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Enhanced Implant Stability After Bioactivation with Injectable Platelet-Rich Fibrin Coating: A Pilot Study

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Abstract

Background: The most recent advancement in platelet-rich fibrin is the liquid injectable platelet-rich fibrin. Coating dental implants with platelet-rich plasma has demonstrated a positive effect on the early stability of implants. The aim of this pilot study was to compare the influence of the coating of injectable platelet-rich fibrinon the early stability of dental implants.

Methods: Ten systemically healthy patients with ideal ridge and indicated for implant placement were included in this study. Routine steps for implant placement were followed and just before placement, injectable platelet-rich fibrin was coated on the implants in test group ($n=10$), whereas in the control group, the implants were placed without any coating ($n=10$), using simple random sampling. Implant stability was assessed immediately after implant placement and at 6, 8, 12 and 16 weeks postoperatively, tabulated, and compared using analysis of variance.

Results: The comparison between the test and control group demonstrated that the Implant Stability Quotient values were significantly higher in the test group as compared to the control group at 6, 8, and 12 weeks after implant placement ($P < .05$).

Conclusion: It can be concluded that coating the implant surface with injectable platelet-rich fibrin significantly increases stability at 6, 8, and 12 weeks postsurgically.

Keywords: Dental implant, injectable platelet rich fibrin, implant stability, resonance frequency analysis.

INTRODUCTION

The success of dental implants depends on a large number of factors, a prominent one of which is optimal osseointegration. The use of platelet concentrates is increasingly gaining popularity for improved regeneration in periodontal tissues. Experimental studies have proposed that fibrin network formation and structural proteins of the blood clot attached to the implant surface may serve as a physical scaffold to support cell adhesion and migration.[1,2]

The most recent approach to creating such bioactive implant surfaces is by a chairside coating of implants with autogenous platelet concentrates including platelet-rich plasma (PRP) and platelet-rich fibrin (PRF). Recent studies have demonstrated that these coatings lead to enhanced early implant stability as compared to control sites.[3,4] However, PRP is not a completely autologous platelet concentrate as it requires the addition of anti-coagulants and bovine thrombin. Although PRF is completely autologous, it is obtained in a gel form that does not easily adhere to the implant surface.[5] This is due to the fact that polymerization is completed in the PRF tube itself. The recently introduced liquid PRF (injectable/i-PRF) addresses this problem as it is obtained in a liquid form that polymerizes after obtention and hence can be applied as a coating on the surface of the implant.[6] Hence, the aim of the study was to evaluate and compare the influence of coating of i-PRF on early stability of dental implants.

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MATERIAL AND METHODS

Ten systemically healthy patients (25-45 years, mean age 32.4 years) with short-span edentulous ridges in the maxillary arch having sufficient residual bone for conventional implant placement were selected. In the study design, only maxillary teeth were included. Patients with compromised medical history, smokers, and pregnant females were excluded from the study. Ethical approval for the study was acquired from the institutional ethical committee (Ref No. BDC/Exam/434), and the study was conducted in accordance with the principles outlined in the declaration of Helsinki. All the risks and benefits of the study were explained to the participants, and a written consent was obtained from them prior to the commencement of the study.

A preoperative cone beam computed tomography was taken to assess the pre-surgical ridge width after which diagnostic impressions were made and the cast was fabricated. Phase-I therapy was carried out 4 weeks prior to the implant placement for all the participants. The selected sites were then randomly assigned into 2 groups, the test and control group, using coin toss method (simple random method). All the cases were performed by the same operator (RR) and carried out under local infiltration anesthesia (2% lignocaine). A mid-crestal incision was given at the edentulous site using no. 15 c BP blade extending on either side as a sulcular incision (buccal and palatal/lingual) on the adjacent teeth to raise a full-thickness mucoperiosteal flap. A routine osteotomy was prepared for implant placement.

In the control group, implant placement was done as a routine procedure. All the procedures were carried out under local infiltration anesthesia (2% lignocaine). A mid-crestal incision was given at the edentulous site using no. 15 c BP blade extending on either side as a sulcular incision (buccal & palatal/lingual) on the adjacent teeth to raise a full-thickness mucoperiosteal flap. Routine osteotomy was prepared for implant placement. A commercially available implant (Standard Internal Hex, Adin) was used. In the test group, first the implants were wetted with i-PRF by dropping it onto the implant surface, and then further, they were dipped in i-PRF for 10 minutes (Figure 1). To prepare i-PRF, 9 mL of blood samples were taken from the patient's antecubital vein and collected in i-PRF tubes (IntraSpin, Intra-Lock International, Boca Raton, FL).[6] This was followed by immediate centrifugation at 700 rpm for 3 minutes. The yellow fluid (i-PRF) at the top of the tubes was aspirated with a sterile syringe (Figure 1). The implant was then dipped in the i-PRF solution following which it was placed inside the osteotomy (Figure 2). Healing abutments were placed, and flaps were sutured with interrupted sutures.

After the completion of the surgery, patients were given routine postsurgical instructions. Medications including antibiotics (amoxicillin 500 mg, 3 times per day) as well as analgesics were prescribed. They were also instructed to use 0.12% chlorhexidine gluconate mouthwash twice daily for 2 weeks. Suture removal was done 14 days postsurgically.

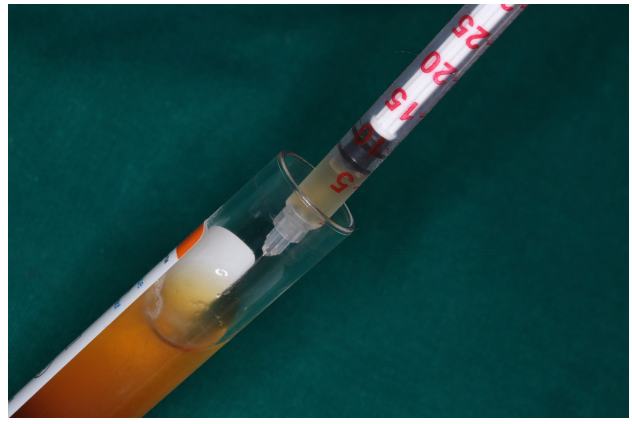

Figure 1. Aspiration of injectable platelet-rich fibrin from platelet-rich fibrin tube using a sterile syringe.

Implant stability was analyzed with the help of Osstell device (Osstell; Integration Diagnostics, Göteborg, Sweden). The transducer (SmartPeg) was attached to the implant and readings were recorded. This was measured at 5 endpoints namely immediately after surgery and at 6, 8, 12, and 16 weeks for all the cases. After, the 16th week, routine prosthesis placement was performed for all the cases. The clinical data obtained was recorded and the difference was assessed using analysis of variance (ANOVA).

RESULTS

All cases showed uneventful healing and there were no dropouts from the study. The clinical data obtained was recorded and the difference was assessed using ANOVA. The mean

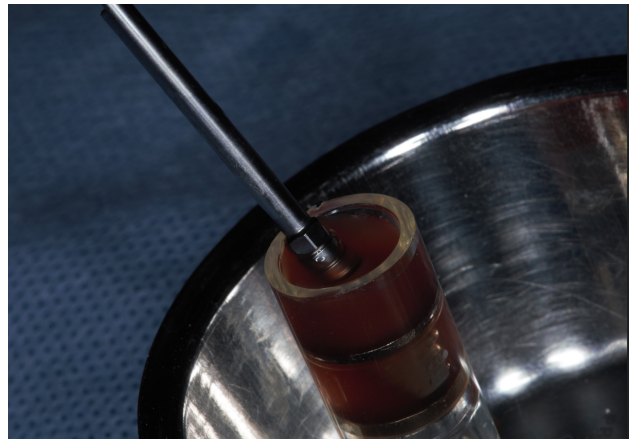

Figure 2. Coating of the implant surface with injectable platelet-rich fibrin.

insertion torque value was 44.3 Ncm for the test group and 41.2 Ncm for the control group which was statistically not significant ($P > .05$, Table 1). There was no significant difference in the Implant Stability Quotient (ISQ) values obtained immediately, 6, 8, 12, and 16 week of the implant within the test group. However, for the control group, there was a statistically significant increase in the ISQ from baseline to 16 weeks ($P < .011$). Also, at baseline and end of 16 weeks, there was no statistically significant difference between ISQ values between the test group and control group ($P > .05$). However, the ISQ values at 6, 8, and 12 weeks were observed to be significantly higher for the test group as compared to the control group (Table 1, $P = .012$, $P = .008$, $P = .042$, respectively)

DISCUSSION

The primary stability of implants is related to the mechanical engagement of an implant with the adjacent bone, while bone regeneration and remodeling phenomena determine the secondary (biological) stability of the implant. The principle of bioactivation of implant surfaces to create a dynamic surface may positively affect the peri-implant bone remodeling. Previously it has been shown that local application of PRP increased the amount of peri-implant newly formed bone and the bone density.[3] According to a recent study by Qu et al, implant stability improves by application of platelet concentrates and reduction in marginal bone loss is seen in short-term period.[7] Injectable platelet-rich fibrin is a new second-generation PRF which contains platelets and leukocytes. These aid in release of several growth factors such as platelet-derived growth factor, vascular endothelial growth factor, and insulin-like growth factor. These factors modulate the local hard and soft tissue healing positively.[8] In the study design, only implants to be placed in the maxillary arch were included. This was done in view of the fact that the maxilla has low bone quality D3/D4 and here the importance of primary stability is more as the bone quality is generally poor.

In the present study, there was no significant difference in the mean insertion torque values and immediate postsurgical ISQs for the test and control group. This indicates that the primary stability of the implants was similar irrespective

Table 1. Clinical Parameters as Observed in Test and Control Groups at Baseline, 6, 8, 12, and 16 Weeks

				ISQ (Implant Stability Quotient) Value				
	Case Number	Tooth Number	Insertion Torque	Baseline	Sixth Week	Eighth Week	Twelfth Week	Sixteenth Week
Control Group	1	15	41	62	59	61	65	70
	2	14	42	75	60	58	61	74
	2	26	41	70	58	58	60	71
	3	11	40	65	51	46	56	75
	5	24	41	70	65	68	65	68
	6	13	41	76	75	74	74	75
	6	16	40	69	61	60	65	72
	7	22	41	72	61	65	65	71
	8	15	45	71	63	63	64	74
	10	25	40	67	59	58	61	70
Mean			41.2	69.7	61.2	61.1	63.6	72
SD			1.48	4.27	6.09	7.39	4.72	2.40
Median			41.2	70.00	60.50	60.50	64.50	71.50
Test group	1	26	43	73	72	72	71	70
	2	25	45	76	75	75	76	78
	4	25	44	70	68	68	72	72
	4	23	46	60	59	62	77	68
	5	14	45	80	72	72	78	78
	7	21	43	78	80	80	81	82
	8	16	44	87	79	79	80	80
	9	14	45	84	77	79	80	80
	9	16	43	78	72	73	76	78
	10	26	45	79	73	74	75	77
Mean			44.3	76.5	72.7*	73.4*	76.6*	76.3
SD			1.06	7.58	6.04	5.50	3.34	4.67
Median			44.5	78.00	72.50	73.50	76.50	78.00

*Significantly different from the control group ($P < .05$).
ISQ, implant stability quotient.

of the coating of i-PRF. This is in contrast to the findings by Eglimez[3] et al. who found that implants coated with PRP demonstrated significantly higher ISQ on the day of operation than those without. This can be attributed to the fact that PRP releases 90% of its growth factors on the first day, whereas i-PRF demonstrates a much more gradual and sustained release pattern.[3,6,7]

In the control group, ISQ values demonstrated a significant decrease in ISQ values from baseline to 12th week. This can be attributed to the physiological healing response wherein the peri-implant bone undergoes initial resorption by osteoclast activation followed by bone apposition initiated by osteoblast activation and this is clinically reflected in the significant reduction in the implant stability. On the other hand, in the test group, there was a reduction in the mean ISQ values but this change was not statistically significant. Also, at the end of 6th, 8th, and 12th week, the mean ISQ was significantly higher for the test as compared to the control group.

In a recent study, Wang et al.[9] in their study on the effect of i-PRF versus PRP on human osteoblasts observed that i-PRF induced a significantly higher cell proliferation at 3 and 5 days. Also, significantly higher alkaline phosphatase levels were observed at the end of 7 days, and alizarin red staining at 14 days. The mRNA levels of alkaline phosphatase, Runx2, and osteocalcin all demonstrated higher levels with i-PRF. Based on these findings, it may be hypothesized that a faster and superior osteoblast response and subsequent bone formation in the test group may have resulted in consistent ISQ values from implant placement to the end of 16 weeks which were significantly higher than those observed in the control group.[9] This is attributed to the pro-angiogenetic, pro-proliferative, and pro-differentiating effects on osteoblasts and growth factors present in i-PRF.[5-8] In a study by Alhussaini et al.[10] it was observed that coating the dental implant with PRF and bone morphogenetic protein increased implant stability which allowed early implant loading.

The liquid form which polymerizes outside the PRF tube gives the operator the control to coat or dip the implant in this concentrate which then forms a biological layer over it. In a recent study, it was observed that dipping titanium discs in i-PRF resulted in the formation of a dense fibrin network with platelets, red blood cells, and white blood cells on the surface. It may be hypothesized that this would result in enhanced cell migration and superior osteogenesis leading to enhanced early implant stability.[11]

Scarano et al in a study on wettability of implant surfaces observed that no significant differences were seen in blood and autologous platelet liquid; even though the cellular composition and concentration were different, they lead to different physical properties (density, viscosity, and capillarity), and a similar spreadability was seen on the surfaces of implants.[12] Hence, it can be said that the coating and wetting of the implant happens similar to conventional placement in osteotomy, where the implant first comes in contact with blood. Clinically, the significance of this finding may be applicable in cases with compromised bone quality or compromised healing response such as those of osteoporosis, diabetics, or patients who have undergone radiation therapy. Such cases would benefit from superior early implant stability and the risk of implant failure due to the compromised systemic conditions may be reduced. Also, the enhanced early stability may avail for early loading of the implants which may reduce the total treatment time.

The difference in mean ISQs at the end of 16th week for the test group and the control group was not found to be significant. This implies that over the end of 4 months when the complete bone remodeling has taken place, the stability of the implants in both control and test groups becomes approximately equal and stable. This indicates that the effect of i-PRF is mainly found in the early healing period.

Limitations of the present study include a small sample size and that histological analysis could not be done as the implant placement was done immediately. Further studies with larger sample sizes are required to corroborate the results observed in the present study.

CONCLUSION

Within, the limitations of the study, it can be concluded that coating dental implants with injectable platelet-rich fibrin prior to placement in the osteotomy site may increase early implant stability at 6, 8, and 12 weeks after implant placement.

Ethics Committee Approval: Ethics committee approval was received for this study from the Ethics Committee of Bapuji Dental College and Hospital (Date: 2017, June 6, Number: BDC/Exam/77/2017-18).

Informed Consent: Written informed consent was obtained from all participants who participated in this study.

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Declaration of Interests: The authors declare that they have no competing interest.

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