Acta Scientific Dental Sciences (ISSN: 2581-4893)

Volume 6 Issue 8 August 2022

Research Article

Influence of I-PRF on Implant Stability and Marginal Bone Loss in the Posterior Mandible: A Split-Mouth Randomized Controlled Trial

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DOI: 10.31080/ASDS.2022.06.1444

Received: June 24, 2022

Published: July 27, 2022

Abstract

Background: PRF (Platelet Rich Fibrin) has been postulated to be releasing elevated concentrations of numerous growth factors and positively contribute towards bone healing and implant success. However, there is a dearth of literature on the effect of i-PRF (injectable- Platelet-rich fibrin) on dental implants' primary and secondary stability and associated marginal bone loss.

Materials and Methods: This, double-blind (patient and statastician), randomized split-mouth clinical trial was done among 12 subjects aged between 25 and 55years. Patients with bilateral edentulous sites having at least two missing posterior teeth in the mandible with intact buccal width and height (6mm*12mm) were included. Twenty-four implant sites among study subjects were then randomly allocated to the PRF and control groups. The implant of size 4.5*10mm was placed in both groups. In the sites assigned to the PRF group, the implant surfaces were coated with i-PRF, and the prefabricated healing abutments were placed and implantswere allowed to heal for 3 months. Wilcoxon signed-rank test was done for the intergroup comparison (p = 0.01*). Implant stability quotient (ISQ), and marginal bone loss was measured

Results: There was a statistically significant difference in the ISQ values between the study groups at three months follow-up, with higher mean values observed in the PRF group (Wilcoxon signed-rank test; p = 0.01*). Intragroup analysis revealed no significant increase in ISQ values in the control group, while there was a significant increase in the ISQ values in the PRF group from baseline to 3 months (Repeated measures ANOVA; p = 0.009). There is a reduction in the crestal bone loss around implants in the PRF group after 1year compared to the control group.

Conclusion: Within the limitations of this study, it can be concluded that i-PRF secondary stability was improved after three months and crestal bone loss was reduced after 1 year.

Keywords: Alveolar Bone Loss; Implant-Supported Dental Prosthesis; Platelet-Rich Fibrin

Introduction

Oral rehabilitation with dental implants has gained prominence over the years for both partially and completely edentulous in light of the improved success rates with these treatment options. The optimal achievement of osseointegration is multi-factorial, which depends on the density and quality of bone, surgical techniques employed, and the design of the implants [1]. It is the combination of these factors which influences the stability of an implant after insertion [2]. It has been well established in the literature that primary stability is one of the fundamental parameters that determine

the success of osseointegration [3,4]. Micromotion of the implant that results from poor primary stability leads to failure of osseointegration owing to the fibrous tissue formation because of displacement of the implant from the bone. Literature suggests that the range of allowable micromotion is 50-150 μm [5]. It has also been discussed that good primary stability is positively correlated with an improved secondary stability [6]. It is for these reasons of improving the primary stability, and relative avoidance of micromotion that leaving implants unloaded for 6-8 months in the maxilla and 3-4 months in the mandible was initially recommended [7-9]. Another critical concern is that the healing process in response to the trauma caused during implant insertion is conditional on foreign material in the bone. So, the aim of the study was to find out the effect of injectable PRF (i-PRF) on the stability and marginal bone loss of dental implants in posterior mandibular region. While a steady-state bone remodeling activity is ensured most often with biocompatible materials, imbalances may result in marginal bone loss, which is designated as another fundamental criterion in determining the success of an implant [10]. With increasing research on the modification of surface topography and design of the implants to reduce the duration required for successful osseointegration by improving bone-to-implant contact (BIC) and facilitating quicker healing on how long the implants had to be left unloaded changed substantially [11]. Another approach for increasing BIC is the surface treatment of implants with growth factors to improve osteoblastic differentiation [12,13]. This approach has its roots in the therapeutic notion that when physiological levels of growth factors are good for bone regeneration, supra-physiological grades would be better [14].

Platelet concentrates, i.e., Platelet-rich Plasma (PRP) and Platelet-rich Fibrin (PRF), have a wide range of applications in many medical fields [15]. PRF necessitates no biochemical manipulation of blood and is a second-generation concentrate of platelets. Along with platelets, PRF contains the activated growth factors, leukocytes within the complex organization of fibrin matrix architecture due to natural polymerization, warranting no addition of an anticoagulant [16-18]. With increasing investment into the surface treatment of implants, various forms of PRF became available: Pure platelet-rich fibrin (P-PRF); Leukocyte rich- PRF (L-PRF); Titanium-prepared PRF (T-PRF); Advanced PRF (A-PRF); injectable PRF (i-PRF) [19]. While the critical advantages of A-PRF are early vascularization, more cytokines, and bone morphogenic proteins (BMP) [19], i-PRF has been postulated to be releasing elevated concentrations of numerous growth factors and promoted increased migration of fibroblasts and expression of PDGF, TGF-β, and collagen1.[20] With this background, the objectives of this study were to evaluate the differences in stability and crestal bone loss around dental implants placed with and without i- PRF.

Materials and Methods

This prospective, double-blind, randomized split-mouth clinical trial was done among 12 subjects, aged between 25 and 55 years, to receive an implant for replacing the missing teeth. The sample size was calculated using G*power 3.1.9.7 software to detect an effect size of 1 using the Wilcoxon signed-rank test at 80% power and an alpha error of 5%. The ethical approval was obtained from the institutional ethical committee (VDC/lEC/2018/41), and the study was conducted between December 2018 and December 2020. Informed consent was obtained from those participants who met the eligibility criteria and were willing to participate.

- **Inclusion criteria:** ASA 1 Patients with bilateral edentulous sites having at least two missing posterior teeth in the mandible with intact buccal ridge width (6mm*12mm) were included in the study. Twenty-four implant sites among the study subjects were then randomly allocated to the PRF and control groups.

- **Exclusion criteria:** Subjects with a history of radiotherapy to head and neck, smokers, and severe bruxism were excluded. Oral prophylaxis was done as a part of routine dental check up for all the study subjects.

Intraoral periapical radiographs followed by a clinical evaluation of edentulous sites receiving implants, and diagnostic study models were prepared. Facebow transfer was done using the Hanau spring bow (Whipmix, USA). An inter-occlusal record was done using Alu wax (Maarc dental, Maharashtra), and casts were mounted on Hanau semi-adjustable articulator (Whipmix, USA). Sites among the study subjects were then randomly allocated to the PRF and control groups using computer randomization. After administering 2% lignocaine with 1:80,000 adrenaline, a mid-crestal incision was made, and a full-thickness mucoperiosteal flap was elevated. The initial preparation was done with a 2 mm drill extending the osteotomy to 10 mm, and the osteotomy site was prepared up to a

diameter of 4 mm using sequential drills. Blood was collected using a 24 gauge butterfly needle in in i-PRF tube (10 ml). i-PRF was prepared by spinning the tubes at 700 rpm for 3 minutes. In the sites allocated to the PRF group, the implant surfaces were coated with i-PRF using a 5 ml syringe. Syna (Life Care, Mumbai) 4.5*10 mm implants were inserted into the prepared osteotomy sites, and implant stability quotients (ISQ) were recorded. healing abutments were placed (Figure 1). Simple interrupted sutures were placed using 4-0 vicryl. Post-operatively, antibiotics and analgesics were prescribed for five days. Patients were called for suture removal after 7 days, and ISQ values were obtained in the mesiodistal direction at one-month, two-month, and three-month recall visits. Marginal bone levels were assessed by intr oral grid, IOPA (intra oral periapical radiograph), and paralleling cone technique at six months and one-year follow-up visits. Figure 2 presents the CONSORT flow chart of the trial.

Statistical analysis was done using IBM SPSS version 20 software (IBM SPSS, IBM, Armonk, NY, USA). Wilcoxon signed-rank tests were used to check the differences in the study parameters between the PRF and control groups. Repeated measures analyses of variance were used to check the changes in crestal bone loss and ISQ values within each study group with changes in time.

Figure 1: i-PRF coating on the implant surface and placement of healing abutment.

a) i-PRF preparation, b) i-PRF coating, c) healing abutment placed

Figure 2: CONSORT flow chart.

Results

The mean age of the study participants was 30.21 ± 8.52 years. Of the 12 study participants, 9 (75%) were males. Wilcoxon signed-rank test was done for the intergroup comparison (p = 0.01*). There was a statistically significant difference in the ISQ values between the study groups at three months follow-up, with higher mean values observed in the PRF group (Table 1and Figure 3). Table 2 presents intra-group changes in ISQ values with time. It was observed from repeated measures analysis of variance that there was no significant change in ISQ values in the control group from baseline to 3months follow-up visits. A significant increase was observed in ISQ values in the PRF group from baseline to 3 months follow-up. Multiple pairwise comparisons using post hoc analysis showed a significant difference between the baseline and three-month follow-up time points; all other pairwise comparisons were not statistically significant.

While no crestal bone loss was observed at baseline in both the study groups, significant differences were observed between groups at six months and one-year follow-up on the mesial and distal sides. (Table 3 and Figure 4). Table 4 shows the intragroup comparisons of crestal bone loss with change in time. A significant increase in crestal bone loss from 6 months to 1-year follow-up visits was observed on the mesial site in the control group, while all other comparisons were not statistically significant.

Time	Group (n)	Mean ± SD	Mean rank	Z value	P value
Baseline	PRF (12)	81.83 ± 4.82	5.2	-1.02	0.307
	Control (12)	83.67 ± 2.57	7.43		
1 month	PRF (12)	84.67 ± 1.82	6.05	-1.7	0.089
	Control (12)	83.42 ± 2.35	8.75		
2 months	PRF (12)	84.83 ± 2.29	6.29	-0.98	0.324
	Control (12)	83.92 ± 2.39	5.5		
3 months	PRF (12)	86.17 ± 2.03	5.83	-2.56	0.01*
	Control (12)	83.67 ± 3.7	2.5		

Table 1: Comparison of ISQ values between the study groups.

Wilcoxon signed-rank test; p ≤ 0.05 considered statistically significant; * denotes statistical significance.

Group	Time	Mean ± SD	Type III sum of squares	F value	P-value
PRF	Baseline	81.83 ± 4.82	119.58	4.58	0.009*[a]
	One month	84.67 ± 1.82			
	Two months	84.83 ± 2.29			
	Three months	86.17 ± 2.03			
Control	Baseline	83.67 ± 2.57	1.5	0.084	0.96
	One month	83.42 ± 2.35			
	Two months	83.92 ± 2.39			
	Three months	83.67 ± 3.7			

Table 2: Comparison of ISQ values in each of the study groups with change in time.

Repeated measures analysis of variance; p ≤ 0.05 considered statistically significant; * denotes statistical significance; a significant difference observed between baseline and three months in post hoc analysis.

Site	Time	Group (n)	Mean ± SD	Mean rank	Z value	P-value
Mesial	Six months	PRF (12)	0.71 ± 1.23	3.33	-2.27	0.02*
		Control (12)	1.26 ± 1.55	7.56		
	1 year	PRF (12)	1.13 ± 2	6.13	-1.13	0.25
		Control (12)	1.48 ± 1.54	6.69		
Distal	6 months	PRF (12)	0.52 ± 0.17	3.67	-2.19	0.028*
		Control (12)	1.43 ± 1.36	7.44		
	1 year	PRF (12)	1.04 ± 1.67	5.5	-2.17	0.028*
		Control (12)	1.52 ± 1.54	6.7		

Table 3: Comparison of crestal bone loss between the study groups.

Wilcoxon signed-rank test; p≤0.05 considered statistically significant; * denotes statistical significance**.**

Site	Group	Time	Mean ± SD	Mean rank	Z value	P-value
Mesial	PRF	Six months	0.71 ± 1.23	5.33	-1.8	0.071
		One year	1.13 ± 2	6.89		
	Control	6 months	1.26 ± 1.55	6.37	-2.19	0.028*
		One year	1.48 ± 1.54	6.09		
Distal	PRF	6 months	0.52 ± 0.17	4.63	-0.15	0.875
		One year	1.04 ± 1.67	10.25		
	Control	6 months	1.43 ± 1.36	10	-0.706	0.48
		One year	1.52 ± 1.54	5.33		

Table 4: Changes in crestal bone loss in each of the study groups with change in time.

Wilcoxon signed-rank test; p ≤ 0.05 considered statistically significant; * denotes statistical significance.

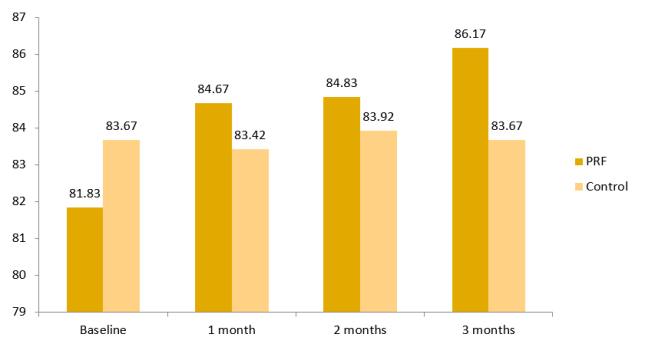

Figure 3: Comparison of ISQ values between the study groups.

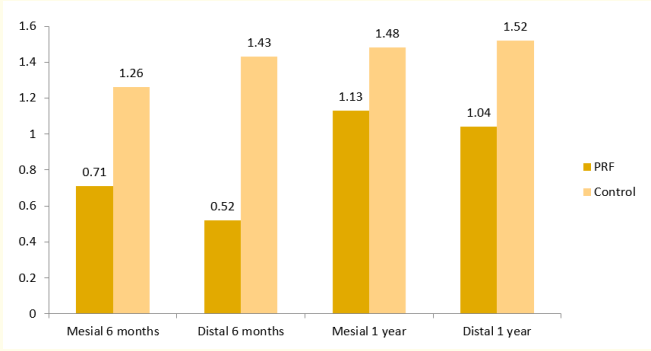

Figure 4: Comparison of crestal bone loss between the study groups.

Discussion

The study results demonstrate that implants in the i-PRF group had better implant stability and less crestal bone loss than those in the control group. The present study showed that the i-PRF group had higher ISQ values compared to the control group. At the same time, stability does depend on factors other than surface treatment of the implants with growth factors such as type of bone, implant design, surgical technique. [21] The methodology adopted in this study with robust exclusion criteria and split-mouth randomization ensures that the differences in implant stability between the study groups could be attributed to i-PRF. By the presence of growth factors, PRF enhances the regeneration of host bone and improves osseointegration [22]. Similar results suggest enhanced osseointegration in implants treated with PRF were reported by Al Nashar A and Yakoob H [23], Anitua E., *et al*. [24] Becker W., *et al.* [25]. In the current study, none of the implants (SYNA, Life Care, Mumbai) in either of the groups had primary stability < 44 ISQ. This distinction is being made to rule out the potential confounding effect in the subsequent evaluation of implant stability owing to reduced primary stability less than 44 ISQ, which is proven to be an important indicator for implant failure [26]. Primary stability is considered as one of the fundamental parameters in the determination of osseointegration. It has been established in the literature that the incidence of implant failure was higher with lesser primary stability values [27-29]. The rationale for this observation could be found in the reduced micromotion and lesser possibility for fibrous tissue formation at the bone and implant junction among implants with higher primary stability [30]. At three months follow-up, a significant difference in ISQ values was observed between the PRF and the control groups. A previous study conducted by Diana C., *et al.* [22], no significant differences in secondary stability were noted at three months follow-up between the PRF and control groups. They reported a substantial increase in stability from baseline to 3 months follow-up in both the PRF and control groups, contrary to what was observed in this study. There was no significant difference in the ISQ values from baseline to 3 months follow-up in the control group.

Based on the expression of growth factors during the healing process following surgical trauma caused during implant placement, the possible therapeutic role of these growth factors in enhancing hard tissue repair could be discerned. i-PRF has been hypothesized to be releasing increased concentrations of multiple growth factors and facilitated increased migration of fibroblasts and expression of PDGF, TGF-β, and collagen1 [20]. The beneficial influence of these growth factors in the healing process has been emphasized in the literature [31,32]. In the present study, less crestal bone loss was observed in the PRF group than the control group adding strength to the existing evidence. Similar findings were reported by Peck MT., *et al.* [33]. Vijayalakshmi R., *et al.* [34] Boora P., *et al.* [35] A single implant system was used in the study, and all the procedural steps were standardized to ensure internal validity. Moreover, the present study reported a relatively longer follow-up than another recent survey conducted by Boora P., *et al.* among 20 subjects in the maxillary anterior region.[35] This is one of the first few studies which reported the positive influence of i-PRF on implant stability and minimizing marginal bone loss. One of the limitations of this study was that the soft tissue parameters were not considered.

Conclusion

Within the limits of this study, it was found that the implants in the i-PRF group demonstrated better stability compared to those in the control group. I-PRF group also showed reduced crestal bone loss as compared to the control group at the follow-up evaluations. Therefore, it can be concluded that i-PRF can enhance osseointegration and positively influence peri-implant tissue healing within three months.

Financial Support

Self-funded study.

Conflict of Interest

None declared.

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