Original Article

Immediate dental implant placement with and without Platelet-Rich Fibrin (PRF) in esthetic zone: A comparative study

ABSTRACT

Context: Biomaterials such as platelet-rich fibrin (PRF) have shown to improve healing and osseointegration.

Aims: The aim of this study was to clinically and radiographically evaluate and compare immediate implants placed with and without PRF.

Settings and Design: This prospective and comparative study was conducted among 30 patients in the Department of Oral and Maxillofacial Surgery, Govt. Dental College and Hospital, Srinagar.

Materials and Methods: Thirty subjects were randomly divided into two groups: group A or PRF group and group B or non-PRF group with fifteen patients in each group. Clinical parameters such as implant mobility and bleeding on probing were recorded. The radiographic parameters such as bone density in Hounsfield units (HU) and marginal bone loss (mm) were measured using cone-beam computed tomography (CBCT).

Statistical Analysis Used: For intergroup analysis of data, Student's independent t-test and Chi-square test were employed. The paired t-test and McNemar test were applied for intragroup analysis of data.

Results: No significant difference in the mean marginal bone level scores between PRF group and non-PRF group (intergroup) at baseline and at 3 months was observed. A Statistically significant difference was observed in the mean bone density (HU) in the PRF group (intragroup) between baseline and 3 months and also in bleeding on probing between baseline and 6 months in the PRF group (intragroup).

Conclusions: The results highlighted the promising but transitory effects of (PRF) membrane in immediate implants and showed an improvement in peri-implant bone density, which improves implant stability and subsequent long implant survival and prognosis.

Keywords: Alveolar bone loss, bone implant interface, CBCT, dental implants, platelet-rich fibrin

INTRODUCTION

Tooth replacement using dental implants has proven to be a successful treatment modality for treating partially and fully edentulous patients. The loss of teeth in the esthetic zone can be the most distressing experience for the patient. Modern dental implantology aims to provide satisfying esthetics and a stable osseointegration.[1] In addition to maintaining the masticatory system and facial esthetics efficiently, teeth play an important role in the maintenance of alveolar process dimensions and periodontal tissue support.[2]

Immediate dental implant placement has become a popular alternative to conventional implant placement. One purported

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advantage of immediate implants over conventional implants is maintenance of alveolar anatomy over extraction alone. Also, the immediate implant placement reduces the number of surgical interventions. When implants are placed into the extraction socket, a partial incongruence would be seen between the outer surface of the implant and bony wall of the socket. This space is known as jumping distance or critical space. Placing an immediate implant usually results in a direct bone to implant contact in the apical part of the socket, which provides osseous anchorage to ensure a high degree of initial mechanical stability.[3,4] In an attempt to preserve the tissue dimensions of the dental socket immediately after extraction and fill the space between the implant and adjacent tissues, grafting has been the technique of first choice.

Many previous reports have justified the use of bone substitutes with blood derivatives to provide a synergistic action in the tissue healing process. Among these blood products, platelet-rich fibrin (PRF) stands out for its osteogenic properties, due to the presence of growth and angiogenic factors.[5] PRF is considered a healing biomaterial, and it has a robust stimulating effect on various aspects of healing of soft and osseous tissue including angiogenesis and immune control, harnessing the circulating stem cells. One of the most desirable features of PRF is its efficacy in providing concentrated growth factors at the surgical site to stimulate the healing process.

The aim of this study was to clinically and radiographically evaluate and compare immediate implants placed with and without PRF.

MATERIALS AND METHODS

This prospective and comparative study was conducted on 30 patients fulfilling the inclusion criteria who reported to the Postgraduate Department of Oral and Maxillofacial Surgery. The sample size was calculated at 95% confidence level and allowable error of 15%, assuming effect in 4% of the population. Sample size = 4 PxQ/L2, where Q = 1-P, $4 \times 4 \times 96/7.52 = 27.3$. Thus, a minimum of 30 study subjects were required as sample size. Informed consent was obtained from all the participants, according to the World Medical Association Declaration of Helsinki. The study protocol was approved by the Institutional Ethical Committee and Review Board Vide No.: Prostho/GDC/5002, dated: 02-11-2020. Written and verbal consent was obtained from the selected patients.

The subjects were randomly divided into two groups: group A: fifteen patients—PRF group (test group) and group B: fifteen patients—non-PRF group (control group). Inclusion criteria included patients with the presence of non-restorable maxillary anterior and premolar teeth due to trauma, caries, root resorption, root fracture and endodontic failure, cooperative patients with good oral hygiene, no acute infection or clinical sign of inflammation present, presence of an intact extraction socket, sufficient bone quality, and availability for primary stability of the implants (D1–D3), with an intact labial bone plate and a minimum of 5 mm bone apically as measured with cone-beam computed tomography (CBCT) and with a jumping distance of <2 mm. Exclusion criteria included heavy smokers smoking >10 cigarettes/day, traumatic occlusion and presence of para-functional habits, presence of acute and chronic systemic disorders such as uncontrolled diabetes, hemorrhagic disorders, immune-compromised patients and other conditions that can affect wound healing responses, extreme bone atrophy, and presence of any periapical pathology.

Each case was subjected to a full diagnostic workup including detailed case history record, diagnostic casts, complete clinical photographs, routine baseline investigations, and radiographic evaluation using periapical radiographs and CBCT to estimate the bone quality and width of the bone in the area of immediate implant placement. A panoramic evaluation was done by CBCT. The PRF preparation for the test group was started just before the surgery. A tourniquet was placed on the hand from which blood was to be drawn. In all patients, cephalic vein in the antecubital fossa was used for blood withdrawal. The collected blood was centrifuged at 3000 rpm for 10 min, and blood was separated into three layers, that is, red lower fraction containing red blood cells, upper straw-colored acellular platelet poor plasma, and the middle fraction containing the PRF clot. The upper straw-colored layer was then removed, and the PRF was easily separated from the lower fraction containing red blood cells using sterile tweezers and scissors.

The surgical site was anesthetized by nerve block, and the affected tooth was carefully removed with minimal trauma to the alveolar bone. Sequential drilling with copious irrigation was performed till the desired dimensions were achieved depending on the selected implant. The implants were placed 2–3 mm beyond the apex to achieve primary stability and also considering the angulation as assessed by CBCT. The cover screw was then placed on the top of the implant. In the test group, the residual gap between the socket wall and implant threads was grafted with PRF and a part of PRF clot was flattened and used as a membrane before flap closure. In the control group, an implant of proper length and diameter was placed 2–3 mm beyond the apex in the

fresh extraction socket to achieve primary stability without the use of PRF. Then, an immediate postoperative X-ray was taken in all the cases.

A prosthesis based on individual patient needs was fabricated, and cementation of the definitive prosthesis was done after 3–6 months depending upon CBCT evaluation.

The following parameters were evaluated at baseline, 3 months, and 6 months of implant insertion:

i) Bleeding on Probing[6]

Bleeding on probing was measured 15 seconds after probing and recorded as present or absent.

ii) Implant Mobility[7]

It was measured in a method similar to that used to assess tooth mobility. With two rigid instruments, a force of approximately 500 gms was applied in the labiolingual direction. The amplitude of implant mobility was scored 0–4, according to the Clinical Implant Mobility Scale:

Score inference:

0 Absence of any clinical mobility with 500 gms in any direction
1 Slight detectable horizontal movement
2 Moderate visible horizontal mobility
3 Severe horizontal mobility > 0.5 mm
4 Visible moderate-to-severe horizontal movement

Radiographic evaluation or CBCT study

The following parameters were evaluated at baseline (immediately after placement) and 3rd month of implant insertion using a cone-beam computed tomographic scan:

1) Marginal bone loss

2) Bone density

i) **Marginal Bone Loss**[8]:

Cone-beam computed tomographic scans were done to assess the quantity and quality of bone around the implant. Evaluation of the buccal bone level (BBL), palatal bone level (PBL), mesial bone level (MBL), and distal bone level (DBL) was performed with the use of cone-beam CT scanner. All patients were examined immediately on the same day through CBCT to assess the marginal bone level as a baseline. Two views, coronal and sagittal, were utilized in the determination of mesial and distal and buccal and palatal marginal bone levels around the implant, respectively. A line (Y) was drawn through the long axis of the implant. The implant–abutment connection line was identified, and a line (X) was drawn through this line perpendicular to the (Y) line. The distance from the crestal bone to the line (X) was measured and recorded to determine the amount of crestal bone loss at the subsequent follow-up periods for MBL, DBL, BBL, and PBL. The radiographic implant sites were analyzed using the NewTom NNT software [Figure 1].[9]

ii. Bone Density Recording[10]

The quality of the bone was assessed with the help of bone density of the bone formed in the peri-implant area obtained through the CBCT scan. Bone density was assessed in terms of Hounsfield unit (HU) in immediate post-op and 3 months post-op CBCT scans. The quality of bone was grouped into D1, D2, D3, and D4 types of bone.

Bone density was recorded from the sagittal view. The total length of the implant was measured and then divided into three parts, representing the coronal, middle, and apical thirds, and the readings were recorded from the mesial and distal aspects of the fixture. Measurements were taken from around approximately 2 mm in a parallel manner away from the implant fixture. Then, those six readings were divided by 6 to get the mean value of bone density around each implant [Figure 2].[11]

Statistical analysis

The recorded data were analyzed by Statistical Package for the Social Sciences (SPSS) version 20.0 (SPSS Inc., Chicago, Illinois, USA). Continuous variables were expressed as mean ± SD, and categorical variables were summarized as frequency and percentages. For intergroup analysis of data, Student's independent *t*-test and Chi-square test were employed. The paired *t*-test and McNemar test were applied for intragroup analysis of data. A *P* value of less than 0.05 was considered statistically significant.

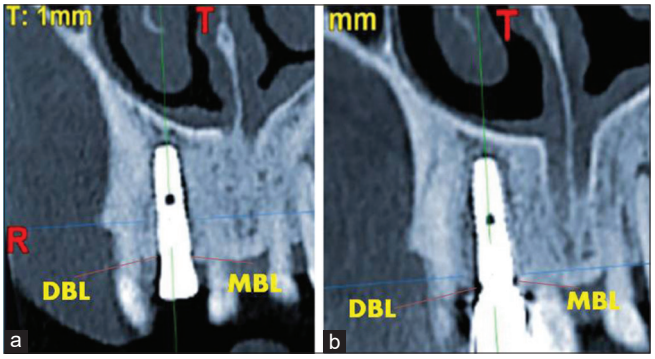

Figure 1: Diagrammatical representation to calculate marginal bone loss. Marginal bone height mesial and distal to the same implant (a) immediately. (b) After 3 months. MBL: Mesial bone less, DBL: Distal bone less

RESULTS

The total number of participants included in the study was 30 of which twenty-five were males (83.33%) and five were females (16.66%). The mean age of the participants was 28.8 ± 6.51 years. The mean age of participants in the PRF group was 29.1 ± 7.18 years. The mean age of participants in the non-PRF group was 28.5 ± 5.84 years.

Intergroup comparison

At baseline, the mean marginal bone level score in the PRF group was 0.71 ± 0.29. The mean marginal bone level score in the non-PRF group was 0.54 ± 0.30. No significant difference was observed between the PRF group and the non-PRF group at baseline [Figure 3]. At 3 months, the mean marginal bone level score in the PRF group was 0.68 ± 0.28. The mean marginal bone level score in the non-PRF group was 0.60 ± 0.30. No significant difference was observed between the PRF group and the non-PRF group at 3 months [Figure 4]. The mean bone density (HU) in the PRF group at baseline and 3 months was 774.9 ± 148.18 and 865.2 ± 129.57, respectively. The mean bone density (HU) in the non-PRF group at baseline and 3 months was 769.1 ± 140.81 and 793.3 ± 149.93, respectively. No significant difference was observed between the PRF group and the non-PRF group at baseline and 3 months [Table 1].

Intragroup comparison

The mean marginal bone level score in the PRF group at baseline and 3 months was 0.71 ± 0.29 and 0.68 ± 0.28. No significant difference was observed between the PRF group at baseline and 3 months [Table 2]. The mean marginal bone level score in the non-PRF group at baseline and 3 months was 0.54 ± 0.30 and 0.60 ± 0.30. No significant difference was observed between the non-PRF group at baseline and 3 months [Table 3]. The mean bone density (HU) in the PRF group at baseline and 3 months was 774.9 ± 148.18 and 865.2 ± 129.57, respectively. The mean bone density (HU) in the non-PRF group at baseline and 3 months was 769.1 ± 140.81 and 793.3 ± 149.93, respectively. A statistically significant difference was observed between baseline and 3 months in the PRF group [Table 4]. Also, a statistically significant reduction in bleeding on probing was observed between baseline and 6 months in the PRF group [Figure 5 and Table 5].

DISCUSSION

The implants placed at the time of tooth extraction are called immediate implants.[12] After implant site preparation and placement, blood vessels and bone injury occur triggering hemostasis that leads to blood clot formation.

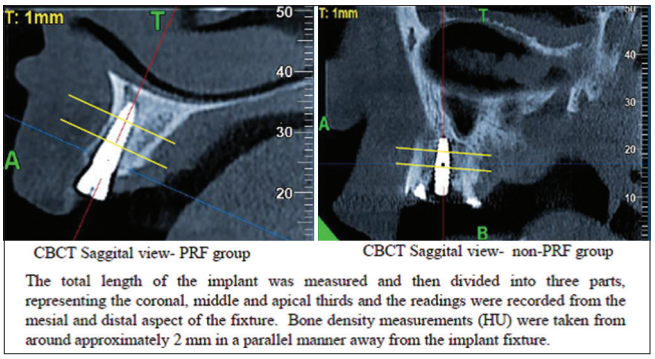

Figure 2: Diagrammatical representation to calculate bone density (HU)

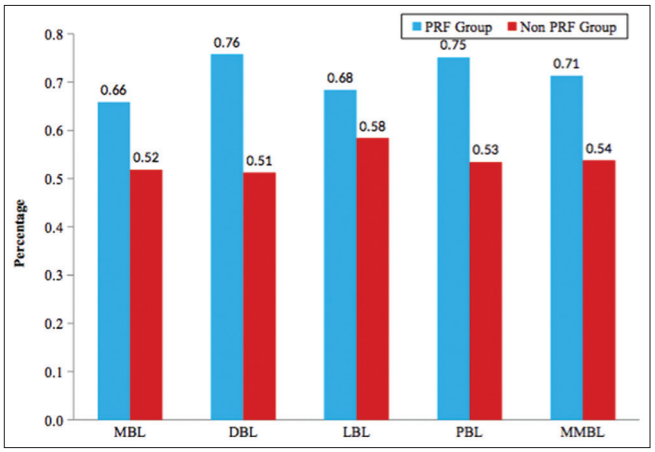

Figure 3: Intergroup comparison based on marginal bone level (mm) at baseline

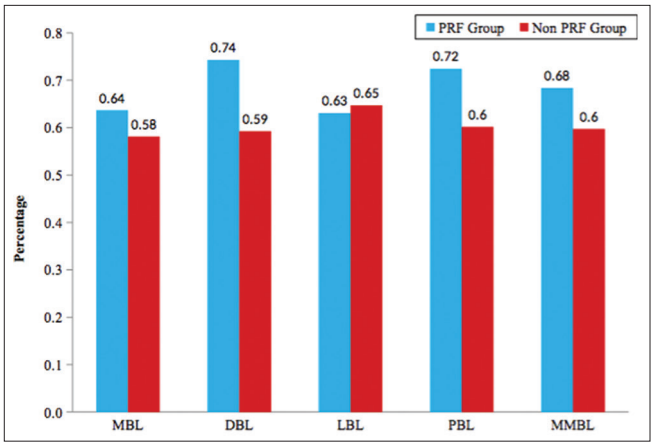

Figure 4: Intergroup comparison based on marginal bone level (mm) at 3 months

This initiates immune-inflammatory response, followed by neovascularization and the transient fibrin-based structural matrix formation serving as an osteoconductive medium.[13]

Platelet-rich fibrin (PRF) is a concentrated suspension of growth factors found in platelets, which contains abundant growth factors. It reduces the risk of bacterial invasion and ensures a microenvironment conducive to tissue growth in

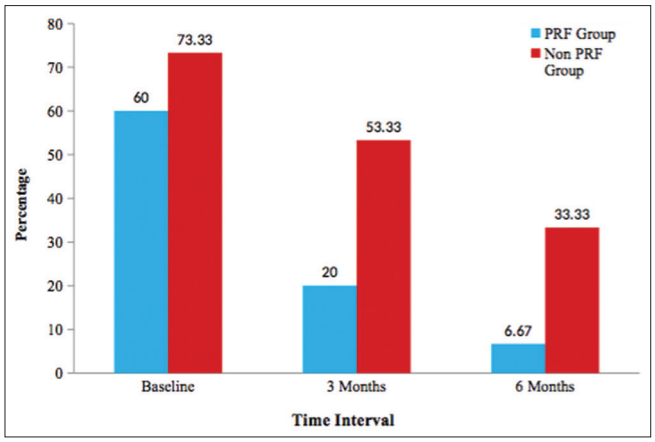

Figure 5: Intergroup comparison based on bleeding on probing

the early stages of healing.[14] In this study, PRF was freshly prepared and used without delay to exert maximum beneficial effect.

In this study, marginal bone level changes were observed in both the PRF and non-PRF groups using CBCT. In the PRF group, although there was a slight reduction in crestal bone loss after 3 months nonsignificant crestal bone level changes were noted at baseline and 3rd month. This suggests that PRF placement slows down the early resorptive phase to some extent even though the changes noted are not statistically significant. Similarly within non-PRF group, nonsignificant crestal bone level changes were noted at baseline and within three months. The amount of crestal bone level changes as exhibited in study group was again statistically insignificant than the control group.

In contrast to the results of this study, Boora P *et al*.[6] reported lower marginal bone loss associated with PRF and non-PRF group and statistically significant crestal bone level changes were noted within three months. However, the amount of crestal bone level changes as exhibited in the study group had a statistically significant lesser mean value than the control group. The insignificant difference reported in our study is probably related to the short-term effect of the PRF. The findings of our study were at par with a study conducted by Kalash S *et al*.,[15] where there was no statistically significant difference observed between groups. Fontana *et al*.[16] reported a significantly greater amount of newly formed bone when dental implants are treated with PRP *in vivo*. There was no statistically significant difference between immediate implant without PRF and delayed implant placement with respect to all parameters, i.e., buccal to lingual bone, i.e., buccolingual bone width at baseline, 3 months, and 6 months.[17]

Table 1: Intergroup comparison based on bone density (HU) at baseline and 3 months

Time interval	PRF group		Non-PRF group		*P*
	Mean	SD	Mean	SD	
Baseline	774.9	148.18	769.1	140.81	0.914
3 months	865.2	129.57	793.3	149.93	0.173

Table 2: Intragroup comparison based on marginal bone level (mm) in PRF group

	Baseline		3 months		Difference	*P*
	Mean	SD	Mean	SD		
MBL	0.66	0.310	0.64	0.288	0.02	0.416
DBL	0.76	0.450	0.74	0.419	0.02	0.601
LBL	0.68	0.320	0.63	0.276	0.05	0.172
PBL	0.75	0.396	0.72	0.415	0.03	0.217
MMBL	0.71	0.295	0.68	0.289	0.03	0.124

Table 3: Intragroup comparison based on marginal bone level (mm) in non-PRF group

	Baseline		3 months		Difference	*P*
	Mean	SD	Mean	SD		
MBL	0.52	0.320	0.58	0.344	-0.06	0.137
DBL	0.51	0.314	0.59	0.320	-0.08	0.082
LBL	0.58	0.359	0.65	0.364	-0.06	0.145
PBL	0.53	0.289	0.60	0.280	-0.07	0.197
MMBL	0.54	0.300	0.60	0.301	-0.06	0.132

Table 4: Intragroup comparison based on bone density (HU) in two groups

Time interval	Baseline		3 months		Difference	*P*
	Mean	SD	Mean	SD		
PRF group	774.9	148.18	865.2	129.57	90.3	0.004*
Non-PRF group	769.1	140.81	793.3	149.93	24.2	0.171

*Statistically significant difference with respect to baseline ($P<0.05$)

Table 5: Comparison based on bleeding on probing in two groups

Bleeding on probing	PRF group		Non-PRF group		*P*
	No.	% age	No.	% age	
Baseline	9	60.0	11	73.3	0.698
3 months	3	20.0	8	53.3	0.129
6 months	1	6.7	5	33.3	0.171

PRF group (baseline vs 6 months) $P=0.008$ (statistically significant). Non-PRF group (baseline vs 6 months) $P=0.061$ (nonsignificant)

The results of our study are in accordance with the study conducted by El Kenawy MH *et al*.[18] wherein there was a significant increase in crestal bone change in PRF with the bone graft group (i.e., group I) when compared to the PRF group (i.e., group II). In the PRF group, the bone loss that occurred may be a result of natural bone remodeling around the implant as a sequel for the placement of the final prosthesis, which may be associated with increased load and, in turn, increased transferred stress on the bone implant interface.

In this study, quantitative and qualitative CT imaging analysis showed that the PRF-treated defects had higher bone volume fraction when assessed three months postoperatively. The quality of bone formed three months postoperatively was superior with high HU values when compared with preoperative bone quality. There is a correlation between high bone density and high rate of implant success and between high bone density and implant primary stability. Also, a statistically significant difference was observed in mean bone density (HU) between baseline and 3 months in the PRF group. The findings of the PRF group were similar to a study conducted by Radwa M *et al*.[11] where both groups showed an increase in its bone density (before fixture placement and after 6 months of fixture placement). However, in the non-PRF group although there was an increase in the bone density value in terms of HU, it was not statistically significant.

In our study, only the PRF group showed a highly significant increase in bone density in comparison with the control group at the end of the study. This may be due to presence of PRF membrane. This is in accordance with studies conducted by Dimofte A *et al*.[19] and Shaimaa A *et al*.[20] The findings were contrary to a study conducted by Kalash S *et al*.[15] Also, the results of PRF group were similar to studies conducted by Elkhidir *et al*.[21] and Barunawaty Y[22] where bone density in both groups resulted in statistically significant increase. The increase in bone density might be due to alveolar bone compression by the implant body that was placed.

These results contributed to the fact that PRF can accelerate human osteoblast proliferation and stimulate strong differentiation of osteoblasts as proven by studies. Studies have reported that PRF plays a significant role in improving bone healing and improving the quality of bone.[23]

All the implants evaluated in the present study did not show any amount of mobility and were grouped into grade 0 mobility. This is in accordance with the studies conducted by David *et al*.[24] In the present study, soft tissue healing was excellent. The findings of our study were in contradiction to the study by Schlegel *et al*.[25] that revealed a better implant stability in the PRF-treated group compared with the control group one month after implant placement. This difference, however, faded away with time, to be insignificant 3 months postoperatively. This is probably attributed to a short-term acceleration of bone healing, which was reflected as a quicker osseointegration offered by the PRF.

In our study, only in the PRF group there was a statistically significant reduction in bleeding on probing on comparing baseline with 6 months. This was in contrast to the study conducted by Boora P *et al*.[6] wherein the intergroup comparison for bleeding on probing at one month and three months was statistically insignificant. The findings of our study were in accordance with the study conducted by Avula KK *et al*.[26] wherein the modified sulcus bleeding index (mSBI) decreased significantly from baseline to 6 months in group I and in group II. It has been clinically proven that PRF enables the simple, effective, and predictable management of the gap between alveolar bone and implant. This, in turn, allows the prevention of secondary gingival recession by maintaining the future level of the biologic space.[27]

Our study group consisted of a limited number of patients with a limited follow-up period. However, more extensive multicenter randomized controlled clinical trials are warranted to come to a definitive conclusion. Immediate placement of implants with PRF could be considered a valuable option to replace a missing tooth. A synergistic effect and clinical effectiveness of PRF on improving the bone quality around dental implant have been noted. Thus, PRF can be considered a healing biomaterial with potential beneficial effect on peri-implant tissue and can be used as a therapeutic adjuvant with immediate implant placement.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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