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Comparison of Bioactive glass-hydroxyapatite alone and in combination with Autogenous bone particulate in the management of periodontal defects

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Abstract. Treatment of periodontal defects with bone grafts has shown promise towards achieving true regeneration. This clinical study evaluated the use of a bioactive glass – hydroxyapatite graft alone and with autogenous bone graft on 10 patients with bilateral defects. There was significant probing depth reduction and bone fill six months post-surgery in both groups. Autogenous bone yielded only marginal benefit over the synthetic bone composite.

Keywords: Bioactive glass, hydroxyapatite, autogenous bone graft, periodontal defects

1. Introduction

Gum disease or "periodontitis" is one of the most common diseases known to man. It is associated with loss of supporting tissues of the tooth, manifested usually by a soft tissue pocket and vertical loss of bone. These "infrabony" defects interfere with disease elimination and maintenance of oral hygiene. Complete regeneration of such lost tissue still remains elusive. Good results in the treatment of periodontal bone loss have been obtained using bone grafts (Bayerlein et al, 2006)[1]. Bone graft placement supports soft tissue walls of the defect and results in gain in clinical attachment level thereby facilitating regeneration of periodontal structures lost during the disease process.

Autogenous bone grafts, obtained from the host, are considered a gold standard as they possess bone formation properties namely, osteogenesis, osteoinduction and osteoconduction (Mazock et al, 2004)[2]. These grafts can be cancellous, cortical or combined. Cortical grafts in particulate form, can be harvested from intraoral sites with less invasive methods (e.g., by using bone scrapers) and result in significantly less donor site morbidity. However, only a small quantity of autogenous cortical bone particulate (ACBP) can be harvested limiting their use in clinical practice (Kim et al, 2005)[3].

Newer synthetic materials (alloplasts) like bioactive glass have exhibited osteopromotive property. It may be hypothesized that combining different alloplastic materials may provide additional benefits. One such graft material, Grabio-Glascera, which combines Bioactive Glass and Synthetic Hydroxyapatite (HABG) has been shown to result in good bone fill in osseous defects (Godfrey S, 2003)[4].

Concurrently, a combination of autogenous bone and alloplastic material together may overcome the problems of limited volume, rapid rate of resorption as well as inferior biological properties respectively. Hence, an attempt was made to compare the effect of a combination of ACBP-HABG as against HABG alone in the management of periodontal osseous defects by assessing clinical and radiographic parameters over a period of six months.

2. Materials and Methods

The study was carried out on two segments of the mouth receiving either of the two graft materials (split mouth design) and followed up for 6 months. 10 subjects (eight males and two females between 23-50 years

of age) diagnosed as having chronic periodontitis with bilateral infrabony defects, were included in the study. The surgical sites were randomly allocated as test and control sites. Flaps were raised with defects on the control side receiving HABG alone [Group A] whereas a combination of ACBP+HABG (1:1) [Group B] was used on the test side.

Autogenous cortical bone particulate (ACBP) was harvested from cortical plates adjacent to the area of defect without exposing a second surgical site. The graft was harvested using the indigenously designed bone scraper. Ribbon-like shavings of the cortical bone were collected in the collection chamber of the instrument. (Fig. 1)

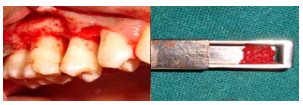

Fig. 1: Autogenous Cortical Bone Particulate

Fig. 2: HABG (Grabio Glascera)

The control, Grabio-Glascera™, i.e. bioactive ceramic composite granules (Dorthom Medi Dents Ltd, India), composed of 50% Bioactive Glass and 50% Synthetic hydroxyapatite (HABG) was used along with ACBP. It is a resorbable synthetic porous ceramic granular graft, with particle size in the range of 150-500 microns and pore size range of 100-200 microns. This new generation composite bioactive material contains Si, Ca and P made through a non-conventional processing method - 'the sol-gel process' (Abhiraman et al, 2002)[5]. (Fig. 2)

Customized acrylic occlusal stents were prepared on study casts of all the patients. The lower border of the stent was used as a reference point to take soft tissue measurements of probing attachment level, reduction in probing depth and gingival recession with a periodontal probe at baseline, 3rd and 6th month visits. Standardized radiographs were taken and the following radiographic measurements were recorded at baseline and 6 months post-surgery: Distance from cemento-enamel junction to bottom of the defect (CEJ to BD), Distance from cemento-enamel junction to the alveolar crest (CEJ to AC) and Infrabony component (DEPTH) = CEJ to BD – CEJ to AC. Defect Angle was measured using image analysis software (Scion Image). (Fig. 3)

The radiographic defect angle was defined by the two lines that represent the root surface of the involved tooth and the bone defect surface, as described by Steffensen & Weber (1989)[6].

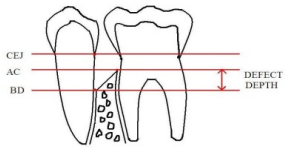

Fig. 3: Illustration of radiographic landmarks

3. Results and discussion

The difference between the two groups, A and B, was tested by paired samples T test and repeated measures of ANOVA was used to test the changes in parameters within groups using SPSS 11.5.

An attempt was also made to find out the influence of the radiographic defect angle and the number of walls of the defect on the percentage of radiographic bone fill, by using Independent samples T test. The defects were divided into narrow (< 37.23°) and wide (> 37.23°) angled defects. The median value, 37.23°, was calculated from the radiographic measurements of all the 20 sites.

10 defects in Group A were filled with bioactive glass - hydroxyapatite granules (HABG/Grabio Glascera) and 10 contralateral defects in Group B were filled with a mixture of autogenous cortical bone particulate (ACBP) and bioactive glass-synthetic hydroxyapatite (HABG) granules. 3 and 6 months post-operatively, the pocket depth had reduced considerably [3.6 mm in Group A vs 3.9 mm in Group B] with good attachment gain and radiographic evidence of bone fill at all grafted sites.

Group A showed probing depth reduction similar to Zamet et al, (1997)[7] who used bioactive glass over a one year study period. Orsini et al, (2008)[8] obtained 4.3 mm probing depth reduction in a study using resorbable barrier membranes along with ACBP, which may be comparable to Group B. However, comparison between the groups showed no statistically significant difference [Table 1].

Table 1: Inter-Group comparison of soft tissue parameters

	BASELINE					3 MONTHS					6 MONTHS				
	Gr A	Gr B	t value	'p' value		Gr. A	Gr. B	t value	'p' value		Gr. A	Gr. B	t value	'p' value	
PAL GAIN mean	7	7.4	0.937	0.373	NS	3.4	3.6	0.480	0.642	NS	3.6	3.7	0.287	0.780	NS
PD mean	6.3	6.6	0.635	0.541	NS	2.7	2.7	0.000	1	NS	2.7	2.7	0.000	1	NS
GR mean	0.7	0.8	0.287	0.780	NS	0.9	0.9	0.000	1	NS	0.9	1	0.318	0.758	NS

The mean gingival recession observed was 0.9 mm and 1.0 mm in Groups A and B respectively [Table 1] which may be a consequence of the shrinkage of lateral wall of pockets post-surgically. This is comparable to a study by Leknes et al (2009)[9] who reported mean gingival recession of 1mm six months following placement of PerioGlas in 13 intrabony defects.

The attachment gain obtained with HABG alone was 3.6 mm, in contrast to 3.7 mm with ACBP-HABG combination, which was again not statistically significant [Table 1]. Froum et al. (1998)[10] reported a comparable mean attachment gain of 3.31 ± 0.26 mm using bioactive glass.

Osseous defects treated with HABG (Grabio-Glascera), in the present study showed a mean defect fill of 3.75mm (74.57%) at 6 months [Table 2] which was statistically significant and better than previous reports using bioactive glass.[10] The superior results of our study could be because of the additional constituent in Grabio-Glascera i.e., Hydroxyapatite, which is a slow resorbing material and results in good bone fill. In Group B, 10 defects were filled with a combination of autogenous cortical bone particulate and HABG, which resulted in 4.03 mm (76.68 %) mean bone fill, which was statistically significant. Guida et al. (2007)[11] showed similar results with 4.3 mm defect depth reduction at the end of one year following the use of ACBP and enamel matrix derivative in 14 intraosseous defects.

Table 2: Inter-group comparisons of Percentage of bone fill at 6 months

	Group A	Group B	t value	p value	Significance
Percentage Bone Fill	74.57 ± 14.37	76.68 ± 14.61	0.405	0.695	NS

Defects that were filled by combination of ACBP and HABG showed slightly more bone fill than those filled by HABG alone. This could be explained by the presence of osteogenic and osteoinductive potential of the autogenous cortical bone particulate in Group B. However, there was no statistically significant difference in radiographic bone fill between the two groups at the end of six months [Table 2].

Linear radiographic measurements provide a two-dimensional perspective for evaluating bone height changes in the defect area. However, computer assisted techniques have been proposed to improve the ability to detect the alveolar bone level (Benn, 1992)[12]. Hence, image analysis software (Scion Image) was used in the present study for recording measurements on the digitized radiographs.

It has been stated that characteristics of infrabony defects may reflect the differences in clinical outcomes after periodontal therapy (Kornman and Robertson, 2000)[13]. In the present study, irrespective of graft material placed, the mean percentage bone fill in narrow angled defects (< 37.23°) was 81.7 in contrast to 65.55 in wide angled (> 37.23°) defects. It was observed that there was more bone fill in narrow angled defects, though this was statistically insignificant, probably due to small sample size. A similar correlation has been described by Steffensen and Weber, 1989[6], where greater potential for bone fill was found in defects with small angles (0–45°) compared with wide angles (45–90°).

Kim et al, (2004)[14] stated that the healing of the intrabony defects appears to be dependent on the number of bone walls. Greater number of defect walls will increase tissue resources from the periodontal ligament, which critically contributes to periodontal regeneration in addition to increasing wound stability during early wound healing and allowing uneventful maturation of the tooth-gingival flap interface. In the present study, the mean percentage bone fill in 3 wall defects (84.28) was greater than in 2 wall defects (69.85). This was statistically significant ($p < 0.05$).

The present study attempted to determine if there was any advantage of adding ACBP to the alloplast (HABG) for treatment of infrabony periodontal defects. The combination of ACBP-HABG showed marginally better results over HABG alone, with no statistically significant differences in any of the clinical or radiographic parameters tested. A plausible explanation could be that an autograft, when mixed with any other bone substitute material, is isolated farther away from any initial source of blood vessels. As a consequence it may not remain vital. Although the release of growth factors, space maintenance, and a calcium source are still of benefit, the primary advantage of osteogenesis is lost when the autogenous bone is mixed with other graft materials (Misch et al, 2008)[15].

Similar studies by other investigators on autogenous bone graft have shown varying results. When compared with Freeze dried bone allograft, a composite of Freeze dried allograft and autogenous grafts offered significantly improved results in osseous regeneration and pocket reduction, especially in combined one / 2 wall defects and furcation involvements.[16] Orsini et al in 2001 compared autologous bone plus calcium sulfate with autologous bone plus membrane and found neither treatment was superior to the other.[17] Cochran DL et al (2003) showed that combining enamel matrix derivative with autogenous bone graft stimulated significant regeneration in narrow lesions compared to wider lesions.[18]

4. Conclusions

The following conclusions can be drawn from the study.

- Clinically, all the treated sites showed remarkable gain in probing attachment levels and probing depth reduction at 3 and 6 months. This improvement was however not statistically different between the groups.
- All the grafted sites showed substantial radiographic bone fill at 6 months. Between groups comparison also did not show any statistical difference.
- The use of ACBP in addition to HABG appears to provide only marginal benefits over use of HABG alone in terms of attachment gain, probing depth reduction and radiographic bone fill of infrabony defects.
- The number of bony walls is a good predictor of treatment outcomes in infrabony periodontal defects, with 3 walled defects showing greater radiographic bone fill than 2 walled defects.

Although studies have been conducted using bioactive graft material, the present study is unique in that a combination of bioactive and autogenous graft has been tried. Results of the present investigation have shown potential for use of combination of autogenous cortical bone particulate and alloplast, especially in terms of clinical improvement. Long term follow up may be required to ascertain definite radiographic changes. Autogenous grafts may therefore be recommended in the management of osseous defects requiring osseous recontouring, in addition to regenerative osseous surgery, considering the availability of viable bone particulate in such areas, which may otherwise be discarded.

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