Evaluation of Autogenous Cortical Bone Particulate with Bioactive Glass-Synthetic Hydroxyapatite in Treatment of Periodontal Bone Defects

A. Bhide, Pratibha P. K., and G. S. Bhat

Abstract—**This study evaluated the effect of combining autogenous bone with synthetic bioactive glass – hydroxyapatite in the treatment of vertical periodontal defects. Ten subjects with chronic periodontitis were treated in a split mouth design with either a combination of bioactive glass – hydroxyapatite and autogenous bone or bioactive glass– hydroxyapatite alone. Clinical and radiographic parameters showed significant improvement within groups in the soft and hard tissue parameters assessed at six months. However, there was no statistically significant difference between the groups. Only marginal benefits were observed on addition of autogenous bone to the synthetic graft.**

Index Terms—**Autogenous cortical bone particulate, bioactive glass, periodontal defects, chronic periodontitis.**

I. Introduction

Periodontitis or 'gum disease' is a widely prevalent disease of the mouth affecting nearly 5 – 20% of most adult populations across the world [1-2]. It is associated with loss of supporting tissues of the tooth, manifested usually by a soft tissue pocket and vertical loss of bone. Severe periodontitis may eventually result in tooth loss.

Good results in the treatment of periodontal bone loss have been obtained using bone grafts [3]. Bone graft placement supports soft tissue walls of the defect, results in clinical attachment gain and regeneration of periodontal structures lost during the disease process.

Of the available bone graft materials, autogenous bone grafts, obtained from the host, are considered a gold standard as they possess desirable properties of bone formation such as osteogenesis, osteoinduction and osteoconduction [4]. These grafts can be cancellous or cortical depending on their source. Cortical origin of the graft makes it excellent for osteoinduction [5]. Cortical grafts, in particulate form, can be adapted to the site being reconstructed. This also increases the density of the graft and enhances the rate of graft healing. This graft may be harvested from within the mouth and thus a second distant surgical site and the extraoral scar can be avoided. However, only a small quantity of autogenous cortical bone particulate (ACBP) can be harvested, which may resorb quickly thus limiting its use in clinical practice [6].

Various synthetic bone substitutes in use, such as tricalcium phosphate, hydroxyapatite, HTR polymer etc. are osteoconductive, acting merely as scaffolds for bone growth. Lately, 'bioactive glass', a new graft material has shown promising results due to its osteopromotive property. These different alloplastic materials when used in combination provide additional benefit in terms of volume fill. One such graft material is Grabio-Glascera TM, which combines bioactive glass and synthetic hydroxyapatite (HABG). Grabio-GlasceraTM (Dorthom Medi Dents Ltd, India), is composed of 50% Bioactive Glass and 50% Synthetic hydroxyapatite. It is a resorbable, porous, granular graft with particle size in the range of 150-500 microns and a pore size range of 100-200 microns. This composite ceramic material contains Si, Ca and P made through a non-conventional processing method - 'the sol-gel process.'

It was hypothesized that the limitations of less volume and rapid resorption associated with autogenous cortical bone (ACBP) could be overcome by combining it with Grabio-Glascera TM. Hence, the present study was conducted to compare the effect of a combination of ACBP-HABG as against HABG alone in the treatment of periodontal defects by assessing clinical and radiographic parameters over a period of six months.

II. Materials and Methods

Institutional ethics committee approval was obtained prior to commencement of the study. The study was carried out on 10 subjects (eight males and two females between 23-50 years of age) diagnosed as having chronic periodontitis with bilateral vertical bone defects. All patients were subjected to an initial preparatory phase of periodontal treatment which included removal of etiologic factors and oral hygiene instructions. A split mouth design was followed where two segments of the mouth received either of the two graft materials and followed up for 6 months.

Initially, study casts of all the patients were prepared and customized acrylic stents were fabricated on them in the areas of interest. The lower border of the stent was used as a reference point to take soft tissue measurements (Fig. 1). The same stent was preserved for reproducing measurements post-operatively at the 3rd and 6th months.

Standardized radiographs were taken and the following

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radiographic measurements were recorded at baseline and 6 months following treatment (Fig. 2): 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. The defect angle was also measured using an image analysis software, 'scion image' (Scion corporation, Frederick, USA).

Following local anaesthesia, a surgical flap was raised on one segment of the mouth (Fig. 3). Complete debridement of bone defects was done using curettes. The defects were then filled with a combination of autogenous bone and an equal amount of HABG [Group B] (Fig. 5).

Autogenous bone particulate was harvested using an indigenously designed bone scraper from the cortical plates adjacent to the defect area (Fig. 4). There are different methods of harvesting bone grafts such as use of chisels, osteotomes, files, trephines, burs, bone rongeurs etc. However, a bone scraper may harvest bone in a less aggressive manner. This is a hand held instrument with a blade, hollow body with cavity bone collector and slidable closure. Ribbon-like shavings are thus planed from the cortical surface of bone, collected and then directly delivered to the recipient site. Histological examination of the bone particulate was also carried out immediately after harvesting the bone.

The second surgery was carried out on the contra-lateral side after 2 weeks. Here, following flap debridement, the defect site was filled with bioactive glass – synthetic hydroxyapatite [Grabio Glascera] alone. Patients were kept on antibiotic cover for a week and followed up at 3 and 6 months.

Figures

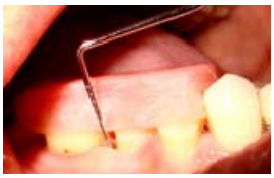

Fig. 1. Customized stent

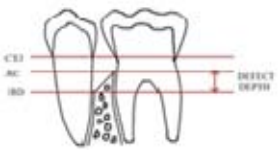

Fig. 2. Radiographic measurements

Fig. 3. Bone defect adjacent to premolar

Fig. 4. Harvesting autogenous bone

Fig. 5. Autogenous bone with HABG

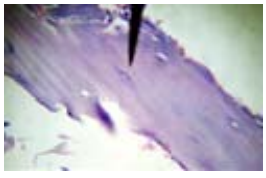

Fig. 6. Osteocytes within lacunae

III. Results and Discussion

At the end of the study period, all surgical sites healed without any untoward reactions or patient discomfort. Examination of the autogenous bone particulate under the light microscope showed nucleated osteocytes in the lacunae indicating viability of the graft (Fig. 6).

Gruber in an in vitro study observed that the cells in the graft which survive the harvesting procedure can develop an osteogenic phenotype and express the markers of early and late osteoblast differentiation, such as alkaline phosphatase and osteocalcin. Thus, irrespective of the preparation technique, cortical bone grafts from the maxilla and the mandible hold cells having ability to proliferate and differentiate into the osteogenic lineage in response to local stimuli that are present at sites of bone repair [7].

SPSS version 11.5 was used to analyze the results. Repeated measures of ANOVA were used to test the changes in clinical and radiographic parameters within groups. The differences between the two groups were verified by paired samples T test.

A. Results for Soft Tissue Parameters

Clinically, there was significant reduction in probing depth and attachment gain at the end of 6 months. In Group A, the pocket depth decreased from 6.3 mm to 2.7 mm at 3 months and remained the same at 6 months. In Group B, the mean probing depth decreased from 6.6 mm to 2.7 mm in 3 months. A comparison of probing depth reduction between two groups did not show any statistically significant difference. A mean attachment gain of 3.6 mm was observed in Group A. In Group B, attachment gain was 3.7 mm at the end of 6 months, which was statistically significant ($p < 0.05$). However, comparison between the attachment gain obtained in Group A and B did not show statistically significant difference. In Group A, the gingival recession was 0.9 mm at 6 months whereas, in Group B, the gingival recession observed was 1 mm. (TABLE I)

Similar studies by other investigators on autogenous bone graft have shown varying results. Orsini in a study on ACBP used along with resorbable barrier membranes obtained 4.3 mm probing depth reduction [8]. 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 [9]. Orsini in 2001 compared autologous bone plus calcium sulfate with autologous bone plus membrane and found neither treatment was superior to the other [10].

Zamet reported a mean probing depth reduction of 3.6 mm 3 months post-operatively with the use of bioactive glass [11]. Froum reported a comparable mean attachment gain of 3.31 ± 0.26 mm using bioactive glass [12].

Leknes (2009) reported mean gingival recession of 1mm six months following placement of PerioGlas in 13 intrabony defects [13]. In our study, more recession was evident in sites with autogenous bone due to greater flap reflection required to retrieve autogenous bone graft.

TABLE I: 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

TABLE II: COMPARISON OF RADIOGRAPHIC PARAMETERS

		Baseline	6 months	Difference	p value	Significance
CEJ-BD mean	Group A	8.58 ± 2.13	4.65 ± 1.26	3.75 ± 1.01	$p < 0.05$	S
	Group B	8.8 ± 2.21	4.54 ± 1.81	4.03 ± 1.36	$p < 0.05$	S

A. Results for Radiographic Parameters

Substantial bone fill was observed at the end of 6 months in both the groups. In Group A, the mean amount of bone fill was 3.75 mm whereas in Group B, the mean amount of bone fill was 4.03 mm (TABLE II).

The percentage of bone fill was 74.57% in Group A as compared to 76.68 % in group B. The bone fill in Group B (ACBP + HABG) was slightly more than that obtained by bioactive glass alone. This could be explained by the presence of osteogenic and osteoinductive potential of the autogenous cortical bone. In the bioactive glass group, the mean bone fill in the present study was better than previous reports using bioactive glass. Fox and Rosenberg showed only 1.75 mm of mean defect fill with bioactive glass [14]. The superior results in the present study could be because of the additional constituent in Grabio-Glascera i.e. Hydroxyapatite, which is a slow resorbing material.

In the present study, there were 10 narrow (< 37.23°) and 10 wide (> 37.23°) angled defects. The value, 37.23° was the median of all the 20 defect angle values. Irrespective of the type of graft placed, the mean percentage of bone fill in narrow angled defects was 81.7 % (±12.17) and that in wide angled defects was 65.55% (±13.87). Though there was greater bone fill in narrow angled defects, it was not statistically significant. These results are comparable with studies by other investigators. A correlation between radiographic bone fill and the corresponding pre-treatment defect angles has been described previously, where greater potential for bone fill was found in defects with small angles(0–45°) compared with wide angles (45–90°) [15]. Cochran DL (2003) showed that combining enamel matrix derivative with autogenous bone graft stimulated significant regeneration in narrow lesions compared to wider lesions [16].

Of the 20 sites treated, 12 defects were 2 walled and the rest 3 walled. Mean percentage defect fill in the 3 - walled defects was 84.28% (±11.80), which was greater than that in 2-walled defects, 69.85% (±12.88). This difference was found to be statistically significant ($p<0.05$).

Kim in 2004 first stated that the healing of the intrabony defects appears to be dependent on the number of bone walls [17]. An increasing number of defect walls will increase tissue resources from the periodontal ligament, which critically contributes to periodontal regeneration. At the same time, it also increases wound stability during early wound healing, allowing uneventful maturation of the tooth-gingival flap interface.

It was hypothesized that the osteogenic and osteoinductive properties of Autogenous bone and novel combination of BioGlass and HA would provide synergistic reconstructive effect resulting in superior treatment outcomes. The combination showed marginally better results over bioglass alone with no significant differences in any of the clinical or radiographic parameters tested. This could be explained due to the fact 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 [18].

IV. CONCLUSIONS

The following conclusions can be drawn from this study.

1. All the treated sites showed remarkable gain in probing attachment levels and probing depth reduction at 3 and 6 months with substantial radiographic bone fill.

2. 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 periodontal defects.

3. The number of bony walls is a good predictor of treatment outcomes in vertical periodontal defects, with 3 walled defects showing greater radiographic bone fill than 2 walled defects.

4. The combination of autogenous cortical bone particulate and bioactive glass in the present study has shown encouraging results in terms of clinical improvement. Thus, combining the ACBP with other bone substitutes compensates for the inferior properties of the individual graft materials.

5. The indigenously designed bone scraper is a useful device for bone harvesting procedures during routine

periodontal surgery.

Although studies have been conducted using bioactive graft material, the present study is unique in that a novel combination of bioactive glass and autogenous bone particulate has been tried. This modality of treatment may be recommended in selected cases where the management of osseous defects requires osseous recontouring, considering the availability of viable bone particulate in such areas, which may otherwise be discarded.

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