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Original Research Article

A novel method for evaluating i-PRF usage in vestibular socket therapy for immediate implant in defective fresh extraction site

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Abstract: ***Objectives:*** This study aimed to evaluate the clinical, esthetic, and radiographic outcomes of immediate implant placement in defective fresh extraction sockets using vestibular socket therapy (VST), with and without the adjunctive use of injectable platelet-rich fibrin (i-PRF). ***Subjects and Methods:*** Twelve patients requiring replacement of a hopeless maxillary anterior tooth were included in this prospective interventional study and randomly allocated into two equal groups. Group I received immediate implant placement using VST alone, while Group II received VST combined with i-PRF mixed with a xenograft bone substitute. Clinical assessment included implant stability quotient (ISQ) measurements recorded at implant insertion and at 6 and 9 months. Esthetic outcomes were evaluated using the Pink Esthetic Score (PES). Radiographic evaluation was performed using cone beam computed tomography to assess cervical facial bone thickness and the vertical distance from the crestal bone level to the implant platform at baseline, 6, and 9 months. ***Results:*** "No statistically significant differences" were observed between the two groups regarding PES, ISQ values, cervical facial bone thickness, or crestal bone level at any follow-up interval. However, both groups demonstrated "statistically significant improvements" over time in esthetic and radiographic parameters, reflecting favorable tissue healing and maturation. Implant stability remained stable throughout the follow-up period in both groups. ***Conclusions:*** Vestibular socket therapy proved to be an effective approach for immediate implant placement in defective fresh extraction sockets, providing stable clinical, esthetic, and radiographic outcomes. The adjunctive use of i-PRF did not result in statistically superior outcomes when combined with VST, suggesting that the surgical technique itself plays a dominant role in determining treatment success.

Keywords: Immediate implant placement; Vestibular socket therapy; Injectable platelet-rich fibrin; Pink Esthetic Score; Implant stability; Cone beam computed tomography.

INTRODUCTION

Dental implant therapy has become a dependable and well accepted therapeutic method for the repair of missing teeth 1, providing long-term functional and esthetic rehabilitation. However, tooth extraction is inevitably followed by dimensional alterations of the alveolar ridge2, particularly involving the buccal bone plate, which may compromise ideal implant positioning and esthetic outcomes in the anterior maxilla.

Immediate implant placement has been proposed to reduce treatment time and limit post-extraction bone resorption by utilizing the existing socket anatomy3. Despite its advantages, this approach is highly technique-sensitive and dependent on precise surgical execution and appropriate management of peri-implant tissues4. The presence of facial bone defects further complicates immediate implant placement and increases the risk of esthetic failure if not adequately managed.

Vestibular socket therapy (VST) represents a minimally invasive, biologically driven surgical approach designed to preserve periosteal blood supply and maintain facial bone contour through a

flapless vestibular access5. By stabilizing graft materials without crestal flap elevation, VST aims to optimize both hard- and soft-tissue healing in compromised extraction sockets.

In parallel, autologous platelet concentrates have gained considerable attention in regenerative dentistry. i-PRF is a third-generation platelet concentrate rich in platelets, leukocytes, and growth factors, delivered in a liquid form that allows easy application and homogeneous distribution6. i-PRF has been shown to enhance angiogenesis, cellular proliferation, and wound healing, although its additional benefit when combined with advanced surgical techniques remains unclear7. Despite increased interest in both VST and i-PRF, limited clinical evidence exists regarding their combined use in rapid implantation in faulty fresh extraction sockets 8. Therefore, the present study was conducted to examine the clinical, esthetic, and radiological effects of rapid implantation using vestibular socket therapy with and without supplementary injectable platelet-rich fibrin.

MATERIALS AND METHODS

Study Design: This was a prospective interventional study.

Sample size: In order to do a power analysis, we relied on trial cases that had already been treated ("Pink esthetic score after 6 months"). G*Power ("version 3.1; Franz Faul, Universität Kiel, Germany"). The necessary "sample size, given α, power, and effect size" was determined by an a priori analysis. There were two groups and the following input parameters: a "α error probability of 0.05", a "effect size" (f) of 2.5572813, a "power of 0.95," and so on. The results showed that a minimum of twelve patients (six in each group) was required for the study.[9].

Twelve (four men and eight females; age range: 20 to 39 years) patients participated in this study. They were seeking replacement of a hopeless anterior tooth; those attending the outpatient clinic, "Department of Oral Medicine, Periodontology, Oral Diagnosis and Oral Radiology, Faculty of Dental Medicine (Boys, Cairo), Al-Azhar University"

Eligibility criteria of the population

A-Inclusion Criteria: Patient has one "hopeless tooth" in the maxillary anterior region with TYPE II according to Elian classification of sockets [4] and sufficient bone apically and palatally. a natural tooth on the opposite side of the missing one must be present. age range from 18 to 50 years. **B-Exclusion Criteria:** Grade III Extraction sockets [4]. acute infection related to a hopeless tooth. [10]. Sensitivity to any of the drugs or materials used in the research. medically compromised patients according to the modified Cornell Medical Index [11]. heavy smokers [12].

Ethical Consideration: Nature of the study was explained to the patients, upon their "agreement, they signed a written consent form". {Ethical number (921/1704)}

Initial therapy and patient grouping: At baseline, clinical evaluation comprised medical and dental history, general and oral health condition, and assessment of the anticipated implant location. Preoperative CBCT scans had been collected for assessment of bone height, width, density, mesiodistal space, and inter-arch relationship (implant treatment plan) utilizing Planmeca ProMax 3D Mid. Before surgery, each patient was given extensive instructions on appropriate dental hygiene. "Full-mouth supra- and subgingival scaling and root planing" were performed in quadrants under local anesthetic. This technique was performed utilizing a mix of hand Gracey curettes ("Hu Friedy, Chicago, IL") and ultrasonic scalers ("Cavitron Corp., Long Island City, NY").

Patient grouping: Patients were randomly allocated to two groups using a coin toss. A single coin flip was performed for each patient immediately after confirming eligibility: a head assigned the patient to Group 1, and a tail assigned the patient to Group 2. This randomization process ensured equal probability of assignment to either treatment group [13]. Group 1: Sockets with a deficient facial plate of bone and intact soft tissue will receive VST only. Group 2: Sockets with a deficient facial plate of bone and intact soft tissue will receive VST and iPRF.

Surgical intervention

As part of an aseptic procedure, which includes maintaining a clean work space, the perioral skin is disinfected using solutions containing povidone-iodine and alcohol. The oral mucosa is cleaned with 0.2% chlorhexidine, which significantly lowers the bacterial count in saliva.[14]. Following injection of local anesthesia ("Articaine HCl 4% with Epinephrine 1:100,000, Inibsa Dental, Barcelona, Spain"), nonsurgical periodontal therapy, including scaling and root planing, was performed as needed. Under local anesthetic, sulcular incisions were made, and then hopeless teeth were extracted atraumatically utilizing periotomes ("Hu-Friedy Periotome, Chicago, IL, USA"). Socket lavage and curettage were done. Implant site preparation was performed utilizing a sequential, progressive drill sequence using the specified implant system ("Anyridge, Megagen, Gyeongsan, South Korea"). "A tapered implant with knife-edge threads was put with the implant shoulder situated" 3 to 4 mm apical to the labial gingival boundary. The appropriate smart peg was then screwed into the implants, and

the implant's primary stability was recorded at baseline using the Osstell ISQ ("Integration Diagnostics Ltd., Sweden").

A horizontal incision was made at the socket site, 3 to 4 mm above the mucogingival junction, and continued 5 to 10 mm horizontally for vestibular access. Constructing a submucoperiosteal tunnel began at the socket orifice's face side and continued apically to the vestibular access incision. A cortical membrane shield made of gradually resorbable xenograft ("Flexible cortical bone sheet, Bioteck") was shaped to fit the socket's face and fixed with bone tacks after being supplied via the tunnel. This membrane was placed over the face bone plate, which might be either entire or deficient.

In group one, xenograft (Bone A-Oss– by Osstem, Seoul, South Korea) was mixed with saline at a 1:1 ratio (0.5 g bone graft to 0.5 mL saline) and filled into the facial gap.

Group two, iPRF was prepared [(148)] immediately before the surgical procedure, 10–20 mL of venous blood was drawn from each patient using a sterile technique with 10 mL disposable syringes. Blood was collected into plain plastic tubes without anticoagulants to allow natural coagulation. All samples were processed immediately after collection to prevent premature clot formation. The collected blood was centrifuged using a tabletop centrifuge (Model TDZ5-WS, Changsha Xiangzhi Centrifuge Instrument Co., Ltd., Changsha, China) following the low-speed centrifugation concept (LSCC). Centrifugation was performed at 700 rpm for 3 minutes, which allows optimal separation while preserving platelets, leukocytes, and growth factors in the upper plasma layer.

After centrifugation, the upper, orange-colored liquid fraction, representing injectable platelet-rich fibrin (i-PRF), was carefully aspirated with a sterile syringe, mixed with xenograft bone, and packed into the facial gap.

Lastly, in order to obtain a soft-tissue emerging profile that was satisfactory, the socket orifice was sealed using a customized healing abutment that was fastened to the implant. It was then appropriately finished and polished. Concurrently, 5/0 polypropylene sutures were used to close the vestibular access horizontal incision. Beginning one day before surgery and continuing for five days after the procedure, patients were given a broad-spectrum antibiotic ("Ciprodiazole, ciprofloxacin 500 mg/Metronidazole 500 mg" [Minapharm Pharmaceutical]) to take twice a day. The patient was given a nonsteroidal anti-inflammatory medication called "Cataflam 50 mg" by "Novartis" every eight hours for five days after the operation. In order to limit mechanical damage to the surgical field, patients were instructed to rinse with "0.12% chlorhexidine mouthwash" twice daily for 10 days, apply cold packs for the first 6 hours after surgery, and to start tooth brushing the day after surgery. Ten days after surgery, the sutures were taken out. Three months after the operation, the final restoration was sent to the patient.

Observations: Dental implants were evaluated esthetically, clinically, and radiographically.

• *Esthetical parameter:* Aesthetic appearance was assessed using the PES at 6 and 9 months. Before the study, two independent examiners underwent a calibration session to ensure standardization of PES evaluation. The calibration process involved: (1) reviewing the original PES criteria and scoring methodology, (2) examining and scoring five clinical cases together to establish consensus, (3) independently scoring 10 additional cases, and (4) calculating inter-examiner reliability using Cohen's kappa coefficient ($\kappa > 0.80$ was considered acceptable agreement) [(15)]. During the study, both examiners were blinded to the treatment groups.

Photography Protocol

Patient Positioning: Patient seated in upright position, Head positioned to align maxillary occlusal plane parallel to floor, Relaxed facial expression with lips and cheeks retracted using appropriate retractors

Camera Positioning: Distance: Fixed distance of 30 cm from camera lens to subject (measured from anterior tooth surface), **Angle:** Camera positioned perpendicular to the long axis of the anterior teeth, **Height:** Camera aligned with the mid-facial level of the anterior maxillary teeth

Standardization Requirements

1. **Consistent lighting:** flash system used to ensure uniform, reproducible lighting conditions 2. **Magnification ratio:** Maintained consistent magnification ratio (typically 1:2 to 1:4) across all photographs 3. **Background:** Neutral background (black or blue retractor) to minimize distractions 4.**Retraction:** Proper soft tissue retraction done to visualize gingival margins, papillae, and tooth structure5. **Focus:** Sharp focus on the region of interest (implant crown and surrounding soft tissue)

Image Capture Views: Full smile with lips retracted, showing maxillary anterior teeth

The PES assessment included "seven variables: mesial papilla, distal papilla, soft-tissue level, soft-tissue contour, alveolar process deficiency, soft-tissue color, and soft-tissue texture". Each variable was

scored on a 0-1-2 scale (0 = poorest, 1 = moderate, 2 = best esthetic outcome) by comparing the peri-implant soft tissue with th tooth, resulting in a maximu final PES score for each patient was calculated as the mean of both examiners' scores [16]. **Clinical parameter:** Implant stability was clinically assessed using resonance frequency analysis and expressed as ISQ values. Following implant placement, a SmartPeg transducer was securely screwed into the implant according to the manufacturer's instructions. ISQ measurements were then obtained using the Osstell device in two perpendicular directions, buccolingual and mesiodistal, to account for directional variations in implant stability [17].

Fig. (3): final restoration after 3 month

Radiological assessment:

1- Cervical facial bone thickness [18].
2- vertical distance from the crestal bone level to the implant platform [19,20].

All radiographic parameters were assessed by CBCT at baseline, 6 months, and 9 months.

Group 1 :

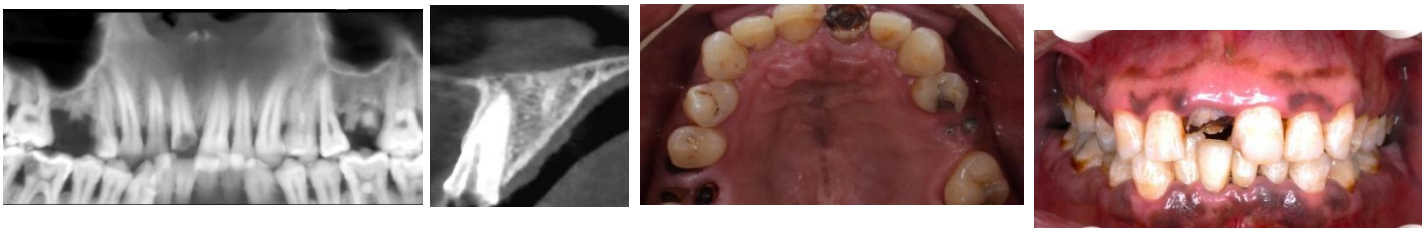

Fig. (1): preoperative radiograph and photographs

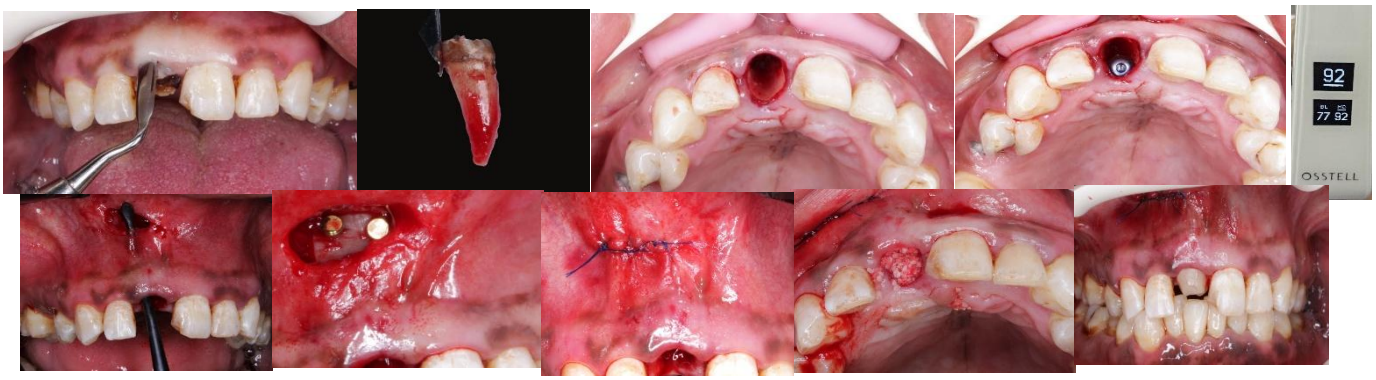

Fig. (2):VST surgical protocol

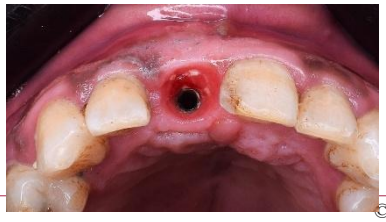

Fig. (4): 6 month isq, PES and cross section

Fig. (5): 9 month isq, PES and cross section

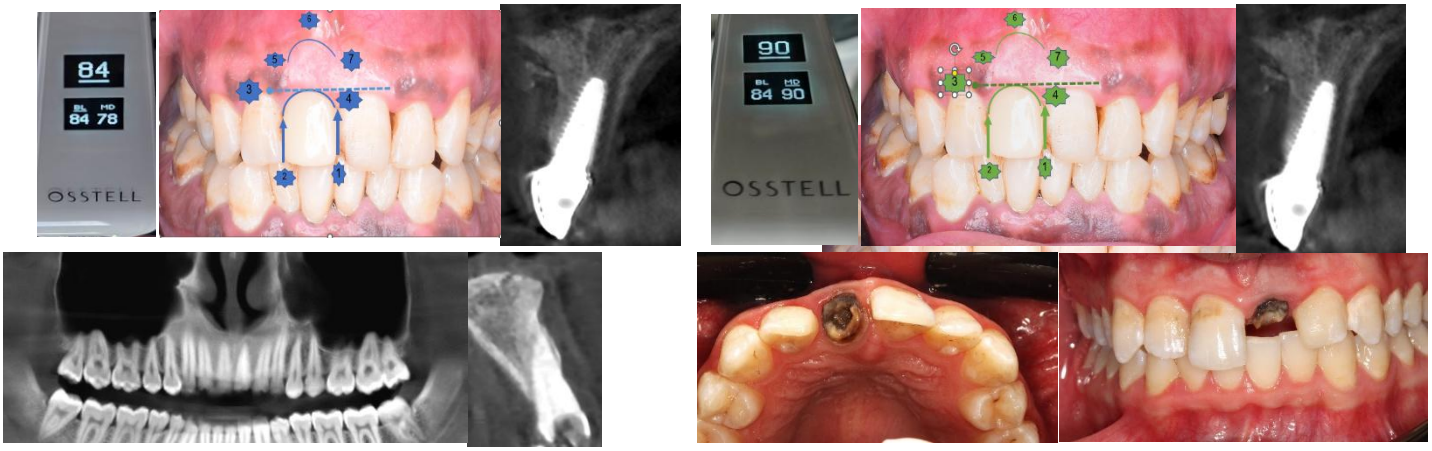

Fig. (6): preoperative radiograph and photographs

Fig. (7):VST surgical protocol with iPRF

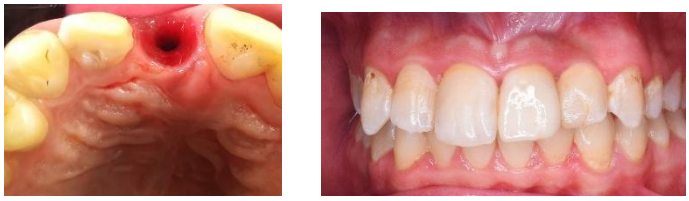

Fig. (8): final restoration after 3 month

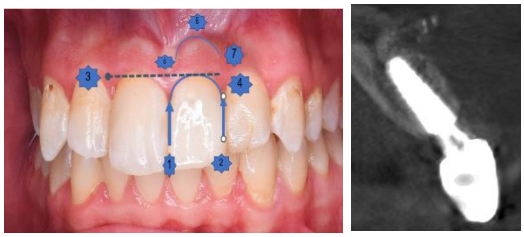

Fig. (9): 6 month isq, PES and cross section

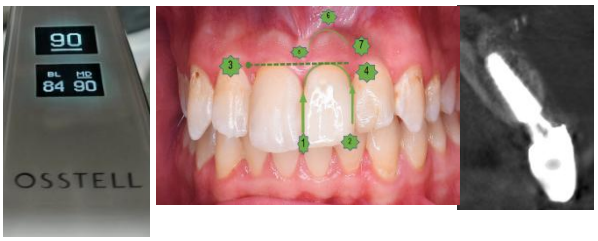

Fig. (10): 9month isq, PES and cross section

Smirnov and Shapiro-Wilk tests") were used to examine numerical data. Other than PES scores, all data were normal (parametric). For parametric data, "Repeated measures ANOVA test" was used to compare the two groups and examine temporal changes within each group. When "ANOVA test" is significant, "Bonferroni's post-hoc test" was used for pair-wise comparisons. The Mann-Whitney U test was used to compare non-parametric data between groups. The "Wilcoxon signed-rank test" assessed non-parametric data changes within each group. The significance threshold was set at $P < 0.05$. "Data was analyzed using IBM SPSS Statistics for Windows 23.0. IBM Corp, Armonk, NY".

RESULTS

I. Pink Esthetic Score (PES)

Both groups demonstrated a "statistically significant improvemen"t in PES scores from 6 to 9 months, as reflected by the intragroup p-values (Group I: p = 0.014; Group II: p = 0.034). Intergroup comparisons at both 6 and 9 months revealed "no statistically significant differences" between the two groups (p = 0.423).

Table 2: comparison between PES scores in the two groups

Time	Group I		Group II		*P*-value	*Effect size (d)*
	Median (Range)	Mean (SD)	Median (Range)	Mean (SD)		
6 months	11 (10, 12)	11.2 (0.8)	11.5 (11, 12)	11.5 (0.5)	0.423	0.425
9 months	12 (11, 13)	12.2 (0.8)	12.5 (12, 13)	12.5 (0.5)	0.423	0.425
P-value	0.014*		0.034*			
Effect size (d)	1		0.866			

**: "Significant at P ≤ 0.05"*

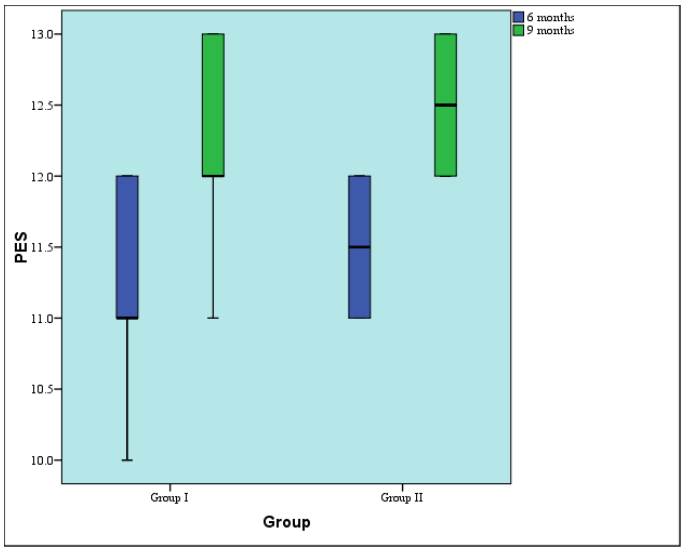

Figure 1: median and range values for PES in the two groups

II. Implant stability (ISQ)

At baseline, both groups exhibited identical mean ISQ values with no intergroup difference (p = 1.000). At 6 months, a slight reduction in mean ISQ was observed in both groups, with Group I showing higher values than Group II; however, this difference was not statistically significant (p = 0.462). By 9 months, Group II demonstrated higher mean ISQ values compared with Group I, yet this difference also failed to reach statistical significance (p = 0.391).

Table 3: comparison between implant stability (ISQ) in the two groups

Time	Group I		Group II		*P*-value	*Effect size (Partial Eta squared)*
	Mean	SD	Mean	SD		
Base line	89.7	4.8	89.7	6.8	1	0
6 months	87.3	5.6	85	4.9	0.462	0.055
9 months	87	7.5	90	3.2	0.391	0.074
P-value	0.688		0.177			
Effect size (Partial Eta squared)	0.08		0.319			

**: "Significant at P ≤ 0.05"*

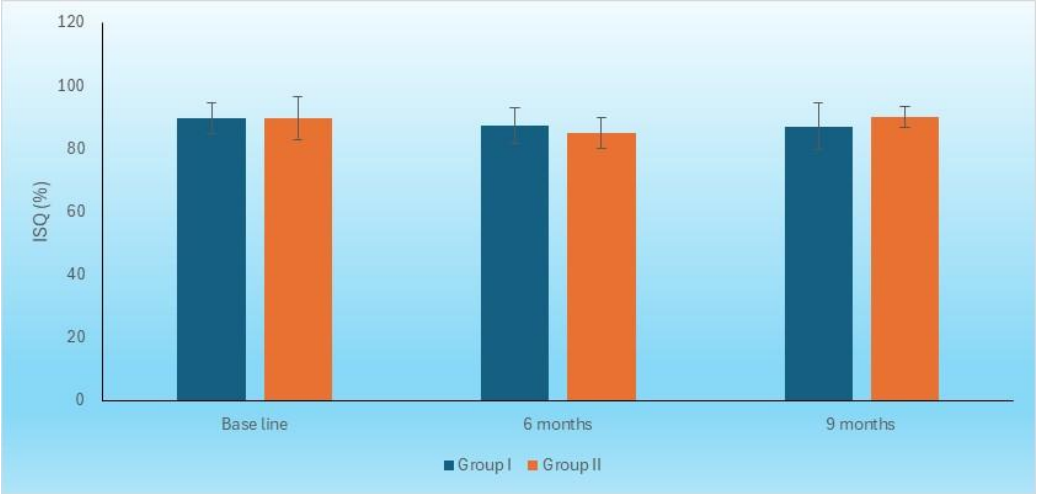

Figure 2: mean and standard deviation values for ISQ in the two groups

Cervical thickness (mm)

At base line, thickness was zero in all cases in the two groups, so no statistical comparison could be made. After six as well as nine months, there was "no statistically significant" difference between the two groups "(p = 0.111) and (p = 0.145)".In both groups, there was a "statistically significant change" in cervical thickness by time (p <0.001) for each group, respectively. Pair-wise comparison between times revealed that there was a statistically significant increase in cervical distance after six months as well as from six to nine months.

Table 4: comparison between cervical distance (mm) in the two groups

Time	Group I		Group II		*P*-value	*Effect size (Partial Eta squared)*
	Mean	SD	Mean	SD		
Base line	0 ^{C}	0	0 ^{C}	0	Not computed	
6 months	1.6 ^{B}	0.02	1.62 ^{B}	0.01	0.111	0.234
9 months	1.8 ^{A}	0.01	1.82 ^{A}	0.02	0.145	0.2
P-value	<0.001*		<0.001*			
Effect size (Partial Eta squared)	1		1			

**: "Significant at P ≤ 0.05, Different superscripts in the same column indicate statistically significant change by time within grou"p*

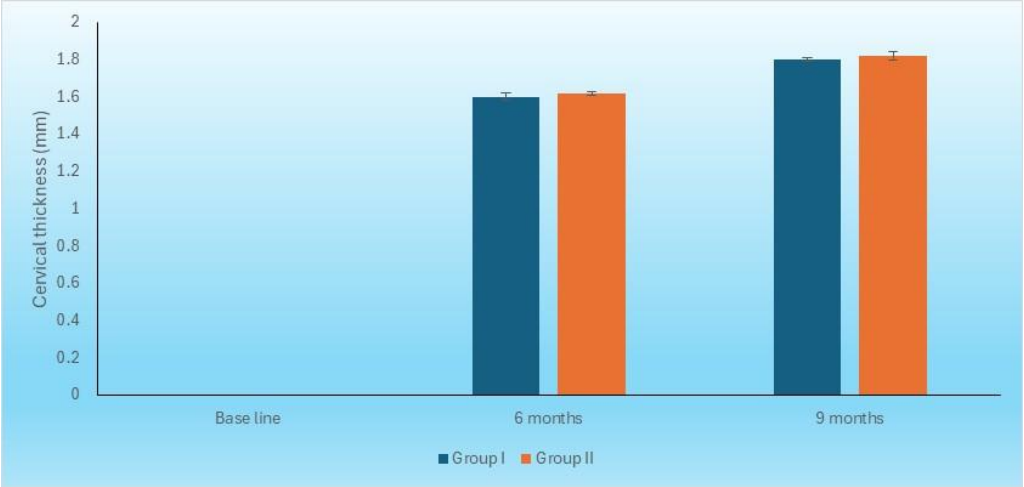

Figure 3: mean and standard deviation values for cervical thickness in the two groups

Distance from implant platform to crest of bone (mm)

At base line, thickness was zero in all cases in the two groups, so "no statistical" comparison could be made. After six as well as nine months, there was "no statistically significant" difference between the two groups (p = 0.111) and (p = 0.062).In both groups, there was a "statistically significant change" in distance by time (p <0.001) for each group, respectively. "Pair-wise comparison" between times revealed that there was a "statistically significant increase" in cervical distance after six months as well as from six to nine months.

Table 5: comparison between cervical distance (mm) in the two groups

Time	Group I		Group II		*P*-value	*Effect size (Partial Eta squared)*
	Mean	SD	Mean	SD		
Base line	-4 ^{C}	0	-4 ^{C}	0	Not computed	
6 months	0.5 ^{B}	0.02	0.52 ^{B}	0.01	0.111	0.234
9 months	1 ^{A}	0.02	1.02 ^{A}	0.02	0.062	0.306
P-value	<0.001*		<0.001*			
Effect size (Partial Eta squared)	1		1			

**: "Significant at P ≤ 0.05, Different superscripts in the same column indicate statistically significant change by time within group"*

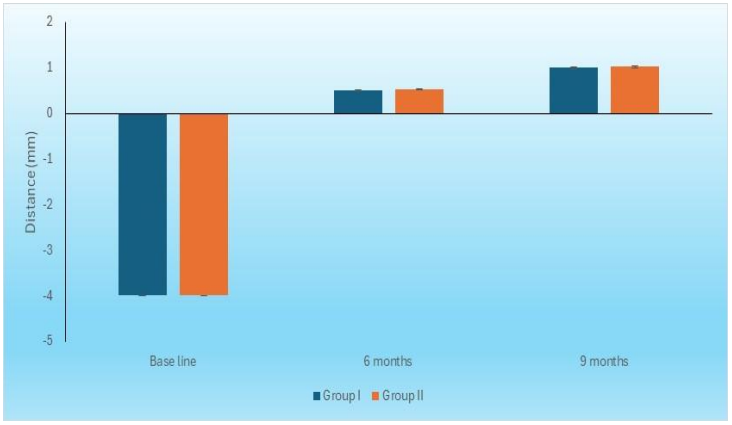

Figure 4: mean and standard deviation values for distance in the two groups

DISCUSSION

This study evaluated the clinical, esthetic, and radiographic outcomes of immediate implant placement in defective fresh extraction sockets using

vestibular VST, with or without the adjunctive use of i-PRF (5-7). The primary objective of this discussion is to interpret the observed inter-group similarities and intra-group changes over time, while correlating these findings with existing evidence addressing immediate implant placement, biologically driven socket management, and the adjunctive use of platelet concentrates (3,10).

Inter-group analysis revealed no statistically significant difference in PES between the two groups at both six and nine months (8). This finding indicates that the VST technique alone is capable of achieving a high level of peri-implant soft tissue esthetics. Preservation of the vestibular bone architecture and the minimally invasive nature of the technique likely contributed to maintaining papillary height and gingival margin stability (5,16).

Within each group, PES values increased significantly over time (16), reflecting progressive maturation and stabilization of peri-implant soft tissues. This observation is consistent with reports supporting the predictability of immediate implants combined with atraumatic socket management (3). Conversely, some studies have reported superior esthetic outcomes when platelet concentrates were used as adjuncts (9,23), which may be attributed to differences in defect morphology, provisionalization protocols, and esthetic assessment methods.

No statistically significant differences in ISQ values were detected between groups at baseline, six months, or nine months (1,3). This suggests that the adjunctive use of i-PRF did not exert a measurable effect on primary or secondary implant stability (21). The consistently high ISQ values observed in both groups can be attributed to optimal implant positioning and adequate engagement of native apical bone (10).

Intra-group analysis demonstrated stable ISQ values over time, supporting the concept that immediate implantation in properly managed extraction sockets does not compromise osseointegration . While some studies have reported enhanced implant stability with biologic adjuncts (21), others corroborate the present findings and demonstrate no significant mechanical benefit when high primary stability is achieved (23).
Both groups demonstrated a statistically significant increase in cervical bone thickness over time, with no significant difference between groups at six or nine months (2,4). This finding underscores the effectiveness of VST in preserving and reconstructing the cervical bone envelope around immediate implants (5). The use of a slowly resorbable graft within a protected vestibular compartment likely ensured space maintenance and graft stability, irrespective of i-PRF use (24).

The absence of inter-group differences contrasts with studies advocating platelet concentrates for enhanced bone regeneration ([18],[19]). However, it supports evidence emphasizing that mechanical stability, defect containment, and guided bone regeneration principles are more critical determinants of bone gain than biologic stimulation alone ([24]).

At baseline, the negative distance values reflected deliberate subcrestal implant placement within defective extraction sockets (25). Both groups exhibited significant improvement over time, indicating coronal bone fill and physiologic remodeling of the peri-implant bone crest .

Although the i-PRF group demonstrated slightly higher mean values at follow-up, the differences were not statistically significant. This finding aligns with literature suggesting that precise surgical technique, accurate implant positioning, and graft containment exert a greater influence on crestal bone stability than adjunctive biologics alone ([24],[25]).

Overall, the present findings confirm that vestibular socket therapy provides predictable esthetic and radiographic outcomes in immediate implant placement within defective fresh extraction sites(5) . Although the adjunctive use of i-PRF did not result in statistically significant advantages, clinically favorable trends—particularly in soft tissue esthetics—were observed, suggesting a supportive biologic role for i-PRF within a stable regenerative environment (18).

CONCLUSION

1. Vestibular socket therapy enabled predictable clinical, esthetic, and radiographic outcomes for immediate implant placement in defective fresh extraction sockets.

2. The adjunctive use of injectable platelet-rich fibrin did not confer a statistically significant additional benefit, although a supportive effect on soft-tissue esthetics was clinically observed.

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