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A Randomized Controlled Trial of the Impact of Platelet Rich Fibrin (PRF) on Crestal Bone and Peri-implant Soft Tissue in One-Stage Implant Placement

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ABSTRACT:

This prospective, randomized controlled trial aimed to evaluate the effect of Platelet Rich Fibrin (PRF) on peri-implant tissue response following one-stage implant placement with non-functional immediate provisionalization in the maxillary anterior region. The study involved 20 systemically healthy subjects (15 males and 5 females) with maintainable oral hygiene, divided into two groups: the PRF group and the non-PRF group. Standard SLA-AB/AE tapered threaded

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dental implants were placed randomly with or without PRF, and provisionalized immediately. Clinical and radiographic evaluations were performed at baseline, one month, and three months post-operatively to assess peri-implant soft tissue and crestal bone responses. At the 3-month follow-up, all implants remained osseointegrated, with the PRF group showing less marginal bone loss compared to the control group. No significant differences in probing depth or bleeding on probing were noted. The study concluded that PRF could be considered a beneficial healing biomaterial, showing potential as an adjunctive therapy in one-stage, single-tooth implant placement in the maxillary anterior region.

INTRODUCTION:

The loss of single tooth in the aesthetic zone is most distressing experience. Single tooth implant placement has revolutionized the treatment options with marked documented success rate. The conventional guidelines have suggested the bone remodeling period of 2-3 months following tooth extraction followed by an additional 6 months load free implant osseointegration. The additional requirement for a removable prosthesis during this extended healing phase appeared inconvenient and results in reduce comfort, acceptance and final outcome of treatment [1,2]. Recent preliminary studies reported high success rate following one stage, immediate provisionalized endosseous implant placement in maxillary anterior region. Besides eliminating the need of interim removable denture, this technique has documented the potential for preserving the osseous and gingival architecture. The highly aesthetic zone of maxilla often requires both hard and soft tissue architecture maintenance and hence, maxillary anterior single tooth placement is often a challenge, regardless of experience of clinician [3,4]Although the propensity of peri-implant tissue to recession after surgical trauma has been well recognized. However, the response of peri-implant tissue loaded with PRF following implant placement is not well documented. Various studies have substantiated the viability of platelet concentrates on enhancement of osseous and associated tissue healing [4-7] and PRF is one of the recent innovations of various platelet concentrates. PRF is an immune and platelet concentrate collecting on a single fibrin membrane and contains all the constituents of blood favorable to healing and immunity. 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. PRF is considered as a healing biomaterial and it has a robust stimulating effect on various aspects of healing of soft and osseous tissue including angiogenesis, immune control, harnessing the circulating stem cells [8-10] . PRF efficacy in optimizing and preserving the existing osseous structure and gingival architecture across periimplant need to be corroborated.

In order to assess the impact of Platelet Rich Fibrin (PRF) on the peri-implant tissue response across a one-stage, non-functional instantaneous provisionalized implant in the maxillary cosmetic zone, a prospective, randomised controlled trial (RCT) was carried out.

MATERIALS AND METHODS

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A prospective randomized controlled trial (RCT) was carried out at The Rama Dental College And Research Centre, Kanpur from December 2023 to November 2024, involving 20 participants (15 males and 5 females) with an average age of 24.6 years (range 18-33 years).

Inclusion criteria for the study were:

i) maintainable oral hygiene
ii) partially edentulous state in the anterior maxilla.
iii) adequate bone quantity at the implant site.

Exclusion criteria included subjects with :-

i) infection at the implant site.
ii) a history of bleeding disorders or use of anticoagulant medication.
iii) immunocompromised conditions, or debilitating diseases.

The study received approval from the Institutional Ethical Committee. All consenting participants underwent standard treatment with a single implant system (Adin Dental Implant System, Israel). Randomization of the participants (10 in each group) was carried out using a lottery system, resulting in two groups: Group I (Test group) received PRF and Group II (Control group) did not. PRF was freshly prepared just before placement at the surgical site by drawing 10 ml of blood from the antecubital vein, which was transferred to a test tube without anticoagulant. The blood was centrifuged at 3000 rpm for 10-12 minutes, and after centrifugation, the fibrin clot was squeezed between gauze to obtain the PRF membrane. The surgical procedure involved reflection of a full-thickness mucoperiosteal flap and sequential osteotomy site preparation for both groups. The implant was placed in the osteotomy site, ensuring it was flush with the crest margin. An abutment was then placed with 30 N-cm of torque following the one-stage non-functional immediate prosthetic protocol. The freshly prepared PRF was placed over the surgical site, and the flap was sutured. After 10-14 days, provisionalization was achieved with prefabricated polycarbonate crowns, which were cemented using temporary zinc oxide non-eugenol (Relyx Temp NE, 3M ESPE) cement. Participants were given instructions on maintaining oral hygiene and following a soft diet. Four months after implant placement, definitive prosthesis cementation was performed using zinc phosphate cement (Super Cement SHOFU).

Clinical and radiographic evaluations were performed to assess crestal bone changes at baseline (during implant placement), one month, and three months post-implant placement. Intraoral periapical radiographs, taken using the paralleling technique, were digitized for measuring the bone level on the mesial and distal surfaces of the implant. Measurements were made with the UTHSCSA Image Tool (version 3.00 for Windows, University of Texas Health Sciences Center, San Antonio, TX). The coronal point of the healing abutment served as a static reference line, with the bone-to-implant contact point identified as the bone level. Measurements were taken from the reference line to the bone level on the mesial and distal sides of the implant using a perpendicular line. Soft tissue changes were assessed at one month and three months after implant placement using William's periodontal probe (North Carolina–Hu-Friedy, Chicago, IL, USA), graded in millimeters. Probing pocket depth (PPD) was measured in millimeters, while bleeding on probing (BOP) was evaluated 15 seconds after probing, recorded as either present or absent.

STATISTICAL ANALYSIS

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Using SPSS version 17.0, the mean, standard deviation, and standard error of mean were computed and statistically analysed using the chi-square test for qualitative data and the Student t-test (paired) and Independent t-test for quantitative data.

RESULTS

Crestal bone level changes were observed in both the study and control groups. In the PRF group, statistically significant changes in crestal bone levels were noted within three months, with a mean change of 0.25±0.06 mm on the mesial side and 0.27±0.07 mm on the distal side. In contrast, the non-PRF group showed statistically significant changes in crestal bone levels, with a mean change of 0.57±0.22 mm mesially and 0.65±0.28 mm distally. However, the mean crestal bone level changes in the PRF group were significantly smaller than those observed in the control group (Table/Fig-1). At the three-month follow-up, both the PRF and non-PRF groups showed a mean decrease in probing depth on the mesial and distal sides of the dental implants (Table/Fig-8). Intergroup comparisons for probing depth and bleeding on probing at both one and three months showed no statistically significant differences (Table/Fig-2,3).

time of Measurments	Bone Loss Side	Group (n=10)	Mean± Standard Deviation	Standard error of mean	p-value
Baseline1month	Mesial	I	0.13±0.04	0.01	0.007
		II	0.3±0.16	0.05	
	Distal	I	0.15±0.04	0.01	0.02
		II	0.3±0.18	0.05	
Baseline- 3 months	Mesial	I	0.25±0.06	0.01	0.0004
		II	0.57±0.22	0.07	

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	Distal	I	0.27±0.07	0.02	0.0006
		II	0.65±0.28	0.08	
1 month- 3 Months	Mesial	I	0.11±0.04	0.01	0.0005
		II	0.26±0.16	0.05	
	Distal	I	0.11±0.05	0.01	0.0004
		II	0.34±0.26	0.08	

[table/Fig-1]: Comparison of crestal bone level changes between Group I and Group II on mesial and distal side at different time interval

time of Measurements	Probing side	Group (n=10)	Mean± Standard Deviation	Standard error of mean	p-value
1 Month	Mesial	I	5±0.8164	0.2	>0.05
		II	5.3±0.6749	0.2	
	Distal	I	5.1±0.7378	0.2	>0.05
		II	5.1±0.8755	0.2	
3 Months	Mesial	I	3.05±1.11	0.3	>0.05
		II	3.1±0.3162	0.1	
	Distal	I	3.65±0.8181	0.2	>0.05
		II	3.8±0.7888	0.2	

[table/Fig-2]: Comparison of probing depth between Group I and Group II on mesial and distal side of dental implants at different time interval

time of Measurement	Group (n=10)	Subjects with positive finding (n=10)	Percentage (%)	p-value
1 month	I	5	50	$\chi^2 = 0.00$; df=1; p=1 (>0.05) N.S.
	II	5	50	
3 months	I	2	20	$\chi^2 = 0.266$; df=1; p=0.605 (>0.05) N.S.
	II	3	30	

[table/Fig-3]: Comparison of bleeding on probing between Group I and Group II on mesial and distal side of dental implants at different time interval

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DISCUSSION

The quantity and quality of peri-implant bone not only impact the osseointegration phase but also influence the soft tissue architecture surrounding the implant. Assessing both the marginal bone levels and peri-implant soft tissues is crucial for evaluating implant health, as these are key indicators of successful implant integration. The preservation of peri-implant bone is critical for successful implant therapy, and the quality and quantity of both peri-implant bone and soft tissues can be enhanced during the tissue repair and regeneration process by leveraging the regenerative potential of the surrounding tissues with appropriate stimuli. Growth factors, which are expressed during various stages of tissue healing, can serve as therapeutic agents to promote both soft and hard tissue repair around implants. Platelet concentrates, including Platelet Rich Fibrin (PRF), are among these growth factors, with PRF being a recent advancement in platelet concentrates.

PRF is a concentrated suspension of growth factors, which includes Platelet-Derived Growth Factors (PDGF), transforming growth factors (TGF) β1 and β2, vascular endothelial growth factors (VEGF), platelet-derived endothelial growth factors, Interleukin 1 and 2, basic fibroblast growth factor (b-FGF), and platelet-activating factor 4 (PAF-4). The cascade of reactions initiated by the binding of secreted growth factors to transmembrane receptors on cells activates internal signaling proteins that trigger the expression of genes responsible for matrix formation, cellular proliferation, osteoid production, and collagen synthesis. The synergistic role of these platelets-derived factors in promoting bone and soft tissue healing has been widely recognized in literature.

PRF has been applied in various dental procedures, including sinus lift augmentations, ridge augmentations, ridge preservation grafting, periodontal defect treatments, and gingival recession management, demonstrating its efficacy as a healing biomaterial for both soft and hard tissues. However, to date, no studies have focused on the effect of PRF on peri-implant hard and soft tissue changes. While PRF has been widely studied for its benefits in bone augmentation and soft tissue healing at other sites, its potential for optimizing peri-implant soft and hard tissue healing remains underexplored. Therefore, this study aimed to evaluate the effect of PRF on peri-implant tissues in the cervical region.

The study found that the low mean marginal bone loss observed in the PRF group could be attributed to the growth factors present in PRF, which promote and enhance both soft and hard tissue repair. The cumulative success rate for dental implants in this study was 100% (20/20) at three months, with an additional follow-up period of eight months. Previous studies have reported similar success rates when implants were placed in the aesthetic zone, using either delayed loading (97%) or immediate provisionalization (98%) approaches. There is evidence that implants with a rough surface contribute to better osseointegration rates. Additionally, threaded implants have been shown to provide stronger immediate mechanical retention after placement.

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In this study, SLA-AB/AE (alumina oxide blasted/acid etched surface) treated threaded implants were used.

Aesthetics in single anterior implants is not only influenced by the restoration itself but also by the surrounding gingival architecture. At one month, bleeding on probing was observed in approximately 50% of both the test and control groups. However, by three months, this was reduced to 20% in the test group and 30% in the control group. Moreover, a reduction in probing depth was observed in both groups by the third month, suggesting tissue stability around the implant. Despite changes in soft tissue observed at three months, the differences between groups were statistically insignificant, indicating a stable and healthy gingival environment around the implants. These findings support the efficacy of the procedure in maintaining gingival architecture, in line with similar studies.

In this study, intra-oral periapical radiographs were used to assess bone levels, utilizing the paralleling technique to minimize distortion. The radiographs were standardized using an occlusal putty jig. Additionally, CT scans were performed with radiographic stents, which were fabricated using a milling machine and filled with radio-opaque markers to allow for accurate bone dimension measurement at the implant site. A single implant system was used for all participants, and PRF was freshly prepared and applied without delay to maximize its beneficial effects. The same centrifuge machine was used consistently throughout the study to prepare PRF, ensuring uniformity in the process.

The results of this study have high clinical relevance, as they provide valuable insight into the effectiveness of PRF in the rehabilitation of the anterior maxillary aesthetic zone. However, further studies with longer follow-up periods would help to substantiate these findings.

CONCLUSION

A synergistic effect and clinical efficacy of PRF on bone growth surrounding dental implants for single staged implants with immediate provisionalization in the maxillary anterior area have been seen based on the study's findings. Therefore, the information that is now available showed that the local application of PRF during implant placement strongly stimulates the production of new bone.

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