

RESEARCH

EFFICACY OF CERAMIC POROUS HYDROXYAPATITE AND PLATELET RICH PLASMA IN THE TREATMENT OF INTRABONY PERIODONTAL DEFECTS: A COMPARATIVE RANDOMIZED CLINICAL AND RADIOGRAPHIC STUDY

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ABSTRACT

Periodontal regeneration is no longer an enigma but now a reality and hence the challenge of periodontal regeneration has come to forefront of research and practice. The aim of the present clinical study was to assess the regenerative potential of porous hydroxyapatite bone graft verses platelet rich plasma, in comparison with open flap debridement in treatment of periodontal intrabony defects. In this study about 30 periodontal intrabony defects in 10 patients, between the age group of 25- 45 were randomly divided into three groups viz., Group-A open flap debridement; group-B bone graft; group-C platelet rich plasma and followed up for a period of 6-months. The clinical and radiographic parameters were assessed in each group at baseline, 3-months and 6-months period. A statistically significant improvement in clinical parameters was observed from baseline to six month treatment period in all the three groups. The observed mean probing pocket depth at 6-months was 5.28 mm for group-A, 4.98 for group-B and 4.36 mm for group-C which was found to be statistically significant [$p < 0.05$] while clinical attachment level were found to be 5.34 mm for group-A, 5.3 mm for group-B and 4.42 mm for group-C, Further, the percentage of radiographic resolution of the defect was found to be 40.8, 66.18 and 46.37% for groups A, B and C respectively. Thus bone grafting was found to be a better treatment modality when compared to open flap debridement and platelet rich plasma alone in treating periodontal intrabony defects.

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INTRODUCTION

Periodontitis is a chronic infective disease of the periodontium caused by bacteria present in dental plaque. It is one of the most prevalent afflictions found worldwide and is the major cause of tooth morbidity and mortality [1-2]. This condition induces the breakdown of the tooth supporting apparatus until teeth are lost. In recent years, several surgical techniques have been suggested as an option to regenerate periodontal tissues including guided tissue regeneration [GTR], bone grafting [BG], platelet-rich plasma [PRP] and the use of enamel matrix derivative [EMD] [3,4]. Platelet-rich plasma, an autologous concentration of platelets, has been reported to significantly enhance bone and soft-tissue healing [5] and has been found to be a promising innovation in dentistry which utilizes the principles of tissue engineering by providing a high and adequate concentration of platelets in a small volume of plasma, which in turn caters the essential

growth factors necessary for periodontal wound healing and thereby helps in regeneration [5, 6].

For a tissue to be engineered a triad of factors must be intricately incorporated and woven together delicately for an apt outcome, the factors being the scaffold, which acts as a housing for the cells to grow, continuous supply of cells and the incorporation of signaling molecules at an appropriate time are essential [7]. Platelet derived growth factor is a potent mitogen & chemo-attractant for many cell types such as fibroblast and osteoblast. They are involved in the migration, proliferation, mature synthesis of cells and gingival wound healing [8]. Porous hydroxyapatite [HA] is a bone replacement material which is being used for several decades as an osteo-conductive material [9,10] and the combination of PRP and a hydroxyapatite [HA] osseous graft has been demonstrated to be efficacious in the treatment of periodontal endosseous defects. Here, we present a 6-month follow-up

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report of a clinical case control study, comprising of periodontal defects treated by using PRP and HA osseous graft for periodontal regeneration.

MATERIALS AND METHODS:

The protocol of this study was approved by the Institutional Ethical Committee of Vinayaka Missions University, Salem-636 308 and was carried out in the department of Periodontics, Vinayaka Missions Sankarachariyar Dental College and Hospital. The study sample included 30 periodontal intra-bony defects consisting of 10 defects in each group in patients, aged between 25 -45 years. The patients with defects were randomly divided into three groups based on the treatment criteria and followed up for a period of 6-months. Group-A indicates- Open flap debridement; group-B: Bone graft; group-C: Platelet rich plasma.

The adopted criteria for inclusion were individuals with good general health without any history of systemic disease or compromising medical conditions; patients with clinical evidence of periodontal pocket with probing depths more than 5mm; Patients having radiographic evidence of intra bony defect. Patients having unacceptable oral hygiene during pre-surgical phase [phase-1 therapy]; patients having history of antibiotics or other medications affecting the periodontium, in the previous 6-months; pregnant women and lactating mothers and smokers were excluded from the study. During this study, comprehensive medical and dental history of the patient was recorded and the patients were briefed about the protocol of the treatment. Initial therapy [pre-surgical therapy] consisted of thorough full mouth scaling and root planning. Six weeks following phase-1 therapy, a periodontal re-evaluation was performed to confirm the suitability of the sites for the study. The patients who showed consistently high level of plaque during assessment were not included in the study. All the clinical parameters were recorded at baseline 3 and 6-months post operatively.

Stent fabrication: A sterile perforated stock metal impression tray for each patient was selected. The impressions were made using an irreversible hydrocolloid material [alginate] following which casts were poured utilizing dental stone. Occlusal-stent using pink polymerizing resin was then fabricated in the area of interest

Pre-surgical/clinical measurements:

The Plaque index [PI], Gingival index [GI], Probing pocket depth [PPD], Clinical attachment level [CAL] were recorded by using a Williams probe and a customized acrylic-stent with a guiding groove. This provided well defined and reproducible clinical measurements at each experimental and control site at baseline, 3 & 6 months. All the customized acrylic stent were stored on the prepared study casts throughout the study period to minimize distortion.

Radiographic assessment:

Prior to surgery intra-oral periapical [IOPA] radiographs, were taken at baseline and also at 6-months postoperatively.

Method for radiographic assessment

The following method was employed, to determine radiographic changes before and after the study.

1. Pre-operative measurement at base line : A - CEJ to base of defect [BOD]; B - CEJ to the Alveolar crest [AC]; C - Defect depth at base line [A-B]
2. Post-operative measurements at 6 months: A¹ - CEJ to BOD; B¹ - CEJ to AC; C¹ - Defect depth at six months [A¹ ± B¹]; E - Changes in alveolar crest at six months [B ± B¹].

The radiographs were scanned on hp x-ray scanner and measurements were carried out by the help of image analysis software [Motic-china in corporation Ltd, facility available at Bangalore university, Bangalore] to assess changes between pre-operative and post-operative radiographs. Bone graft material was a resorbable porous hydroxyapatite [Synbograft] of particle size 0.25-1 µm was used in the study.

Procurement and preparation of Platelet-rich plasma:

PRP was prepared by adopting the procedures given by Lynch et al. [11]. Half an hour before surgery, 10.0 ml of blood was drawn from each patient by venipuncture of the antecubital vein. The blood was mixed with 1 ml anticoagulant citrate dextrose-A [ACD-A] and centrifuged at 5,600 rpm to separate the platelet poor plasma from the erythrocytes, platelets and leukocytes. The centrifuge speed then is slowed to 2400 rpm to allow for further separation of the platelets and leukocytes from the red blood cell pack. Removal of this red blood cell pack yields 3.0ml of plasma with concentrated platelets. The resultant platelet rich plasma is stored at room temperature until the surgical team is ready. Immediately before the application, PRP was mixed with 10ml of 10%calcium chloride and then mixed with 100 U/ml of sterile bovine thrombin. Within 5-30 seconds a gel is formed which is then injected into the surgical field as required. Post-operative care included systemic administration of Amoxicillin 500mg thrice daily for 5 days and a NSAID thrice daily for 5 days and 0.2% chlorhexidine gluconate rinse twice daily for a period of 2-weeks. **Post treatment assessments:**

The clinical parameters were recorded at three and six months and radiographic assessments were done after 6-months post-operatively.

STATISTICAL ANALYSIS:

The data at baseline, 3-months and 6-months after surgery was first collected. Following this, the data was subjected to statistical analysis using -ANOVA, Paired t test. All data were expressed as mean ±SD. Statistical analysis was performed using a commercial SPSS 9.0 version. One way analysis of variance was applied to examine the difference among the 4 groups. Clinical and radiographic parameters were subjected to student t test and 'p' values were obtained with appropriate level of significance.

RESULTS:

Plaque index

Fig-1 summarizes the plaque index in different treatment groups. Statistically significant [p<0.002] changes were observed in both group-B and group-c.

In group-B the baseline plaque index was 2.96 and upon 3 and 6-month interval were decreased significantly [1.50 and 1.32 respectively]. In group-C baseline plaque index was 3.01 and upon 3 and 6-month interval the values were found to be 1.87 and 1.42 respectively. When compared to PRP [group-C] HA osseous graft [group-B] treated sites showed higher efficacy in bringing down the incidence of plaque index.

Gingival index

Significant [$p < 0.001$] reductions in gingival index were found upon 3 and 6-months interval for HA osseous graft and PRP treated groups [Fig-2]. In group- B, the mean gingival index of 2.24 at baseline, 0.83 at 3-months and 0.45 at the end of 6-months was observed. In group-C the baseline plaque index was 2.42 and upon 3 and 6-months interval the values were found to be 0.60 and 0.5 respectively. When compared to PRP [group-C] HA osseous graft [group-B] treated sites upon 6 months follow-up showed higher efficacy in bringing down the incidence of gingival index.

Clinical attachment level (CAL)

When compared to PRP [group-C], HA osseous graft [group-B] treated sites upon 6-months follow-up showed higher clinical attachment gain [Fig-3]. In HA osseous graft group the clinical attachment values were found to be 11.08 ± 1.49 mm at baseline, 7.1 ± 2.36 mm at 3 months [$P < 0.001$] and 5.3 ± 0.67 mm [$P < 0.001$] at the end of six months versus in PRP [group-C] treatment group it was 11.98 ± 1.47 mm at baseline, 8.26 ± 2.32 mm at three months and 4.42 ± 0.38 mm at the end of 6 months.

Probing Pocket depth (PPD)

The changes in probing pocket depth [PPD] in HA osseous graft and PRP treatments are shown in Fig-4. In Group-B the observed values were found to be 9.8 ± 2.62 mm at baseline, 6.5 ± 1.83 mm at three months and 4.98 ± 0.58 mm at the end of six months. Likewise, the mean probing pocket depth in the group- C was 11.73 ± 1.2 mm at baseline, 6.16 ± 1.10 mm at three months and 4.36 ± 0.43 mm at the end of 6 months and results were statistically significant [$p < 0.001$]. When compared to PRP [group-C], HA osseous graft [group-B] treated sites upon 6-months follow-up showed higher efficacy in probing pocket depth reduction.

Radiographic bone level [RBL]

Digital subtraction analysis of the films at 6-months postoperatively and baseline [Fig-5-8] showed significantly more radiographic gains in alveolar bone mass in the test group than that in the control group [$P < 0.001$]. The radiographic defect fill values in HA osseous graft [group-B] was found to be 1.65 ± 0.30 mm, while PRP [group-C] treatment upon 6-months follow-up showed 1.59 ± 0.5 mm [Table 6].

DISCUSSION

The ultimate goal of periodontal therapy is to regenerate the lost periodontal tissues caused by Periodontitis. PRP was first introduced to the periodontal regenerative community by Marx 1998 [1], only a few clinical trials tested and proved the efficacy of combined PRP/bovine porous bone mineral/GTR as a therapy for intrabony defects [12- 14]. In this study, 6-month clinical and radiographic outcomes of ceramic porous hydroxyapatite [open-flap debridement] and platelet rich plasma in the treatment of intrabony periodontal defects were compared. Results from the present investigation showed both treatment modalities [HA osseous graft and PRP] were found to be effective in improving clinical and radiographic parameters 6-months after surgery. The results of this study corroborate the findings of earlier reports of Okuda et al., [15], their investigation strengthen the present findings by confirming the effectiveness of PRP

and HA in clinical attachment gain. In HA osseous graft group the clinical attachment level values were found to be 7.1 ± 2.36 mm at 3-months [$P < 0.001$] and 5.3 ± 0.67 mm [$P < 0.001$] at the end of 6-months versus 11.08 ± 1.49 mm at baseline, while in PRP treatment [group-C] it was 11.98 ± 1.47 mm at baseline, 8.26 ± 2.32 mm at three months and 4.42 ± 0.38 mm at the end of 6-months. Similarly when compared to PRP [group-C] HA osseous graft (group-B) treated sites upon 6-months follow-up showed a probing depth reduction [4.98 ± 0.58 mm], while PRP [group-C] showed 4.36 ± 0.43 mm. In addition, the benefit by PRP to HA in reduction of bony defect depth measured on radiographs corroborate the findings of Okuda et al., [15] and the percentage of radiographic resolution of the defect was found to be 40.8, 66.18 and 46.37% for groups A, B and C respectively.

Clinical evidence suggests that PRP could have beneficial therapeutic effects on hard and soft tissue healing, due to the contents of growth factors stored in the platelets. When these growth factors are released from the platelets they trigger a tissue regeneration process. [7, 8] In general, the initiation of bone regeneration starts with the release of platelet derived growth factor and also by transforming growth factor[s] from the de-granulation of platelets in the graft. The Platelet derived growth factor stimulates mitogenesis of the marrow stem cells and endosteal osteoblasts transferred in the graft to increase their numbers by several orders of magnitude. It also begins an angiogenesis of capillary budding into the graft by inducing endothelial cell mitosis [8, 16-17]. The transforming growth factors initially activate fibroblasts and pre-osteoblasts to mitose and increase their numbers, as well as promoting their differentiation towards mature functioning osteoblasts. Continued transforming growth factor[s] secretion influences the osteoblasts to lay down bone matrix and the fibroblast to lay down collagen matrix to support capillary in growth. These activities begin immediately on wound closure [18-21]. The inherent hypoxia of an early bone graft holds a strong attraction for the macrophage, which arrives at the wound and secretes additional growth factors to regulate and continue the bone regeneration [22-24].

In conclusion, although both PRP and HA osseous graft led to a favorable clinical improvement in periodontal intrabony defects, bone grafting was found to be a better treatment modality when compared to open flap debridement and platelet rich plasma alone in treating periodontal intrabony defects. Further studies are necessary to assess the long-term effectiveness of PRP and combination of PRP and HA osseous graft.

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