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Evaluation of Clinical Effectiveness of Bioactive - Glass and Platelet - Rich Fibrin in the Management of Intrabony Defects - A Comparative Study

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Abstract

Background: Platelet-Rich Fibrin (PRF), the second-generation platelet concentrate has various fringe benefits over other platelet concentrates. Just finite number of research works have concentrated on the utilization of PRF in combination with various kinds of bone grafts in intra-bony defects. **Objective:** The primary intention of this study was to determine the clinical and radiographical efficacy of Bioactive-glass with and without autologous PRF in the management of three-wall vertical defects. **Methods:** Twenty intrabony defects were arbitrarily chosen and treated either with Bioactive Glass (BG) alone or in mix with PRF (PRF/BG). Clinical parameters were documented preoperatively (baseline) and at six months post-operatively. Radiographic analysis was performed at baseline, third and sixth-month intervals. **Results:** The study outcome demonstrated that both treatment approaches were effectual. Significant decrease in the mean probing depth and gain in clinical attachment was observed in BG+PRF and BG groups as compared to baseline but was statistically insignificant at 6 months. (p=0.475, p=0.245 respectively). Radiographically, reduction in defect depth was significantly greater in BG+ PRF group than BG group (p=0.007) at 6 months. **Conclusion:** Within the limitation of the current study, it is proposed that both treatment modalities are effective in the management of 3-wall intra-bony defects. The outcomes additionally uncovered that incorporation of PRF with BG has more successful and promising results. Hence in future, clinical trials with bigger sample size may be employed to further explore the potential benefits of PRF as a sole grafting material.

Keywords: Blood Platelets, Glass, Intrabony, Regeneration

1. Introduction

Periodontal reinvigoration per se might be a complex process, needs an orchestrated chain of biochemical events which incorporates cell adhesion, migration, multiplication and differentiation involving recruitment of regionally derived progenitor cells[1]. Bone graft materials have revolutionized the periodontal therapy in regenerating the lost periodontal tissues over the recent years.

Several alloplastic bone grafts on the market today act as osteoconductive and inert filler materials. Synthetically made Bioactive glass is a notorious material that once exposed to body fluids creates a bond with bone. Bioactive glass alongside their osteoconductive properties, conjointly has an osteostimulatory effect[2,3].

These materials when grafted won't solely provoke osteoblast production, but as they are biodegradable, are eventually substituted by new bone. Currently, the fascination has been shifted towards varied biologic

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mediators like growth factors, which might modulate the proliferation, differentiation and chemotaxis of the local progenitor cells to the defect site[4].

Among the richest sources of autologous growth factors, the varied generations of platelet concentrate are used presently. PRF, the second-generation platelet concentrate has a rich autologous source of numerous growth factors, leukocytes, cytokines and structural glycoproteins. PRF shows a continuous delivery of assorted growth factors over a period of 7-11 days, thereby inducing proliferation, differentiation and migration of cells culpable for periodontal regeneration[5]. The fibrin component acts as a hemostatic agent. It aids in the blood clot stabilization and the graft material. PRF alone has shown promising results once utilized in the management of intrabony defects[6].

However, only limited studies are available focusing on the application of Platelet-rich fibrin combined with other bone graft materials[7,8]. Thus, the current study was aimed to determine and compare the clinical and radiographic efficacy of bioactive glass combined with platelet rich fibrin in relation to bioactive glass alone in the management of 3-wall vertical defects.

2. Materials and Methods

Twenty patients with non-contributory medical history (12 males and 8 females; age range: 20 to 49 years; mean age: 33.2 ± 7.4 years) diagnosed to have moderate to severe chronic periodontitis had been recruited among the outpatients attending the Department of Periodontics and Oral Implantology of our institution. The study design was approved by the Institutional Ethical Committee (IEC).

The informed consent was acquired from each patient before participation in the study. All the procedures were executed in accordance with the Declaration of Helsinki and the Good Clinical Practice Guidelines. The exclusion criteria include: 1) Patients showing poor oral hygiene maintenance and compliance during phase-I therapy 2) Patients under any medications within 6-months period 3) Patients using tobacco or tobacco related products 4) Pregnant/Lactating women 5) Patients with known systemic diseases/metabolic disorders 6) Patients with any known allergies.

The inclusion criteria were: 1) Systemically healthy patients with moderate to severe generalized chronic periodontitis[9] 2) Patients with pocket depth ≥5mm following Phase-I therapy 3) Radiographic evidence of vertical bone loss. All the subjects underwent full-mouth periodontal screening and charting and radiographic evaluation. The patients were arbitrarily selected and allocated into two groups.

Group I (BG) included 10 sites treated with Bioactive glass (PerioglasTM) alone, whereas Group II (BG/PRF) consists of 10 sites treated with Bioactive glass (PerioglasTM) in combination with PRF.

2.1. Clinical recordings

The clinical recordings were evaluated pre-operatively and 6 months post surgically. Plaque Index (PI) (Silness & Loe 1964) and Gingival bleeding Index (BOP) (Ainamo & Bay 1975) were recorded for all sites. The clinical parameters like Probing Depth (PD) and the Clinical Attachment Level (CAL) were measured using customized acrylic stents with guiding grooves and cemento-enamel junction as a reference point.

2.2. Radiographic assessment

Intraoral periapical radiographs were taken for each site utilizing paralleling technique and XCP holders[a] at baseline, 3 months and 6 months postoperatively. The radiographs were digitized using digital camera (canon Powershot sx260 HS), and the images were analyzed using Adobe Photoshop version 10.0. Based on the criterion given by Bjorn et al[10] and by Schei et al[11] the following landmarks were marked in the radiographic images:

1. CEJ: The cemento-enamel junction of the tooth with the intrabony defect.
2. AC: The most coronal position of the alveolar bone crest.
3. BD: The bottom of the defect where the periodontal ligament space still retained its normal width.

For measurements, the connector line tool of the software was used. A line was drawn from the CEJ to Root Apex (RA) and also to the base of the defect. Then a perpendicular line was drawn from the alveolar crest to this line to obtain the distance between CEJ and alveolar crest.

Defects were radiographically evaluated to measure[12,13].

1. Defect Depth (DD) = CEJ to the bottom of the defect (CEJ to BD)
2. CEJ to most coronal extent of the alveolar crest (CEJ to AC)
3. Depth of the intrabony defect = (CEJ to BD) - (CEJ to AC)
4. Correction Factor = CEJ to RA (baseline)/ CEJ to RA (post-op). In cases where measuring the root length was not feasible, the crown length was measured
5. Bone fill (BF) = CEJ to BD (baseline) - [CEJ to BD (post op) x CF]
6. Bone fill percentage (BF %) = Bone fill/Defect Depth (at baseline) x 100
7. Bone crest change (BCC) = CEJ to AC (baseline) - [CEJ to AC (post op) x CF]
8. Bone crest change percentage (BCC %) = Bone Crest change/ CEJ AC (baseline) x 100
9. The negative value indicates that a process of bone resorption had occurred.[12]
10. Amount of original defect resolution (DR) = Bone fill (BF) - bone crest change (BCC)
11. Percentage (%) of original defect resolution = Defect Resolution x Preoperative defect depth x 100

All the observations were recorded and subjected to statistical analysis.

2.3. Surgical procedure

Four to eight weeks after the etiotrophic phase, a periodontal reevaluation was performed to confirm the desired sites for the study. The intra-oral asepsis and extra-oral asepsis was achieved with 0.2% chlorhexidine digluconate rinse and 5% povidone iodine solution, respectively. After anaesthetizing the area with 2% lignocaine containing 1:80,000 adrenaline, sulcular incisions were made and a full-thickness mucoperiosteal flap was elevated taking care not to injure the interdental papilla.

After flap elevation and exposure of the osseous defect, a thorough debridement of the defect was done using hand and ultrasonic instruments. Debridement was followed by copious irrigation with 0.9% normal saline and the defect was filled with BG in group I and with a combination of BG/PRF in group II patients (Figure 1).

2.4. Procurement of PRF[6,14]

The PRF was processed in accordance with the protocol recommended by Choukroun et al. During the surgery approximately 5-6ml of intravenous blood was collected without anticoagulant in a test-tube and centrifuged immediately at 3000 rpm for 10 minutes. Blood centrifugation resulted in the segregation of blood into 3 layers[14]. After removing the Platelet-Poor Plasma (PPP),

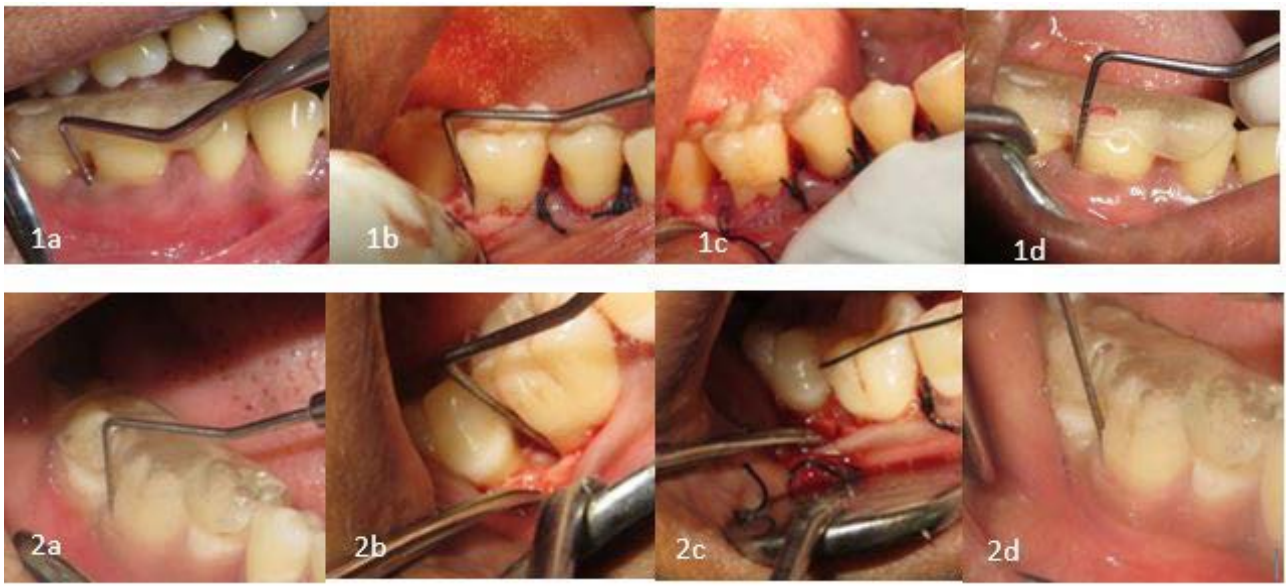


Figure 1: Group -I, Pre-operative view (1a), Intra-operative view (1b), After placement of Bioglass (Perioglas) (1c) and Post-Operative view (1d). Group-II, Pre-operative view (2a), Intra-operative view (2b), After placement of PRF + Bioglass (Perioglas) (2c) and Post-Operative view (2d).

PRF was cut apart from the red corpuscles [retaining a small layer of Red Blood Cells (RBCs)] using sterile tweezers and scissors. In the BG/PRF group, PRF is mixed with equal proportion of bioactive glass (1:1 v/v)[15]. The mixture was then placed into the osseous defect with gentle pressure and packed upto the most coronal level of the osseous defect.

The flaps were repositioned and secured using 3-0 black braided silk sutures. Periodontal dressing (Coe-pac™) was placed. Systemic antibiotics and analgesics were prescribed. Post-operative instructions were given to all the patients. Next day, the patients were re-evaluated for any acute signs of inflammation or infection.

After 1 week, the periodontal dressing and sutures were removed, and the surgical site was irrigated with normal saline. The patients were observed for any signs or symptoms of post-operative complications. The patients were reviewed every week for the first four weeks and thereafter depending on individual patient's maintenance recall appointments were made, after 3 months and finally at 6 months and radiographs were repeated (Figure 2). During the follow-up period, oral hygiene maintenance was reinforced.

3. Statistical analysis

The statistical analysis was done using the computer software program SPSS version 20.0 (Statistical Package for Social Science, Version 20). The data of the parameters evaluated were expressed as mean ± standard deviation of the parameters evaluated. In both groups, the clinical parameters were evaluated at baseline and 6 months whereas the radiological parameters were evaluated at baseline, 3 month and 6 month post-operatively. The Gingival bleeding index between group I and II was compared using Fischer Exact test. The comparison of mean values for other clinical parameters was done using Paired T –Test for within a group (intra-group analysis) and Mann Whitney- U Test for intergroup comparisons. The comparison of mean values for radiographic parameters was done using Repeated Measures ANOVA for defect depth (BL vs. 3M vs. 6M) and Paired T –Test for other parameters (intra-group analysis) and Independent sample T- test for intergroup comparisons to calculate the p-value. In all the above statistical tools the probability value $p \leq 0.05$ was considered as significant.



Figure 2: Radiographic Views: Group- I, At Baseline (1a), At 3 months (1b) and At 6 months (1c). Group-II, Baseline (2a), 3 months (2b) and 6 months (2c).

4. Results

In group I(BG), the mean reduction in plaque index from baseline (0.65±0.27) to 6 months was 0.2 ±0.26 which was statistically significant (p=0.037) whereas in group II(BG/PRF) the mean plaque index at baseline was 0.60± 0.29, with significant reduction to 0.40±0.21 (p=0.011) at 6 months thus demonstrating good patient compliance.

Gingival bleeding index value compared between baseline and 6 months was found to be statistically significant in both the groups. Mean clinical measurements BG and BG/PRF groups at baseline and at 6 months are

Table 1: The comparison of clinical parameters -group I (BG) and group II (BG/PRF)

	Group I- BG			Group II- BG/ PRF			Group I v/s Group II			
	At Baseline	At 6 months		At Baseline	At 6 months		At Baseline		At 6 months	
	Mean ± SD	Mean ± SD	p value	Mean ± SD	Mean ± SD	p value	Mean diff	P value	Mean diff	p value
PI	0.65±0.27	0.45±0.23	0.037*	0.60±0.29	0.40±0.21	0.011*	0.05 ±o.13	0.696	0.05	0.615
GBI	-	-	0.003*	-	-	0.001*	-	-	-	0.606
PPD(mm)	7.40±1.17	2.60±1.15	0.010*	7.70±1.34	2.30±1.25	0.008*	0.30 ±1.48	0.601	0.30	0.475
CAL (mm)	8.50±1.08	4.60±2.01	0.015*	8.10±1.37	3.40±1.96	0.002*	0.40 ±0.55	0.478	1.20	0.245

Paired T –Test for Intra-group comparisons ***Significant**
Mann Whitney- U Test for Intergroup comparisons
Fischer Exact test- Intergroup comparison for GBI

Table 2: Comparison of radiographic parameters group I (BG) and group II (BG/PRF)

	Group I- BG				Group II- BG/PRF				Group I v/s Group II			
	Baseline	At 3 months	At 6 months		Baseline	At 3 months	At 6 months		At 3 months		At 6 months	
	Mean±SD	Mean ± SD	Mean ± SD	p value	Mean±SD	Mean ± SD	Mean ± SD	p value	Mean diff	p value	Mean diff	p value
Defect depth (mm)	4.69±1.26	3.87±1.14	2.86±0.65	0.031*	5.19±1.66	3.70±1.83	2.91±1.67	0.011*	0.17	0.057	0.05	0.007*
Bone fill (mm)	-	0.93±0.82	2.27±1.09	0.012*	-	1.89±0.68	2.98±1.08	0.008*	0.96	0.962	0.71	0.809
Bone fill%	-	19.14±15.20	46.89±17.12	0.018*	-	38.10±15.27	59.62±20.17	0.007*	18.95	0.809	12.72	0.848
Bone crest change(mm)	-	0.137±0.52	0.424±0.63	0.013*	-	0.286±0.53	0.511±0.51	0.008*	0.149	0.591	0.087	0.454
Bone crest change %	-	2.97±12.40	9.28±15.46	0.016*	-	6.22±11.86	10.82±10.92	0.013*	3.25	0.805	1.54	0.289
Defect Resolution%	-	15.42±15.90	36.02±19.32	0.013*	-	32.59±18.21	49.30±19.38	0.006*	17.17	0.700	13.28	0.669

Paired T –Test for Intragroup comparisons *** Significant**
Repeated Measures ANOVA for Intragroup comparison of DD
Independent sample T- test for Intergroup comparisons

shown in Table 1. The mean reduction in PPD was 2.60 ± 1.17mm (p=0.010) and 2.30 ± 1.25mm (p=0.008) from baseline to the 6 months for BG and BG/PRF group, respectively, with no statistically significant difference between the groups (p=0.475). CAL gain for BG and BG/PRF groups was 3.90 ± 0.93 (p=0.015) mm and 4.70 ± 0.59 mm (p=0.002) respectively, from baseline to the 6 months with statistically significant difference. The mean CAL gain between the BG and BG/PRF groups were not significant (p=0.245) at 6 months postoperative. (Table 2) reports the mean radiographic parameters. There was statistically significant reduction in mean defect depth, mean defect fill and mean defect resolution observed in both groups from baseline to 6 months. At 6 months mean reduction in defect depth between BG and BG/PRF was 0.05 which was statistically significant (p=0.007). On comparison, the difference in mean defect fill, mean defect resolution and bone crest change between the two groups was not statistically significant.

5. Discussion

Several bone graft materials have been utilized in intrabony defects for promoting periodontal regeneration yet till date, none of the materials have been proven as a gold standard. However, in a systematic review, Trombelli et al.[16] have inferred that the utilization of different bone grafts in intraosseous defects was more yielding in gaining attachment levels than open flap debridement alone.

Among the various alloplastic bone graft materials, the use of BG has gained momentum in the recent years. BG is a sort of bioactive ceramic that has an antibacterial effect in addition to its osteoconductive and osteostimulatory property[17]. Low et al.[18] and Zamet et al.[19] reported promising clinical outcomes in intrabony defects treated with a BG when compared to open flap debridement.

The recent innovation in regenerative therapy is towards the utilization of various commercially available poly-peptide growth factors, but their use is restricted because of their limited availability and high cost. Recently, the various generations of platelet concentrate which contains a rich source of autologous growth factors are being utilized.

PRF, the second-generation platelet concentrate was produced to sweep over the shortcomings of PRP like complicated procedures to produce PRP and to reduce the immunogenicity of PRP as bovine thrombin was used to form a gel with PRP. The decision to utilize PRF was made because of its inexpensive nature, ease of manipulation and delivery to the surgical site and sustained release of growth factors over a period than PRP. Marx et al.[20] demonstrated a 1.62 to 2.16-fold gain in bone formation utilizing platelet concentrate with a bone graft compared to bone graft alone.

However only limited number of research works have centered on the utilization of PRF in combination with alloplastic graft materials in management of intrabony defects[21,22]. PRF when used alone tends to get resorbed in approximately 7-10 days[23,24]. Nevins et al.[25] demonstrated the formation of new attachment in one tooth out of five human intrabony defects treated with BG. Hence, Bioglass was added hypothesizing that it could enhance the effects of PRF by its osteostimulative and osteoconductive properties, by maintaining space at the wound site.

The present study was intended to assess the efficacy of incorporating PRF with BG when compared to BG alone. For this purpose, a total of 20 sites with only 3-wall and combined intrabony defects were selected because the number of remaining bony walls was found to be correlated positively with regeneration potential in grafting procedures[26]. In addition, 3-wall defects provide the best spatial relationship for defect bridging by vascular and cellular components from the periodontal ligament and adjacent osseous wall.[27] The uneventful healing and the lack of adverse reactions post-operatively showed that BG and PRF were well tolerated and was comparable with the observations of prior investigations[20,26,27].

On evaluation of clinical parameters, plaque index showed similar clinical values in both groups at baseline and after 6 months, with no significant change thus suggesting good hygiene maintenance by all patients during the study. These results coincide with those of studies by Yukna et al.[28] who observed that patients undergoing periodontal therapy try to maintain optimal oral hygiene. According to Rosen et al.[29] periodontal probing and recording of attachment levels should not be done for at least 6 months post-surgically, since probing can damage the healing site, thereby diminishing regenerative outcomes. Therefore, in the present study probing related clinical parameters were entered only at baseline and 6 months post-operatively.

The mean pocket depths at baseline in both the BG and BG-PRF groups were 7.40±1.17 mm and 7.70±1.34

mm, respectively, showing that cases with similar severity of defects were selected for both the groups. Significant reductions were observed in pocket depths in both the groups at the end of 6 months ((4.80±0.02 mm in BG and 5.40±0.09 mm in the BG/PRF) but the intergroup comparison showed no statistically important deviation between two groups. The pocket depth reduction in the combination group was greater compared to the findings of Pradeep et al.[8] observations of 4.27 ± 0.98 mm in the PRF + HA group which may be attributed due to the osteostimulatory effect of Bioactive glass compared to HA (osteoconduction).

A significant gain in clinical attachment levels was also observed in both the groups at the end of 6 months. Nevertheless, better levels were observed with BG/PRF combination (4.70 ± 1.82 mm) than with BG alone (3.90 ± 1.34 mm). The gain was still better than PRF-BPBM group of the comparative study by Lekovic et al.,(3.82 ± 6.78)[7].

On radiographic evaluation, significant decrease in defect depth was observed in both the study groups at the remainder of 3 months and 6 months in comparison to baseline. However, the intergroup comparison between the two groups showed significantly more reduction in defect depth at the end of 6 months with the combination (BG+PRF) therapy. This suggests that PRF has a better regenerative potential when applied along with bone graft (BG).

The mean percentage of bone fill obtained in the present study was 46.89% for bioactive glass and 59.62% for BG+PRF at the end of 6 months. These results compare favorably to those found by Pradeep et al.[8] who observed (63.39 ± 16.52 %) of bone fill with PRF + HA combination at the end of 9 months.

Percentage of original defect resolution is an important parameter that considers not only the amount of bone fill, but also the change in alveolar crest level, if any[10]. In the present study, the combination group (BG+PRF) showed much higher defect resolution (32.59 ± 18.21 %) when compared to bone graft (BG) alone (15.42 ± 15.90 %). At 6 months the defect resolution for the BG+PRF group (49.52 ± 19.38 %) and BG group (36.02 ± 19.32 %) respectively. There was statistically significant difference in defect resolution at 3 months between the two groups, whereas at 6 months the results were statistically non-significant which can be attributed to the possible radiographic limitations.

In the present study BG-PRF group demonstrated better results in clinical and radiographic parameters than BG alone in the management of periodontal intrabony defects. This result may be attributed to the additional beneficial effects of PRF. However, future long-term clinical and histological studies should be attempted to ascertain the efficacy of bioactive glass in combination with PRF. So, in future, PRF may prove to be a novel adjunct to conventional regenerative methods in the management of periodontal osseous defects.

6. Conclusion

Within the limitation of the current study, it can be concluded that both the modalities of treatment were efficient in improving the clinical as well as radiographic parameters. The incorporation of Platelet Rich Fibrin to bone graft has demonstrated successful and promising solutions. Thus, in the future, clinical trials with larger sample size and longer follow up may be employed to further explore the potential benefits of PRF as a grafting material.

7. References

1. Giannobile WV. The potential role of growth and differentiation factors in periodontal regeneration. J Periodontol. 1996;67(5):545–553.
2. Schepers EJ, Ducheyne P. Bioactive glass particles of narrow size range for the treatment of oral bone defects: a 1-24 month experiment with several materials and particle sizes and size ranges. J Oral Rehabil. 1997;24(3):171–181. https://doi.org/10.1111/j.1365-2842.1997.tb00311.x
3. Osteostimulation of bioglass.Hu YC, Zhong JP. Osteostimulation of bioglass. Chin Med J (Engl). 2009 Oct 5;122(19): 2386–1289.
4. Chen FM, Shelton RM, Jin Y, Chapple IL. Localized delivery of growth factors for periodontal tissue regeneration: role, strategies, and perspectives. Med res Rev. 2009;29(3):472–513. https://doi.org/10.1002/med.20144. PMid:19260070
5. Dohan DM, Choukroun J, Diss A, Dohan SL, Dohan AJ, Mouhyi J, et al. PlateletRich Fibrin (PRF): a secondgeneration platelet concentrate. Part I: Technological concepts and evolution. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2006;101(3): e37–e44. https://doi.org/10.1016/j.tripleo.2005.07.008
6. Tang YQ, Yeaman MR, Selsted ME. Antimicrobial peptides from human platelets. Infect Immun. 2002;70(12):

6524–6533. https://doi.org/10.1128/IAI.70.12.6524-6533.2002. PMid:12438321 PMCid:PMC132966
7. Lekovic V, Milinkovic I, Aleksic Z, Jankovic S, Stankovic P, Kenney EB, et al. Platelet-rich fibrin and bovine porous bone mineral vs. platelet-rich fibrin in the treatment of intrabony periodontal defects. J Periodontal Res. 2012;47(4):409–417. https://doi.org/10.1111/j.1600-0765.2011.01446.x. PMid:22126591
8. Pradeep AR, Bajaj P, Rao NS, Aggarwal E, Naik SB. Platelet rich fibrin combined with a porous hydroxyapatite graft for the treatment of three-wall intrabony defects in chronic periodontitis: A randomized controlled clinical trial. J Periodontol. 2017;88(12):1288–1296. https://doi.org/10.1902/jop.2012.110722
9. Armitage GC. Development of a classification system for periodontal diseases and conditions. Ann Periodontol. 1999 Dec;4(1):1–6.
10. Björn H, Halling A, Thyberg H. Radiographic assessment of marginal bone loss. Odontol Revy.1969;20(2):165–179. PMid:5259016
11. Schei O, Waerhaug J, Lovdal A, Arno A. Alveolar bone loss as related to oral hygiene and age. J Periodontol.1959;30:7–16. https://doi.org/10.1902/jop.1959.30.1.7
12. Li-ares A, Cortellini P, Lang NP, Suvan J, Tonetti MS. European research group on periodontology (ErgoPerio). Guided tissue regeneration/ deproteinized bovine bone mineral or papilla preservation flaps alone for treatment of intrabony defects. II: radiographic predictors and outcomes. J Clin Periodontol. 2006;33(5): 351-8. https://doi.org/10.1111/j.1600-051X.2006.00911.x. PMid:16634957
13. Prapayasatok S, Janhom A, Verochana K, Pramojanee S. Digital camera resolution and proximal caries detection. Dentomaxillofac Radiol. 2006;35(4):253–77. https://doi.org/10.1259/dmfr/32165678. PMid:16798921
14. Dohan Ehrenfest DM, de Peppo GM, Doglioli P, Sammartino G. Slow release of growth factors and thrombospondin -1 in Choukroun's platelet-rich fibrin (PRF): a gold standard to achieve all surgical platelet concentrates technologies. Growth Factors. 2009;27(1):63–69. https://doi.org/10.1080/08977190802636713. PMid:19089687
15. Thorat M, Pradeep AR, Pallavi B. Clinical effect of autologous platelet-rich fibrin in the treatment of intra-bony defects: a controlled clinical trial. J Clin Periodontol. 2011;38(10):925–932. https://doi.org/10.1111/j.1600-051X.2011.01760.x. PMid:21777267
16. Trombelli L, Heitz-Mayfield LJ, Needleman I, Moles D, Scabbia A. A systematic review of graft materials and biological agents for periodontal intraosseous defects. J Clin Periodontol. 2002;29 Suppl 3:117–135. https://doi.org/10.1034/j.1600-051X.29.s3.7.x. PMid:12787213
17. Allan I, Newman H, Wilson M. Antibacterial activity of particulate bioglass against supra- and subgingival bacteria. Biomaterials. 2001;22(12):1683–1687. https://doi.org/10.1016/S0142-9612(00)00330-6
18. Low SB, King CJ, Krieger J. An evaluation of bioactive ceramic in the treatment of periodontal osseous defects. Int J Periodontics Restorative Dent. 1997;17(4):358–367. PMid:9497726
19. Zamet JS, Darbar UR, Griffiths GS, Bulman JS, Brägger U, Bürgin W, et al. Particulate bioglass as a grafting material in the treatment of periodontal intrabony defects. J Clin Periodontol. 1997;24(6):410–418. https://doi.org/10.1111/j.1600-051X.1997.tb00205.x
20. Marx RE, Carlson ER, Eichstaedt RM, Schimmele SR, Strauss JE, Georgeff KR. Platelet rich plasma: Growth factor enhancement for bone grafts. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 1998;85(6):638–646. https://doi.org/10.1016/S1079-2104(98)90029-4
21. Okuda K, Tai H, Tanabe K, Suzuki H, Sato T, Kawase T, et al. Platelet-rich plasma combined with a porous hydroxyapatite graft for the treatment of intrabony periodontal defects in humans: a comparative controlled clinical study. J Periodontol. 2005;76:890–898. https://doi.org/10.1902/jop.2005.76.6.890. PMid:15948682
22. Demir B, Sengün D, Berberoğlu A. Clinical evaluation of platelet-rich plasma and bioactive glass in the treatment of intra-bony defects. J Clin Periodontol. 2007;34(8):709–715. https://doi.org/10.1111/j.1600-051X.2007.01108.x. PMid:17635247
23. Clark RA. Fibrin and wound healing. Ann N Y Acad Sci. 2001;936:355–367. https://doi.org/10.1111/j.1749-6632.2001.tb03522.x. PMid:11460492
24. Choukroun J, Adda F, Schoeffler C, Vervelle A. Une opportunité en paro-implantologie: Le PRF. Implantodontie. 2001;42:55–62.
25. Nevins ML, Camelo M, Nevins M, King CJ, Oringer RJ, Schenk RK, et al. Human histologic evaluation of bioactive ceramic in the treatment of periodontal osseous defects. Int J Periodontics Restorative Dent. 2000;20(5):459–467.
26. Prichard JF. The intrabony technique as a predictable procedure. J Periodontol. 1957;28:202–216. https://doi.org/10.1902/jop.1957.28.3.202
27. Blumenthal NM, Alves ME, Al-Huwais S, Hofbauer AM, Koperski RD. Defect-determined regenerative options for treating periodontal intrabony defects in baboons. J Periodontol. 2003;74(1):10–24. https://doi.org/10.1902/jop.2003.74.1.10. PMid:12593591

28. Yukna RA, Krauser JT, Evans GH, Cruz R, Martin M. Multi-center clinical comparison of combination anorganic bovine-derived hydroxyapatite matrix (ABM)/cell binding peptide (P-15) and ABM in human periodontal osseous defect. 6 months results. J Periodontol. 2000;71(11): 1671–179. https://doi.org/10.1902/jop.2000.71.11.1671. PMid:11128913
29. Rosen PS, Reynolds MA, Bowers GM. The treatment of intrabony defects with bone grafts. Periodontol 2000. 2000;22:88–103. https://doi.org/10.1034/j.1600-0757.2000.2220107.x. PMid:11276519

Notes:

a. Extension Cone Paralleling holders supplied by Dentsply Rinn