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Treatment of periodontal intrabony defects with platelet-rich fibrin and porous hydroxyapatite bone graft: A comparative clinical and radiographic study using Dentascan

Guneet Juneja, Vipin Bharti

Abstract:

Objective: The aim of the present study was to compare autologous platelet-rich fibrin (PRF) combined with a porous hydroxyapatite bone graft to porous hydroxyapatite bone graft alone in the treatment of periodontal intrabony defects clinically and radiographically using Dentascan.

Materials and Methods: In a split-mouth study design, 10 patients suffering from generalized chronic periodontitis, having two almost identical intrabony defects with probing pocket depth of at least 5 mm were selected for the study and randomly divided into two groups. In Group I periodontal flap surgery followed by placement of porous hydroxyapatite bone graft was done and in Group II, periodontal flap surgery followed by placement of a homogenous mixture of PRF and porous hydroxyapatite bone graft was done. All the clinical parameters were recorded at baseline, 3 and 6 months postoperatively and radiographic parameters were recorded at baseline and 6 months postoperatively.

Results: There was statistically significant reduction in probing pocket depth and gain in clinical attachment level in both groups. On comparison Group II showed statistically significant more probing pocket depth reduction than Group I at all-time intervals. There was statistically significant mean defect fill and mean defect resolution observed in both groups at all-time intervals. However, the intergroup comparison was statistically nonsignificant.

Conclusion: Within limits of the study it may be concluded that a combination of PRF with porous hydroxyapatite bone graft demonstrated better results as compared to porous hydroxyapatite bone graft alone in the treatment of periodontal intrabony defects. Spiral multislice computed tomography equipped Dentascan provides three-dimensional images of excellent quality for evaluating the morphology of the periodontal bone defects. Its use in ascertaining the various defect parameters in the periodontal treatment of intrabony defects is promising.

Key words: Periodontal intrabony defects, periodontal regeneration, platelet-rich fibrin, porous hydroxyapatite

Regeneration of lost structures has become the primary therapeutic goal in periodontics.^[1] Porous hydroxyapatite is calcium-phosphate based material that is biocompatible and non-immunological.^[2] It has excellent bone conductive properties.^[3]

Recently, platelet-rich fibrin (PRF), a second generation platelet concentrate has been introduced by Choukroun *et al.* in 2001.^[1] It is an autologous leukocyte and PRF material.^[4]

To overcome the inherent difficulties of conventional radiography, three-dimensional (3D) image analysis by computed tomography

(CT) has been introduced and is widely used for 3D maxillofacial imaging in dentistry.^[5] Dentascan, a dental CT software program, is an extension of CT technology.^[6]

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Department of
Periodontology,
Government Dental
College and Hospital,
Patiala, Punjab, India

**Address for
correspondence:**

Dr. Guneet Juneja,
H. No 1649, Sec 39 B,
Chandigarh, India.
E-mail: dr.gunn27@gmail.
com

MATERIALS AND METHODS

Ten patients suffering from generalized chronic periodontitis, visiting the Department of Periodontology, Government Dental College and Hospital, Patiala, Punjab were selected for the study according to split-mouth design.

Criteria for patient selection

The patients included in the study were in the age group of 30–50 years, having sufficient platelet count for PRF preparation and having two almost identical intrabony defects, one on either side of arch based on radiographic observations (intraoral periapical radiograph) with probing pocket depth of at least 5 mm. However, the patients with any systemic problem that contraindicate periodontal surgery, a history of coagulation defect or current anticoagulation treatment, a smoker or an alcoholic patient and teeth with furcation defects, endodontic treatment, Miller’s Grade II or greater mobility were excluded from the study. All subjects received verbal information regarding participation, and written informed consent was obtained for participation in the study.

Materials used in the study

Porous hydroxyapatite bone graft (OsteoGen (HA Resorb))

It is a synthetic, resorbable, osteoconductive, nonceramic form of hydroxyapatite manufactured by Implants, Ltd. It is supplied sterile in a crystalline form (300–400 μ). Controlled manufacturing produces bone grafting crystals of nearly perfectly-formed clusters bound to a single nucleus and relatively hexagonal-shaped crystals. These clusters intertwine to each other for greater porosity to form a 360° lattice mechanism for the host cell proliferation and integration.

Platelet-rich fibrin

Prior to the surgical procedure, informed consent was taken from each patient for taking a blood sample for the preparation of PRF. A 10 ml peripheral blood sample was collected from the subjects in a test tube without anticoagulant and centrifuged immediately at 3000 rpm for 10 min. The resultant product consisted of the following three layers [Figure 1]:

- Top most layer consisting of acellular platelet poor plasma
- Platelet-rich fibrin clot in the middle
- RBCs at the bottom.

The PRF clot was recovered and cut into few millimeter fragments and mixed with 0.5 mg of porous hydroxyapatite bone graft to form an easy to use homogenous graft material [Figure 2].

METHODOLOGY

Presurgical therapy

A general assessment of selected subjects was made through their history, clinical examination, and routine investigations. All subjects were treated with Phase I therapy involving proper oral hygiene instructions, full mouth scaling and root planning.

Following Phase I therapy the subjects were re-evaluated after 6 weeks and those who still fulfilled the selection criteria were finally taken up for the study. The clinical parameters recorded from the selected sites of these subjects included probing pocket depth, clinical attachment level, Gingival marginal position, site-specific plaque index, and site-specific sulcus bleeding index. The radiographic parameters included defect fill, Alveolar crest resorption, and defect resolution.

Study design

Immediately before surgery, selected sites in each subject were randomly divided by the toss of a coin into two groups according to split-mouth study design. In Group I, - Periodontal flap surgery followed by placement of porous hydroxyapatite bone graft was done and in Group II, - Periodontal flap surgery followed by placement of a homogenous mixture of PRF and porous hydroxyapatite bone graft was done.

Postsurgical management

Amoxicillin 500 mg thrice a day was prescribed for 5 days. Ibuprofen 400 mg thrice daily and Vitamin-B complex, 1 capsule daily was also prescribed for 5 days. The subjects were instructed not to brush the operated area for 1-week and to rinse the oral cavity twice a day with chlorhexidine (0.12%) mouthwash daily. Periodontal dressing and sutures were removed after 10 days postoperatively.

Postoperative assessment

Clinical parameters were again recorded at 3 months and at 6 months postoperatively and radiographic parameters were again recorded at 6 months postoperatively [Figure 3-6]. The data thus recorded were compiled, tabulated, and statistically analyzed to arrive at the results.

RESULTS

There was statistically significant probing pocket depth reduction found in both groups from baseline to 3 months, baseline to 6 months and between 3 months to 6 months. On comparison, Group II showed statistically significant more probing pocket depth reduction than Group I at all-time intervals [Table 1].

Statistically nonsignificant change in gingival marginal position from baseline to 3 months, baseline to 6 months and

Table 1: Comparison of mean probing pocket depth reduction (in mm) of groups I and II at different time intervals

Time interval	Group	Number	Mean change	Mean difference	t	P	S
Baseline and 3 months	I	10	2.3±0.483	0.9±0.390	2.30	≤0.05	S
Baseline and 6 months	I	10	3.2±0.918	1.7±0.500	3.40	≤0.05	S
3 months and 6 months	I	10	4.9±1.286	0.8±0.316	2.53	≤0.05	S
Baseline and 3 months	II	10	3.2±1.135	0.9±0.390	2.30	≤0.05	S
Baseline and 6 months	II	10	4.9±1.286	1.7±0.500	3.40	≤0.05	S
3 months and 6 months	II	10	1.7±0.483	0.8±0.316	2.53	≤0.05	S

S = Significant

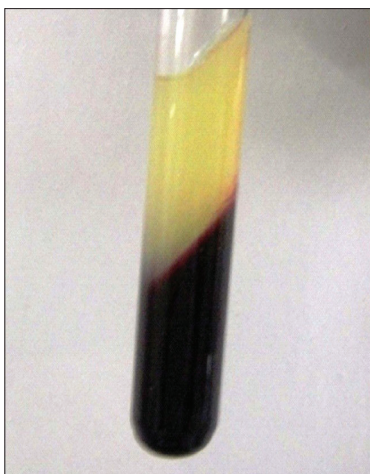


Figure 1: Test tube containing platelet-rich fibrin



Figure 2: Homogenous mixture of platelet-rich fibrin with porous hydroxyapatite bone graft



Figure 3: Dentascans reformatted spiral computed tomography image at baseline (before surgery) in Group I

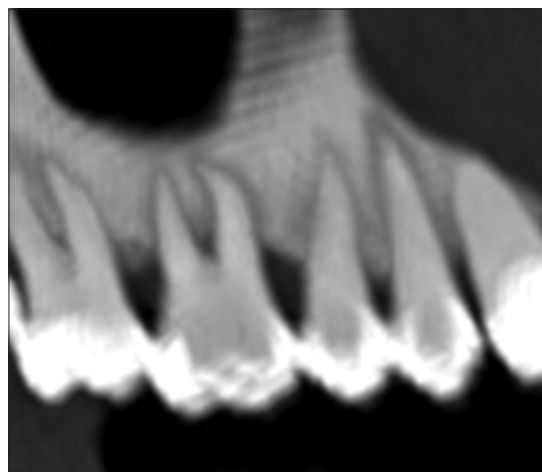


Figure 4: Dentascans reformatted spiral computed tomography image at 6 months (after surgery) in Group I

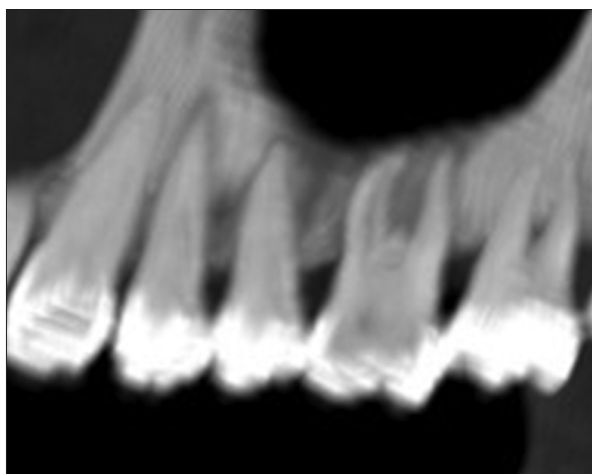


Figure 5: Dentascans reformatted spiral computed tomography image at baseline (before surgery) in Group II

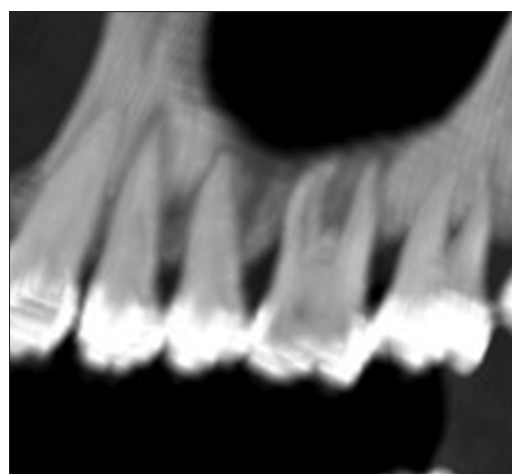


Figure 6: Dentascans reformatted spiral computed tomography image at 6 months (after surgery) in Group II

between 3 months and 6 months was found on both intragroup and intergroup comparison.

There was statistically significant clinical attachment level gain observed in both groups from baseline to 3 months, baseline to 6 months and between 3 months to 6 months. On comparison, Group II showed statistically significant more clinical attachment level gain than Group I at all-time intervals [Table 2].

Reductions in the site-specific plaque index score and site-specific sulcus bleeding index score were observed in both groups from baseline to 3 months, baseline to 6 months and between 3 months and 6 months, but they were statistically nonsignificant. On comparison, the difference between the two groups was also statistically nonsignificant at all-time intervals.

There was statistically significant mean defect fill observed in both groups from baseline to 6 months. On comparison, more mean defect fill was observed in Group II at all-time intervals. However, the difference in mean defect fill between the two groups was statistically nonsignificant [Table 3].

Slight alveolar crest resorption was observed in both groups from baseline to 6 months, but it was statistically nonsignificant. On comparison, the difference in alveolar crest resorption between the two groups was statistically nonsignificant.

There was statistically significant mean defect resolution observed in both groups from baseline to 6 months. On comparison, more mean defect resolution was observed in Group II at all-time intervals. However, the difference in mean defect resolution between the two groups was statistically nonsignificant [Table 4].

DISCUSSION

Periodontal disease is among the most prevalent diseases worldwide and is characterized by the presence of gingival inflammation, periodontal pocket formation, loss of periodontal attachment and loss of alveolar bone around the affected teeth.^[7,8] The goal of periodontal therapy includes not only the arrest of periodontal disease progression, but also the regeneration of structures lost due to disease.^[9] Bone grafting is one of the most common forms of regenerative therapy and is usually essential for restoring periodontal supporting tissue.^[9] Regeneration of cementum, bone, and functionally oriented periodontal ligament fibers has been seen at sites treated by bone grafting (Hiatt *et al.* 1978).^[10] A wide range of bone grafting materials, including bone grafts and bone graft substitutes, have been applied and evaluated clinically, including autografts, allografts, xenografts, and alloplasts (synthetic/semisynthetic materials).^[8]

Autografts are ideal but have certain limitations like paucity of suitable donor tissue and requirement of additional surgery for harvesting the graft that preclude their widespread use.^[11,12]

Table 2: Comparison of mean clinical attachment level gain (in mm) of groups I and II at different time intervals

Time interval	Group	Number	Mean change	Mean difference	t	P	S
Baseline and 3 months	I	10	2.1±0.567	1.0±0.391	2.55	≤0.05	S
	II	10	3.1±1.100				
Baseline and 6 months	I	10	2.9±0.994	1.9±0.500	3.80	≤0.05	S
	II	10	4.8±1.229				
3 months and 6 months	I	10	0.8±0.788	0.9±0.292	3.07	≤0.05	S
	II	10	1.7±0.483				

S = Significant

Table 3: Comparison of mean defect fill (in mm) of groups I and II

Time interval	Group	Number	Mean change	Mean difference	t	P	S
Baseline and 6 months	I	10	1.72±0.379	0.10±0.181	0.552	>0.01	NS
	II	10	1.62±0.428				

S = Significant, NS = Not significant

Table 4: Comparison of mean defect resolution (in mm) of group I and Group II

Time interval	Group	Number	Mean change	Mean difference	t	P	S
Baseline and 6 months	I	10	1.74±0.400	0.09±0.184	0.487	>0.01	NS
	II	10	1.65±0.424				

S = Significant, NS = Not significant

Allografts on the other hand, are available in considerable quantity but they are immunogenic and the problems of disease transmission are well documented.^[13] To overcome these issues, alloplastic materials, which are synthetic, inorganic, biocompatible bone graft substitutes, represent a possible alternative in the treatment of periodontal intrabony defects.^[14] For decades, various types of synthetic artificial bone substitutes have been utilized for regenerative periodontal treatment in intrabony defects. Among these synthetic materials, porous hydroxyapatite has been widely used.^[3]

Porous hydroxyapatite is calcium-phosphate – based material.^[2] It has been used to fill periodontal intrabony defects, which has resulted in clinically acceptable responses. It has been shown that porous hydroxyapatite bone grafts have excellent bone-conductive properties which permit outgrowth of osteogenic cells from existing bone surfaces into adjacent bone graft material. Since there are no organic components, this bone graft material does not induce any allergic reaction and is clinically very well tolerated.^[3] It is capable of inducing migration, adhesion, and proliferation of osteoblasts inside the pore network. The architecture effectively promotes angiogenesis inside the pore system and interconnections, and blood vessels are able to carry cells and soluble signals promoting bone formation and finally bone regeneration (Mangano *et al.* 2006).^[2]

Desirable results with porous hydroxyapatite bone graft have been shown by studies of Sunitha and Manjunath^[15] and

Corsair^[6] who used it in the treatment of periodontal intrabony defects. It was found to be well tolerated with no immunologic complication, graft rejection or infection.

A different approach to periodontal regeneration is the use of polypeptide growth factors. Among the known polypeptide growth factors, platelet-derived growth factor and transforming growth factor- β have been studied most extensively.^[17] Platelet-rich plasma (PRP) is an autologous concentration of platelets in plasma and Platelet-rich plasma-enhanced grafts produce a more mature and dense bone than do grafts alone.^[15,18] However, there are potential risks associated with the use of Platelet-rich plasma. The preparation of Platelet-rich plasma involves the use of calcium chloride and bovine thrombin. It has been discovered that the use of bovine thrombin may be associated with the development of antibodies to the factor V, XI, and thrombin, resulting in life-threatening coagulopathies.^[19]

Recently, PRF, a second generation platelet concentrate has been introduced by Choukroun *et al.* in 2001 that has several advantages over Platelet-rich plasma. It requires neither anticoagulant nor bovine thrombin.^[20] The affinity of osteoblasts to PRF membrane appeared to be superior. The conversion of fibrinogen into fibrin takes place slowly with small quantities of physiologically available thrombin present in the blood sample itself. Thus, a physiological architecture that is very favorable to the healing process is obtained with PRF.^[19] The presence of leukocytes and cytokines in the fibrin network play a significant role in the self-regulation of inflammatory and infectious phenomena within the grafted material.^[20]

Hence, a combination of PRF and porous hydroxyapatite bone graft can be more beneficial in treating periodontal intrabony defects. This is based on the fact that two distinct healing processes, may take place together and this may probably results in their synergistic effect. Favorable results have been obtained by Choukroun *et al.*,^[21] Diss *et al.*^[22] Simonpieri *et al.*^[23] who used PRF in combination with bone graft in sinus augmentation procedures.

The evaluation of hard tissue changes after regeneration therapy can be done either by surgical re-entry procedure or by radiographic assessment. However, re-entry procedures require a second surgical intervention which is usually not acceptable to the patient. Furthermore, it may cause a disturbance of the new connective tissue attachment. Radiographic assessment, however, provides a noninvasive method for evaluating the hard tissue changes.^[24,25]

Conventional radiographs have been used as a surrogate technique to evaluate regenerative outcomes *in vivo*.^[26] However, radiographs are a two-dimensional mapping of 3D periodontal structures and their limitations have been well described. They underestimate the true amount of bone loss. Many complicated anatomic structures, such as cortical plates

or teeth, may superimpose the region of interest. Moreover, foreshortening or elongation of radiographic images caused by cone indication, and variations in the contrast and density caused by poor control of film processing, may prevent the accurate detection of osseous changes by the clinician.^[27]

To overcome the difficulties caused by the nature of conventional radiography, 3D image analysis using CT has been introduced which enables the clinician to have access to 3D images of the selected areas of interest.^[27,28] The use of CT as an effective method to assess the bone defect morphology and outcome of regenerative therapy have been shown by Naito *et al.*,^[27] Ito *et al.*^[5] and Pradeep *et al.*^[17] They concluded that the use of CT in ascertaining the various defect parameters in the periodontal treatment of intrabony defects appears promising.

Recently, Spiral multislice tomography has replaced conventional CT. Spiral CT has been shown to be diagnostically superior in terms of reducing artifacts and blurred images.^[28]

Dentascan, a dental computed tomographic software program, is an extension of CT technology. Dentascan reformats standard axial CT scan which improves specificity and sensitivity over standard imaging.^[6]

Therefore, in the present study radiographic parameters were taken and assessed using Spiral multislice CT equipped with a 3D image reconstruction software package, Dentascan.

Hence, the present study was undertaken to compare autologous PRF combined with a porous hydroxyapatite bone graft to porous hydroxyapatite bone graft alone in the treatment of periodontal intrabony defects clinically and radiographically using Dentascan.

CONCLUSION

Within limits of the study it may be concluded that a combination of PRF with porous hydroxyapatite bone graft demonstrated better results in probing pocket depth reduction and clinical attachment level gain as compared to porous hydroxyapatite bone graft alone in the treatment of periodontal intrabony defects. However, histological studies are needed to establish the exact nature of this clinical attachment gain. Spiral multislice CT equipped Dentascan provides 3D images of excellent quality for evaluating the morphology of the periodontal bone defects. Its use in ascertaining the various defect parameters in the periodontal treatment of intrabony defects is promising and could be of greater clinical relevance if a longer observational period is envisaged. Future long term studies with a large sample size should be carried out to further explore the role of PRF in the management of periodontal intrabony defects and to verify the results of *in vitro* studies in a clinical study.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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