comfort of the dentition during the patient’s lifetime. When tissues are destroyed by periodontal disease, regeneration of the lost attachment apparatus is the most desirable goal of therapy. Regeneration has been defined as the reproduction or reconstitution of a lost or injured part to restore the architecture and function of the periodontium. Histologic characteristics of periodontal regeneration include the formation of new bone, cementum, and periodontal ligament to form a new attachment apparatus.

Various types of regenerative approaches have been proposed for the treatment of intrabony defects, including root debridement with or without flap elevation, the placement of bone grafts or bone substitutes, root conditioning and the use of barrier membranes. The aforementioned approaches have

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been used separately and in combination to enhance healing of intrabony defects. (2-6)

Studies have been conducted based on the concept that the concurrent use of guided tissue regeneration (GTR) and bone grafts or bone substitutes may not only result in a new connective tissue attachment but also promote bone regeneration, thereby enhancing the therapeutic effect. (7-9)

Calcium sulfate (Ca S) has been used in orthopedic and dento-alveolar applications for at least 30 years. Peltier (13) has reported that surgical implantation of CS may facilitate healing of human bone defects. Calhoun et al. (14) discovered that Ca S enhanced osseous union of the fractured dog mandible. Payne et al. (11) have reported that CS barriers offer great potential for GTR in sites where primary wound closure is challenging. Also, Sottosanti (15,16) has suggested that Ca S may prevent epithelial migration by acting as a resorbable barrier for GTR.

Studies have shown that both allogenic grafts and calcium phosphate ceramics can be successful in treating interproximal periodontal defects (17-20).

Allogenic materials however may present disadvantages such as immunological mediated resorption (21). Although the risk of disease transmission is considerably reduced in demineralized freeze-dried bone allografts, this represents a concern in the clinical use of such materials. (22) Furthermore, there are some questions as to its osteogenic properties. (23)

In a comparative clinical study of porous hydroxyapatite (PHA) and decalcified freeze-dried bone (DFDB) in human periodontal defects, the results have shown a more clinical resolution of interproximal periodontal defects with the use of PHA than with the use of DFDB. (18)

Porous and dense hydroxyapatite and beta-tricalcium phosphates (B-TCP) are biocompatible calcium phosphate ceramics with no organic components, which make them safe materials. They have been used in dentistry for their unique compatibility with alveolar bone (24).

A recent study has suggested that normal osteoconduction and repair occurred in and around the highly bisphosphonats complexed hydroxyapatite (HA) implants in rat tibia. (25) HA has shown good clinical results when used alone (26) or with GTR. (8)

Naturally bovine derived hydroxyapatite (BHA) (osteograft) is a new member of calcium phosphate ceramic material. Along with the advantages of the HA structure, it has been reported as a resorbable material by some investigators. (27) The absence of organic components ensures no local or systemic reaction (28) and a high osseointegration rate associated with bone deposition around it’s particles has been observed. (29)

Thus, the purpose of the present study was to provide a clinical and histological evaluation of calcium sulfate “bone graft barrier” associated with naturally bovine derived Hydroxyapatite (BHA) (osteograft N 300) compared to BHA alone in management of angular defects in adult periodontitis.

MATERIAL AND METHODS

Clinical study on humans

A total of 16 defects where chosen from 10 patients for this study. The patients were chosen on the basis of:

- Having moderate to advanced slowly progressive periodontitis according to the criteria set by AAP (1989) (30)
- Having one or more angular osseous defects with clinical probing depth >6mm.
- Radiographic evidence of osseous defects.
- All periodontally involved patients were systemically healthy and non-smokers, with no antibiotic therapy in the 3 months preceding time of surgery.

Each patient was subjected to a thorough clinical dental examination including:
- Plaque index (PI) (31,32)
- Papillary bleeding index (PBI) (33)
Probing depth (PD) (34)

Clinical attachment level (CAL) (34)

All these clinical measurements were taken prior to surgery and at 3 and 6 months postsurgery in the selected sites.

All patients underwent basic therapy through scaling and root planing with hand and ultrasonic instruments and received oral hygiene instructions. Basic therapy was considered successfully concluded when the plaque index and papillary bleeding index reached a full mouth score of 0.5 or less and a score of 1 or less in selected sites. If trauma from occlusion was present, occlusal adjustment was performed.

The angular defects were divided into two groups:

Group I: comprised 8 angular defects, which were treated with full thickness mucoperiosteal flap and filled with naturally derived bovine hydroxyapatite (BHA) which was covered with a calcium sulfate barrier (Ca S).

Group II: comprised 8 angular defects, which were treated with flap surgery and filled with the BHA only.

Calcium sulfate bone graft barrier “Capset®” is a pre-measured formulation of a medical grade calcium sulfate powder and accelerating diluent solution. (Fig.1) The powder and diluent are combined to form an easily moldable paste, which hardens over the bone graft forming a resorbable barrier “cap”. It is supplied sterile and is available in 1.0 and 2.0 gm applications. Capset bone graft barrier is provided in convenient sterile trays which include a mixing / delivery spatula, premeasured mixing solution and the capset “calcium sulfate” in its own mixing cup. A second cup of reserve calcium sulfate is also provided.

Setting time: It is mixed gently and thoroughly for approximately 60 seconds if a rapid set is desired and for 30 seconds for a slower setting time.

Osteograf / N300® (Fig.2):

It is a pure, natural form of hydroxyapatite. It is manufactured as radiopaque, rounded particles sized between 250-520 microns (40-60 mesh). The particles are supplied in sterile vials.

Application: The desired quantity of osteograf N-300 particles are dispensed into a sterile saline or sterile water to facilitate delivery to the surgical site, using conventional instruments such as curettes or plastic amalgam carriers.

Surgical procedures

Sulcular incisions were initiated after local infiltration anesthesia and full thickness flaps were elevated. Root debridement followed removal of granulation tissue (Fig.5). For group 1 a Calcium sulfate barrier (approximately 1 to 2 mm thick) was placed to cover the graft, barrier margins overlapped defect margins by 2 to 3 mm. (15,16) (Fig.7,8). The gingival flaps were then positioned to cover the implant and sutured.

Group II received the same surgical protocol without the Ca S barrier. Patients were instructed to substitute mechanical oral hygiene measures with chlorohexidine rinse three times daily for four weeks. (35) Tetracycline 250-mg q.i.d. for 7 days was prescribed for each patient. Sutures were removed one-week post surgery. Oral hygiene routines were reinforced.

Experimental study on dogs:

Five adult dogs approximate weight 15 KG were used. The animals exhibited intact dentition and healthy periodontium. 10 defects were surgically induced in the five dogs.

Surgical protocol:

All surgical procedures were performed under intravenous sodium pentobarbital anesthesia. Following sulcular incisions and elevation of buccal and lingual mucoperiosteal flaps, two angular defects were created in each dog in mandibular pre-
molar region using water-cooled rotating burs (Fig.10). The defects were made as similar as possible as regard to intrabony depth and number of osseous walls in the five dogs.

Following bone removal and root planing a reference notch was made on the root surface at the entrance of the defect to allow for comparison of regeneration between two modalities of treatment.

**Fig. (1):** Package of Calcium sulfate bone graft barrier “Capset”

**Fig. (2):** Package of Osteograft N-300

**Fig. (3):** Pre-surgical periapical radiographic film showing an angular defect between upper left first and second molar.

**Fig. (4):** Pre-surgical clinical view showing about a 7-mm pocket depth.

**Fig. (5):** Angular periodontal defect debrided.

**Fig. (6):** 3 mm intrabony component of osseous defect.
Five defects were filled with BHA which was covered with a calcium sulfate barrier (Fig. 11, 12), while the other five were filled with BHA only. The flaps were repositioned and sutured (Fig. 13).

Sutures were removed after 10 days. Postsurgery management included intramuscular administration of antibiotics, soft diet, and daily topical application of 2% chlorhexidine solution for entire healing interval.

Fig. (7): Bovine hydroxyapatite (Osteograf) inserted in osseous defect.

Fig. (8): Calcium sulfate barrier applied over the bone graft material.

Fig. (9): Clinical healing at 6 months post-surgery.

Fig. (10): Clinical view of surgically created two angular defects in left premolar region in a dog.

Fig. (11): Bovine hydroxyapatite (osteograf) inserted in angular defect.

Fig. (12): Calcium sulfate barrier applied over the bone graft material.
Histologic Procedures:

Animals were sacrificed at 3 months post-surgery by intravenous injection of concentrated sodium pentobarbital.

Tissue blocks including teeth, bone and soft tissues were fixed in 10% buffered formaline and decalcified in 10% trichloroacetic acid.

5 um thick serial paraffin sections were cut in a bucco-lingual direction and stained with hematoxyline/eosin and trichrom stain.

RESULTS

Clinical results

Clinical healing was uneventful in both groups. Limited signs of inflammation, swelling or redness were observed.

Plaque and bleeding indices exhibited low scores during the course of treatment and did not present statistically significant differences between the two groups at various periods of follow up (Tables 1,2).

Significant probing depth reduction was observed for both BHA +Ca S group and the BHA group at 3 and 6 months post surgery without statistically significant difference between the two groups at various periods of follow up (Tables 3,4).

Significant clinical attachment gain was observed for both groups at 3 and 6 months post-surgery. There was no statistically significant difference between the groups (Tables 5,6).

Table (1): Range, Mean (± SD) of plaque index In-Group I and group II pre-surgery and 3 and 6 months post-surgery.

<table>
<thead>
<tr>
<th></th>
<th>Group I</th>
<th>Group II</th>
<th>t-test</th>
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<tbody>
<tr>
<td><strong>Pre-surgery</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Range</td>
<td>0.25</td>
<td>0.5</td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>.063 ±17</td>
<td>.125 ±19</td>
<td>.80 NS</td>
</tr>
<tr>
<td><strong>3 months</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Range</td>
<td>0.5</td>
<td>0.75</td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>.219 ±21</td>
<td>.156 ±23</td>
<td>.57 NS</td>
</tr>
<tr>
<td><strong>6 months</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Range</td>
<td>0.5</td>
<td>0.5</td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>.187 ±18</td>
<td>.184 ±22</td>
<td>.01 NS</td>
</tr>
</tbody>
</table>

Group I: treated with Ca S + BHA
Group II: treated with BHA
S.D.: Standard deviation
N.S.: non significant P> 0.05

Table 2: Range, mean (± S.D.) of papillary bleeding index in group I and group II pre-surgery and at 3 and 6 months post-surgery.

<table>
<thead>
<tr>
<th></th>
<th>Group I</th>
<th>Group II</th>
<th>t-test</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pre-surgery</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Range</td>
<td>0.5</td>
<td>1</td>
<td>1.13 NS</td>
</tr>
<tr>
<td>Mean</td>
<td>.063 ±18</td>
<td>.19 ±26</td>
<td></td>
</tr>
<tr>
<td><strong>3 months</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Range</td>
<td>0.5</td>
<td>0.1</td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>.19 ±22</td>
<td>.31 ±37</td>
<td>.82 NS</td>
</tr>
<tr>
<td><strong>6 months</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Range</td>
<td>0.1</td>
<td>0.5</td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>.25 ±27</td>
<td>.44 ±42</td>
<td>1.07 NS</td>
</tr>
</tbody>
</table>

Group I: treated with Ca S + BHA
Group II: treated with BHA
S.D.: Standard deviation
N.S.: non significant P> 0.05
Table 3: Range, mean (±S.D) of probing depth scores in mm in group I and group II pre-surgery and at 3 and 6 months post-surgery.

<table>
<thead>
<tr>
<th></th>
<th>Group I</th>
<th>Group II</th>
<th>t-test</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pre-surgery</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Range</td>
<td>4.5 - 6</td>
<td>4.4 - 6.8</td>
<td>.891 NS</td>
</tr>
<tr>
<td>Mean</td>
<td>5.33</td>
<td>4.9</td>
<td></td>
</tr>
<tr>
<td>S.D.</td>
<td>±.413</td>
<td>±2.18</td>
<td></td>
</tr>
<tr>
<td><strong>3 months</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Range</td>
<td>.75 - 2.5</td>
<td>1 - 2.3</td>
<td>.604 NS</td>
</tr>
<tr>
<td>Mean</td>
<td>1.31</td>
<td>1.47</td>
<td></td>
</tr>
<tr>
<td>S.D.</td>
<td>±.59</td>
<td>±.46</td>
<td></td>
</tr>
<tr>
<td><strong>6 months</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Range</td>
<td>.25 - 1.25</td>
<td>.42 - 2</td>
<td>1.7 NS</td>
</tr>
<tr>
<td>Mean</td>
<td>.719</td>
<td>1.14</td>
<td></td>
</tr>
<tr>
<td>S.D.</td>
<td>±.41</td>
<td>±.57</td>
<td></td>
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</tbody>
</table>

Group I: treated with CS + BHA
Group II: treated with BHA
S.D.: Standard deviation
N.S.: non significant P>0.05

Table 4: Paired t-test of probing depth between baseline and different follow up periods in both groups.

<table>
<thead>
<tr>
<th></th>
<th>Baseline / 3 months</th>
<th>Baseline / 6 months</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group I</td>
<td>12.7*</td>
<td>22.8*</td>
</tr>
<tr>
<td>Group II</td>
<td>4.45*</td>
<td>4.66*</td>
</tr>
</tbody>
</table>

Group I: treated with Ca S + BHA
Group II: treated with BHA
* : Significant P< 0.05

Table (7) shows the percentage change of probing depth and clinical attachment gain between their preoperative and postoperative values at 6 months. The results were in favor of group I.

**Histologic observations**

In-group I, where the angular defects were treated with BHA+CaS, it demonstrated considerable evidence of periodontal regeneration (Fig. 14,15).

Table 5: Range, mean (±SD) of loss of attachment in mm in group I and group II pre-surgery and at 3 and 6 months post-surgery.

<table>
<thead>
<tr>
<th></th>
<th>Group I</th>
<th>Group II</th>
<th>t-test</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pre-surgery</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Range</td>
<td>4.25 - 7.5</td>
<td>3.35 - 7.70</td>
<td>4.02 NS</td>
</tr>
<tr>
<td>Mean</td>
<td>5.11</td>
<td>5.43</td>
<td></td>
</tr>
<tr>
<td>S.D.</td>
<td>±1.11</td>
<td>±1.90</td>
<td></td>
</tr>
<tr>
<td><strong>3 months</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Range</td>
<td>.25 - 3.5</td>
<td>.25 - 3.7</td>
<td>.887 NS</td>
</tr>
<tr>
<td>Mean</td>
<td>1</td>
<td>1.5</td>
<td></td>
</tr>
<tr>
<td>S.D.</td>
<td>±1.09</td>
<td>±1.35</td>
<td></td>
</tr>
<tr>
<td><strong>6 months</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Range</td>
<td>.25 - 3</td>
<td>.08 - 2.8</td>
<td>1.5 NS</td>
</tr>
<tr>
<td>Mean</td>
<td>.687</td>
<td>1.45</td>
<td></td>
</tr>
<tr>
<td>S.D.</td>
<td>±.952</td>
<td>±1.07</td>
<td></td>
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</table>

Group I: treated with Ca S + BHA
Group II: treated with BHA
S.D.: Standard deviation
N.S.: non significant P>0.05

Table 6: Paired t-test of loss of attachment level between baseline and different follow up periods in both groups.

<table>
<thead>
<tr>
<th></th>
<th>Baseline / 3 months</th>
<th>Baseline / 6 months</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group I</td>
<td>17.2*</td>
<td>20.3*</td>
</tr>
<tr>
<td>Group II</td>
<td>16.4*</td>
<td>11.9*</td>
</tr>
</tbody>
</table>

Group I: treated with Ca S + BHA
Group II: treated with BHA
*: Significant P< 0.05

Table 7: Percentage of change in probing depth and attachment level in group I and group II at 6 months post-surgery.

<table>
<thead>
<tr>
<th></th>
<th>Group I</th>
<th>Group II</th>
</tr>
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<tbody>
<tr>
<td>Percentage of change of PD</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Range</td>
<td>77.7-95.3%</td>
<td>70 - 91 %</td>
</tr>
<tr>
<td>Mean</td>
<td>86.4 %</td>
<td>80.2 %</td>
</tr>
<tr>
<td>SD</td>
<td>± 7.7</td>
<td>± 8.78</td>
</tr>
<tr>
<td>Percentage of change of attachment level</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Range</td>
<td>12% - 95%</td>
<td>63 - 97 %</td>
</tr>
<tr>
<td>Mean</td>
<td>79.5 %</td>
<td>76.3 %</td>
</tr>
<tr>
<td>SD</td>
<td>±29.8</td>
<td>±13.4 %</td>
</tr>
</tbody>
</table>
Fig. (14): Bucco-lingual section of group I (BHA+ Ca S) 3 months post-surgery illustrating considerable amount of periodontal regeneration. Note the coronal position of the reference notch (N) at the entrance of the osseous defect. H&E (X 100)

Fig. (15): Higher magnification at the apical area of the notch (N) showing filling the osseous defect (D) with new reparative bone (RB), immature connective tissue fibers and new cellular cementum formation (C). H&E (X 200)

Fig. (16): A higher magnification of the defect and notch area seen in Figure 15 exhibiting intense proliferation of an immature, loose, and deeply vascularized connective tissue with moderate degree of inflammation. H&E (X 400)

Fig. (17): Bucco-lingual section of group I (BHA+ Ca S) at the osseous defect area showing newly deposited cementum and highly vascular perpendicular oriented periodontal fibers. Note almost complete obliteration of the osseous defect with reparative alveolar bone. Trichrome stain (X 200)

Fig. (18): Bucco-lingual section of group II (BHA) showing little manifestations of periodontal regeneration. There is a minimal bone formation apical to the notch and diisorientation of the connective tissue fibers. H&E (X200)

Fig. (19): Higher magnification at the defect area showing apical migration of the junctional epithelium below the reference notch (N) with little cementogenesis and osteogenesis. H&E (X 400)
Group I

The CaS barriers were incorporated with the surrounding connective tissue. The newly attached connective tissue fibers exhibited fibrillar, highly vascular, dense, deeply staining with irregular or perpendicular orientation along the root surface opposite to the surgical defect. There was a moderate degree of inflammation (Fig. 15, 16).

Newly regenerated bone had almost completely filled the previous periodontal defect leading to an increase in the alveolar crest height. This new bone has the characteristics of a dense, lamellar bone with osteocytes embedded throughout exhibiting a mature physiologic form. A new layer of newly deposited cellular cementum was observed along the defect root surface with inserting collagen fibers in the apical part of the defect. (Fig. 17)

As regard to the defects treated with BHA only, the angular osseous defects revealed little evidence of osteogenesis. There was only a small amount of reparative bone formation in the most apical portion of the defect. Accordingly, the distance between the crest of the alveolar bone and the reference notch was large. New cementum formation was limited and extended coronal for a short distance with inserting of few, thin collagen fibers. Most of the fibers were observed aligned parallel to the root surface in disorganized form with apical migration of the junctional epithelium. (Fig. 18, 19)

DISCUSSION

The potential to regenerate lost periodontal tissues has been an area of considerable interest to periodontists for many years. Examples of current periodontal regenerative therapies include bone grafts and guided tissue regeneration.

In this study, we evaluate the clinical and histologic outcome following the use of calcium sulfate "bone graft barrier" (CaS) associated with naturally bovine derived hydroxyapatite (BHA) compared to hydroxyapatite alone in management of angular defects in adult periodontitis.

A six month post-surgery observation interval was chosen since previous studies have reported that most tissue changes following surgical therapy (38) will occur within 6 months of therapy.

The clinical results of the present study showed that plaque and bleeding indices exhibited reduced scores during the course of treatment and did not present statistically significant differences between two groups at various periods of follow up. This may be due to the constant patients plaque control through out the study period. It appears that the reduced plaque index was associated with a decrease in gingival inflammation as manifested by the reduced papillary bleeding scores through out the follow up period. Also, this reduced bleeding at post-surgical observations may due to proper healing and tissue maturation following therapy.

In the present study, both of the approaches CaS +BHA, and BHA alone showed significant probing depth reduction, significant clinical attachment gain at 3 and 6 months post-surgery, however no significant difference between both groups was observed.

The clinical results of the present study with respect to the adjunctive affect of bone graft to GTR are in agreement with other studies (8,35,40-44) which reported significant improvements in probing depth, clinical attachment level and probing bone level from pre to post-surgery observations.

Concerning surgical implantation of BHA alone in group two, a similar magnitude of clinical improvements was reported in management of intrabony periodontal defects following surgical implantation of calcium carbonate (40,43), hydroxyapatite (44) or demineralized bone matrix.

On comparing both groups, although no significant difference was observed, it is of interest to note that clinical improvement was in favor of CaS +BHA group. It appears that CaS might have provided a stable barrier to graft material migration, thus BHA acted as a space marker creating a biologic environment, which favor clot stabilization and bone growth.

These findings are in accordance with Kilic (46) who reported that the adjunctive effect of hydroxyapatite-collagen graft (HAC) to GTR (e-PTFE) lead to more attachment gain and bone fill than did HAC or conventional flap surgery alone, however on comparison between his studied groups.
the difference did not reach statistical significance. Also these findings are in line with the results of other investigators (35,41) who have not found significant differences on comparing combined treatment to guided tissue regeneration alone or bone implants alone.

Evaluation of reconstructive periodontal therapy most often includes clinical and radiographic recordings, however only histologic assessments may ascertain whether periodontal regeneration actually occurred. (47)

In the present study healing of human defects following surgical therapy was not evaluated by histological methods but by periodontal attachment level measurements, thus the question remains whether or to what extent, improved clinical parameters represent actual regeneration of the periodontal attachment.

It is increasingly evident that controlled preclinical models with reproducible defect characteristics and biologic reaction are critical for evaluation of tissue reaction and biologic potential (safety and potential) of periodontal reconstructive protocols (48). The experimental model in the present study was used to compare the regenerative potential of BHA+CaS and BHA alone in induced angular defects.

The light microscopic observations revealed that all angular defects treated by BHA+CaS healed with connective tissue interfacing the root surface. Several studies (49,50) have suggested that 3 wall intrabony defects may provide wound stability for uneventful maturation of a connective tissue attachment to the root surface rather than epithelization of root gingival interface.

The histologic findings demonstrated that defects treated with BHA+CaS exhibited enhanced formation of alveolar bone and cementum. These findings are in accordance with those of Kim (51) who found statistically significant regeneration of alveolar bone and cementum following implantation of DBM+CS composite with a CS barrier in deep 3 wall intrabony defects in dogs.

Cementum regeneration was observed as a continuous cellular layer of varying thickness from the base of all defects, which received BHA+CaS. A fibrous attachment bridging the gap between bone and cementum was evident in most specimens. These findings are in accordance with previous reports showing extensive cementum regeneration at 8 to 12 weeks post-surgery in similar preclinical models (52,53).

Concerning defects treated by BH alone, histologic findings revealed healing by a long junctional epithelium. The epithelium extended apically at various degrees depending on the position of the serial sections. In the point where the junctional epithelium terminated there were connective tissue fiber bundles running diagonally from the cementum to alveolar crest. It is possible that this connective attachment is rather reattachment than a new attachment. Col et al (54) were able to exclude from measurement attachment that part of root surface at the deep end of the defect which might only show reattachment rather than new attachment.

In the present study, in which only descriptive histology was carried out the reference notch was not placed apically because this might be an area of reattachment rather a new attachment. We considered new attachment to occur when new bone and new periodontal tissue fibers attaching bone to cementum occurred in the defects.

Microscopic examination of root in sites which received BHA only, revealed a limited layer of cementum. Also limited bone formation was noticed in these sites.

These observations are consistent with the findings of other investigators (55,56) who failed to demonstrate the regenerative potential of HA. The suppressed alveolar regeneration could be an effect of the implanted material merely acting as physical obstacles to coronal bone growth or as a result of an inflammatory reaction around the graft or both. (57)

In contrast, published human histologic observations demonstrated increase bone mass when nonporous HA particles were place in vertical defects. (58,59)


52. Sigurdsson TJ, Hardwick R, Bogle GC, Wikesjo UME.


55. Stahl SS, Froum SJ. Histologic and clinical responses to porous hydroxyapatite implants in human periodontal defects. 3 to 12 months post implantation. J Periodontol 1987; 8: 689


