Evaluating the Efficacy of Platelet-Rich Fibrin Matrix versus Subepithelial Connective Tissue Grafts in Dental Root Coverage: A Comparative Study Using Modified Ruben’s Technique

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Background: Dental root coverage, crucial in managing gingival recessions, traditionally utilizes subepithelial connective tissue grafts. However, this approach has limitations such as donor site morbidity and graft availability. Recent studies have introduced platelet-rich fibrin (PRF) as an alternative, leveraging its regenerative potential and growth factors. Despite the promise, comparative assessments between PRF and conventional grafts remain limited. This research probes whether PRF, when used beneath a modified Ruben’s mixed flap, could provide comparable or superior dental root coverage than a subepithelial connective tissue graft.

Material/Methods: We enrolled 30 patients exhibiting Miller’s class I and II recession in this comparative case series. Patients were randomly assigned to receive either a connective tissue graft (15 patients) or a PRF matrix (15 patients), both covered by a modified Ruben’s mixed flap.

Results: Clinical parameters – full mouth plaque scores, bleeding scores, probing sulcus depth, clinical attachment level, gingival position assessment, width and thickness of attached gingiva, and root coverage percentage – were evaluated at baseline and 6, and 12 months post-operation, revealing statistical significance. At the 12-month mark, complete root coverage was achieved in 93% of the control group (connective tissue graft) and 87% of the test group (PRF matrix), showing statistical significance with a p-value £0.53.

Conclusions: The study outcomes suggest comparable gains in root coverage and attached gingiva between the connective tissue graft and PRF matrix groups. Thus, the results support our hypothesis that a subepithelial PRF matrix can serve as a viable alternative to a subepithelial connective tissue graft for treating dental root coverage.

Keywords: Autografts • Blood Platelets • Connective Tissue • Fibrin • Gingival Recession

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Background

Tissue engineering requires an intricate interplay between native cells, growth factors, and signaling molecules, as well as the matrix, which serves as a framework for regeneration [1]. The key to tissue engineering is stimulating a series of events that cascade in a temporal sequence, which results in a coordinated cellular migration into the defect from the surrounding tissues. One of the challenges of both hard and soft tissue regeneration is to provide a bioactive matrix, so that, even while providing the framework for cellular migration, the matrix would be able to teach certain growth factors and signaling molecules required for cellular migration into the matrix. The ideal scaffold therefore serves as a mesh for the extracellular cells and growth factors, while serving as a matrix that facilitates and regulates cellular processes like mitosis, cell synthesis, and migration [2]. Gingival recession is defined as exposure of the root surface, due to the apical displacement of the gingival margin from the cemento-enamel junction [3-5]. Although gingival recession frequently occurs without any symptoms, patient-related concerns due to gingival recession are dentinal hypersensitivity from exposed root surfaces, apprehension regarding tooth loss, poor esthetics, inability to maintain proper oral hygiene, and bleeding gums.

Procedures used to correct gingival recession are broadly categorized into free gingival autograft and its variants, pedicle grafts, and matrices for soft tissue augmentation. The sub-pedicle connective tissue graft is often considered as the criterion standard, owing to the high percentage of predictable root coverage reported by different studies [6,7]. Studies with subepithelial connective tissue graft [8] and acellular dermal matrix allograft have shown predictable root coverages of 96% and 89.1%, respectively. Another study by Sedon et al conducted in 2 groups of patients treated with subepithelial connective tissue graft and an acellular dermal matrix-guided tissue regeneration membrane revealed predictable root coverage of 98.9% and 92.3%, respectively [9].

The pedicle graft technique, which involves a bilaminar technique, uses dual blood supply to the soft tissue graft, which increases the potential for optimal healing using this technique. Matrices have been used for root coverage with a high degree of success. The techniques commonly use either a guided tissue regeneration membrane [10] or an acellular dermal matrix [11] beneath a coronally or a laterally displaced flap to ensure predictable periodontal tissue regeneration, along with management of the esthetic deficit. The techniques that use these matrices also demonstrated a high level of success, which was comparable to the level of root coverage with a sub-pedicile connective tissue graft. There is also a much higher potential for new attachment, as evaluated in a few histological studies [12]. A histological study performed by Harris et al in their study on gingival recession coverage done with connective tissue graft and partial thickness flap showed new bone, cementum, and connective tissue attachment after 5 months of healing [13]. Also, a study by Bruno et al evaluated root coverage using a subepithelial connective tissue graft after 1 year, which histologically suggested connective tissue attachment [14]. A study has also revealed healing by the long junctional epithelium [15].

Concerns with the matrix technique, however, involve the additional cost for the matrix, despite it having a similar healing potential as connective tissue grafts. Platelet rich fibrin (PRF), a second generation platelet concentrate, is a rich source of growth factors that stimulates wound healing and thereby improves clinical success in various procedures, including root coverage procedures [16,17]. PRF has many of the characteristics that are required for an ideal matrix, including enhancing soft and hard tissue healing, so as to engineer the regeneration of the lost periodontal tissues. PRF also contains physiologically available thrombin, which results in slow polymerization of fibrinogen to fibrin, leading to a physiologic architecture that will serve as a favorable bioactive matrix for periodontal wound healing [18]. The cytokines that are present in the platelet concentrates play an important role in wound healing, with the natural polymerization of PRF resulting in incorporation of platelet-derived cytokines in a fibrin mesh, which allows the progressive release of growth factors over time (7-11 days) as the network of fibrin disintegrates. These intrinsic cytokines have an increased span of activity, as they will be released and used only at the time of matrix remodeling, which creates a long-term effect. The added advantage of PRF is the presence of a natural fibrin network that prevents growth factors from proteolysis [19].

The use of PRF as a tissue engineering scaffold has been investigated by many researchers [20], who have reported that PRF is a superior scaffold, compared with collagen, for human periosteal cell proliferation [19], bone tissue engineering, and for development of micro-revascularization, resulting in a more efficient matrix which causes cell migration and cell adhesion. PRF also has angiogenic properties, which help in the formation of new blood vessels and allow migration, division, and phenotype change of the endothelial cells. The fibrin matrix also acts like a barrier membrane, which prevents epithelial down-growth and modulates the expression of growth factors and fibroblastic cells, facilitating their migration into the wound. The existing data validate that the PRF membrane can be considered as a 3-dimensional mesh polymerized in a specific structure, with incorporation of platelets, leukocytes, and growth factors and the presence of circulating stem cells, which enable optimal healing. Studies on PRF have long shown its success in periodontal defects, including socket augmentation [21] and gingival recession [22]. In a recent study by Chekurthi et al [22], advanced PRF was used for RT (recession...
type 2) gingival recession, demonstrating esthetic advantages. Recently, Jankovic et al performed a coronally advanced flap-PRF matrix as part of a randomized controlled trial [23]. They reported complete root coverage of 75.85% in the PRF group and 79.56% in the coronally advanced flap group. Their study highlights the potential to use PRF as a matrix for root coverage, although they did not report a high percentage of complete root coverage. A few case series and case reports suggest a high degree of root coverage with the sub-pedicle PRF matrix, especially with a laterally displaced flap, to increase the predictability of the pedicle flaps. Gautam et al showed an improvement in clinical attachment level after 6 months, resulting in an observed recession coverage of up to 80% [24].

In 2013, Singh et al assessed the modified laterally sliding flap along with PRF for class II gingival recession, and the 6-month follow-up showed 80% root coverage [25]. Oncu et al suggested the use of PRF in multiple recessions, stating that PRF is a viable alternative to the subepithelial connective tissue graft [26]. It is therefore clear that PRF has the potential to be the perfect matrix for root coverage when used with a pedicle, which has all the features of the lost periodontal tissues.

The Ruben mixed pedicle flap technique uses a partial full-thickness and a partial split-thickness pedicle flap [27] and a modification of the lateral sliding flap technique, which was originally described by Harvey in 1970 [28,29]. It is therefore proposed that the partial full-thickness segment, which is dissected from the area just adjacent to the recession site, will serve as a rich reservoir of progenitor cells, from the cambium layer of the periosteum, which could migrate into the PRF matrix. Further, when a PRF matrix is overlaid by a Ruben’s mixed-pedicle flap, we expect the transient release of growth factor from the matrix, which would initiate the growth of connective tissue elements from the periodontal ligament and periosteum into the recession site. Further keratinized tissue from the adjacent tooth could significantly increase the width of the attached gingiva, which could together secure a comprehensive regeneration of the lost periodontal tissues. The probable outcome based on a systematic review and meta-analysis by Rodas et al would be to equate the subepithelial connective tissue graft with PRF so that PRF could be used as a viable alternative to subepithelial connective tissue graft to bypass the use of morbid autografts [29].

To date, no prospective randomized controlled clinical trials have compared the efficacy of a sub-pedicle PRF matrix with a sub-pedicle connective tissue graft underlying a modified mixed Ruben’s flap technique; therefore, in the present study, we aimed to compare dental root coverage following the use of a PRF matrix or subepithelial connective tissue graft combined with the modified laterally positioned pedicle flap-revised technique (modified Ruben’s technique) in 30 patients with Miller’s class I and II gingival recession.

### Material and Methods

This study was conducted at the Department of Periodontics, SRM Dental College, Ramapuram, Chennai, India. This study was approved by the SRM Dental College, Institutional Review Board (SRMU/M&HS/SRMDC/2012/M.D.S-PGStudent/504), and final clearance was obtained on November 18, 2014. This study was conducted in accordance with the Helsinki Declaration of 1975, as revised in 2013, and all patients gave their informed consent for inclusion before they participated in the study.

In the study, we aimed to assess the outcomes of comparing a sub-pedicle PRF matrix and a sub-pedicle connective tissue graft in terms of root coverage and gain in the width and thickness of the attached gingiva. A total of 30 participants (one site from each patient) were recruited and numbered randomly from 1 to 30 and assigned randomly into 2 groups. In the control group, patients received a subepithelial connective tissue graft, and in the test group, patients received PRF.

The cases were matched between the groups with relation to the 2 types of recession (Millers Class I and II recession) Signed informed consent was obtained from all patients, indicating willingness to participate in the study. The patients were then randomized into 2 groups, based on odd and even numbers: the control and the test group, respectively. The surgical procedures were performed by a single operator (P.S.G.P.) and later clinical evaluations were done by S.S., who was blinded for the entire study.

#### Sample Size Calculation

The formula for the sample size required comparing 2 populations means μ0 and μ1, with common variance, σ², was:

\[
n = \frac{2 \left( z_{\alpha/2} + z_{\beta} \right)^2}{\left( \mu_0 - \mu_1 \right)^2}
\]

where n=number of participants required in each intervention group, μ0=0.45, μ1=0.15, α=0.05, β=0.20, and power=(1-β)=95%.

The resulting estimated sample size was 15 study participants in each group, with a power of 95%. SPSS software was used.

#### Inclusion Criteria

To participate in the study, patients had to present gingival recession of Miller Class I or II, age between 18 and 45 years, full mouth plaque scores ≤10%, full mouth bleeding scores v10%, and facial surface gingival recession depth ≥2 mm.
Exclusion Criteria

Patients with the following were excluded from the study: cervical abrasion, root caries, smoking, trauma from occlusion, bruxism, non-vital teeth, pregnancy or lactation, any systemic disease with a potential influence on periodontal tissues, wound healing processes, or the immune response action, periodontal disease, sites adjacent to dental implants/edentulous sites, sites at teeth with prosthetic crowns, presence of adjacent recessions, and previous periodontal surgery.

Evaluation of Clinical Parameters

Prior to intervention, all patients underwent phase I therapy, including scaling and root planing, followed by polishing using a rubber cup to ensure optimal gingival health and minimize the inflammation prior to surgery. The patients were instructed to follow oral hygiene instructions, including correction of brushing habit (modified Stillman brushing technique).

Percentage of root coverage was calculated using the formula

\[
\frac{\text{Recession at baseline} - \text{Recession at post-op}}{\text{Recession at baseline}} \times 100
\]

The following clinical parameters were assessed at baseline, 6 months and 12 months after surgery: Full mouth plaque scores [30] were assessed as a dichotomous index, using plaque disclosing agent.

Full mouth bleeding scores [31] were assessed using gentle probing of the orifice of the gingival crevice.

Probing sulcus depth at surgical site was measured from the gingival margin to the base of gingival sulcus around each tooth using a UNC 15 probe.

Clinical attachment level at the surgical site was measured by preparing a modified acrylic stent and placed on the site of measurement and inserting a probe parallel to the long axis of the tooth gently along the sleeves, which were prepared on the stent, and the nearest millimeter was recorded from the cemento-enamel junction to the base of the sulcus.

Gingival position (recession height) was measured by preparing a modified acrylic stent placed on the site of measurement and inserting a probe parallel to long axis of the tooth gently along the sleeves, which were prepared on the stent, and the nearest millimeter was recorded from the cemento-enamel junction to the gingival margin.

Width of attached gingiva at the surgical site was measured by subtracting the probing gingival sulcus depth from the width of the gingiva at the midfacial aspect of the tooth, which was indicated for the root coverage to be calculated as the width of attached gingiva.

Thickness of attached gingiva at the surgical site was assessed mid-buccally in the attached gingiva 2 mm from the gingival margin. The gingival thickness was assessed by anesthetizing the facial gingiva with lidocaine topical aerosol USP (Nummit spray) ICPA, and if required, infiltration was done using 2% lignocaine HCL with 1: 80000 adrenaline injection using a No. 30 endodontic K file with a rubber stopper. The measurements were recorded with the help of steel ruler calibrated at 1 mm at baseline, 6 months and at 12 months after surgery.

Surgical Intervention

Modified Ruben’s Mixed Pedicle Flap Technique

After proper isolation of the surgical field, the operative site was anesthetized using 2% lignocaine hydrochloride, with adrenaline at 1: 80000 concentration. A collar of tissue was removed around the recession by 2 vertical incisions joining at 1 point apical to the base of the recession [27].

Preparation of Donor Site

The donor site was prepared by placing a vertical incision from the gingival margin to the oral mucosa up to the level of the tooth, which was prepared for root coverage with a No.15 surgical blade, after which a thorough root planing was done, as depicted in Figures 1 and 2.

Preparation of Connective Tissue Graft

The connective tissue graft was harvested from the palate using a trap door technique, and the desired amount of connective tissue graft harvested was placed on the denuded root surface (recipient bed) and sutured using simple interrupted sutures at the coronal most portion and at the lateral portions. The flap was then slid to completely cover the sub-pedicle connective tissue graft and secured using sling sutures. The periodontal dressing (Coe-pack) was placed to cover the surgical area as depicted in Figure 1.

PRF Site

An amount of 5 mL of blood was withdrawn in a 10-mL autoclaved test tube without an anticoagulant and was centrifuged immediately. Blood was centrifuged in a single step using a centrifugation machine (R-8C) for 10 min at 3000 rpm. The resultant product consisted of the following 3 layers: a top layer consisting of platelet-poor plasma, bottom layer consisting of red blood cells, and the middle portion consisting of a PRF clot. The PRF membrane was obtained by squeezing the fibrin clot.
clot between sheets of sterile gauze to obtain a fibrin membrane. The harvested PRF matrix was placed over the denuded root and stabilized using simple interrupted sutures at the coronal most portion and at the lateral portions. The flap was then slid to completely cover the sub-pedicle PRF matrix and secured using sling sutures, as depicted in Figure 2.

**Postsurgical Care and Measurements**

After the surgery, a periodontal dressing (Coe pack) was placed to cover the surgical area. The pre- and postoperative evaluation is shown in Figures 3 and 4. The patients were advised to abstain from mechanical oral hygiene procedures in the surgical area and also were advised to avoid pulling of lips. Chlorhexidine mouth rinse (0.12%) was used to support local plaque control for 2 weeks. Dressing and sutures were removed 12 days after surgery. Patients were recommended to follow all normal postoperative oral hygiene instructions and were prescribed analgesic medication (ibuprofen 400 mg every 8 h) for 5 days. All clinical parameters were assessed at 6 and 12 months postoperatively. All patients were instructed to maintain adequate plaque control during the course of the study. Professional maintenance care was performed at each recall visit (6 and 12 months), and the post-surgical measurements were performed as percentage of root coverage, full mouth plaque scores, full mouth bleeding scores, probing sulcus depth, clinical attachment level at the surgical site, assessment of gingival position, assessment of width of attached gingiva at the surgical site, and attachment of thickness of attached gingiva at the surgical site. No postoperative complications were encountered. Figures 3 and 4 depict the pre- and postoperative comparative photographs of the control group (connective tissue graft) and test group (PRF).

**Statistical Analysis**

Sample size was calculated using SPSS software based on proportionate methodology, with type II β error set at 95% and
type I α error set at 5%. The data were analyzed using ANOVA to analyze the mean, standard deviation, and test of significance of mean values for various parameters for the descriptive statistics for the control and test groups. Paired t tests were performed for the intra-group analysis of the clinical parameters for the control and test groups, un-paired t tests were performed for inter-group comparisons between the clinical parameters for the control and test groups. Fisher’s exact test was performed to determine the significance of percentage of root coverage within and between the groups.

**Results**

The descriptive statistics including age and sex were equal for the control group (28.2±4.91) and test group (26.70±5.17), with a sex distribution of male: female of 7: 8 in the control group and 9: 6 in test group; the variables were evaluated at different time intervals.

The intergroup comparisons of test and control groups showed no statistical significance when the different parameters were
compared at baseline, 6 months, and 1 year (Table 1): full mouth plaque scores, $P \leq 0.597$; full mouth bleeding scores, $P \leq 0.41$; probing sulcus depth at surgical site, $P \leq 0.247$; clinical attachment level at surgical site, $P \leq 0.555$; position of gingival margin, $P \leq 0.677$; width of attached gingiva at surgical site, $P \leq 0.593$; and thickness of attached gingiva at surgical site, $P \leq 0.254$.

Intragroup comparisons in the control group among all clinical parameters at baseline, 6 months, and 1 year revealed statistically significant differences ($P \leq 0.0001$) at different time intervals (Table 2, Figure 5). The following readings were recorded for each parameter from baseline to 1 year: probing sulcus depth at surgical site, 2.06 mm vs 1.46 mm ($P \leq 0.001$); clinical attachment level at surgical site, 4.66 mm vs 0.66 mm ($P \leq 0.0001$); assessment of gingival position, 2.53 mm vs 0.33 mm ($P \leq 0.0001$); width of attached gingiva at surgical site, 1.26 mm vs 3.26 mm ($P \leq 0.0001$); and thickness of attached gingiva at surgical site, 1.26 mm vs 3.2 mm ($P \leq 0.0001$).

Intragroup comparisons in the test group among all clinical parameters at baseline, 6 months, and 1 year revealed statistically significant differences ($P \leq 0.0001$) at different time intervals (Table 3, Figure 6). The following readings were recorded for each parameter from baseline to 1 year: probing sulcus depth at surgical site, 2.40 mm vs 1.73 mm ($P \leq 0.001$); clinical attachment level at surgical site, 4.8 mm vs 1.06 mm ($P \leq 0.0001$); position of gingival margin, 2.46 mm vs 0.46 mm ($P \leq 0.0001$); width of attached gingiva at surgical site, 1.93 mm vs 3.46 mm ($P \leq 0.0001$); and thickness of attached gingiva at surgical site, 1.46 mm vs 2.8 mm ($P \leq 0.0001$).

Percentage of root coverage assessed by Fischer’s exact test at the 1-year time point revealed that both the control group and test group had significant increases in root coverage (91% and 86%, respectively). The intergroup comparison revealed no statistical significance ($P \leq 0.53$; Table 4).
healing aims at healing with minimal or no tissue loss in which results in optimal periodontal wound healing. Periodontal wound healing has improved through the evolution of newer surgical techniques that rely on stringent patient and surgical site selection, and the use of membranes for regeneration of periodontal tissues and bioactive matrices that actively modulate postoperative healing. This improvement can also be explained by better understanding of biological wound repair [32].

This progress has taken us from the use of autogenous grafts to the use of membranes and membranes that release growth factors in a controlled manner. The PRF membrane, for example, has shown promise in the regeneration of periodontal tissues. The PRF membrane releases a variety of growth factors and signaling molecules that can stimulate wound healing and regenerate periodontal tissues [33].

Recent studies have also shown that the PRF membrane can stimulate the proliferation of periodontal ligament fibroblasts and osteoblasts and increase the secretion of osteoprotegerin, which is important for bone formation and regeneration. This is probably due to its ability to upregulate the signaling molecule, extracellular signal-regulated protein kinase (ERK).

The results of the present study revealed that both techniques, a connective tissue graft and a PRF membrane covered by a lateral pedicle flap, are effective in the treatment of gingival recession defects, with significant root coverage of 91% and 86%, respectively, and a clinical attachment gain at 1 year of 4 mm in the connective tissue graft group and of 3.74 mm in the PRF group. In this study, we aimed to adopt a modified Ruben’s laterally displaced pedicle flap overlying a bioactive matrix PRF, which accelerates the predictability of root coverage and increases the thickness of attached gingiva, and to compare it with a sub-pedicle connective tissue graft. Regenerative periodontal therapy has shown substantial improvement over the last 3 decades, owing to our understanding of the principles that govern periodontal wound healing, which is thanks to the prominent researchers who have helped us understand the nuances of biological wound repair [32].

In the present study, complete root coverage was obtained in 93% of cases in the control group and 87% of cases in the test group. In the literature, reports of mean root coverage for connective tissue graft in combination with a coronally advanced flap range from 70% to 98%. Zucchelli et al reported an 80% root coverage [25]. In accordance with the above-mentioned studies, in the present study, we gave a higher significance of root coverage with both sub-pedicle connective tissue graft and the sub-pedicle PRF matrix.

### Table 1. Intergroup comparison of clinical parameters at baseline, 6 months, and 12 months after surgery: full mouth plaque scores (FMPS), full mouth bleeding scores (FMBS), probing sulcus depth at surgical site (PSDS), clinical attachment level at the surgical site (CALS), gingival position/recession height (GP), width of attached gingiva (WAGS), and thickness of attached gingiva (TAGS).

<table>
<thead>
<tr>
<th>Clinical parameter</th>
<th>Baseline</th>
<th>P value</th>
<th>6 months</th>
<th>P value</th>
<th>12 months</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>FMPS</td>
<td>Control</td>
<td>16.86±4.34</td>
<td>1.000</td>
<td>21.4±5.75</td>
<td>0.84</td>
<td>22.6±4.74</td>
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<td></td>
<td>Test</td>
<td>16.86±4.44</td>
<td></td>
<td>24.53±3.56</td>
<td></td>
<td>21.73±0.9</td>
</tr>
<tr>
<td>FMBS</td>
<td>Control</td>
<td>13.53±2.9</td>
<td>0.024</td>
<td>17.2±50</td>
<td>0.10</td>
<td>15.93±6.06</td>
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<tr>
<td></td>
<td>Test</td>
<td>16.3±0.2</td>
<td></td>
<td>20.4±4.3</td>
<td></td>
<td>17.6±4.9</td>
</tr>
<tr>
<td>PSDS</td>
<td>Control</td>
<td>2.06±0.79</td>
<td>0.318</td>
<td>1.47±0.63</td>
<td>0.247</td>
<td>1.46±0.63</td>
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<td></td>
<td>Test</td>
<td>2.4±0.98</td>
<td></td>
<td>1.73±0.59</td>
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<tr>
<td>CALS</td>
<td>Control</td>
<td>4.66±1.79</td>
<td>0.836</td>
<td>0.66±1.79</td>
<td>0.914</td>
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<td></td>
<td>Test</td>
<td>4.8±1.69</td>
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<td>0.73±53</td>
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<td>GP</td>
<td>Control</td>
<td>2.53±1.18</td>
<td>0.865</td>
<td>0.33±0.89</td>
<td>0.677</td>
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<tr>
<td></td>
<td>Test</td>
<td>2.46±0.95</td>
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<tr>
<td>WAGS</td>
<td>Control</td>
<td>1.26±1.33</td>
<td>0.191</td>
<td>3.26±1.09</td>
<td>0.737</td>
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<td>Test</td>
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<td>3.4±1.05</td>
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<td>3.46±0.91</td>
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<tr>
<td>TAGS</td>
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<td>1.26±0.88</td>
<td>0.529</td>
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<tr>
<td></td>
<td>Test</td>
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<td>2.8±1.08</td>
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**Discussion**

The results of the present study revealed that both techniques, a connective tissue graft and a PRF membrane covered by a lateral pedicle graft, are effective in the treatment of gingival recession defects, with significant root coverage of 91% and 86%, respectively, and a clinical attachment gain at 1 year of 4 mm in the connective tissue graft group and of 3.74 mm in the PRF group. In this study, we aimed to adopt a modified Ruben’s laterally displaced pedicle flap overlying a bioactive matrix PRF, which accelerates the predictability of root coverage and increases the thickness of attached gingiva, and to compare it with a sub-pedicle connective tissue graft.

In the present study, complete root coverage was obtained in 93% of cases in the control group and 87% of cases in the test group. In the literature, reports of mean root coverage for connective tissue graft in combination with a coronally advanced flap range from 70% to 98%. Zucchelli et al reported an 80% root coverage [25]. In accordance with the above-mentioned studies, in the present study, we gave a higher significance of root coverage with both sub-pedicle connective tissue grafts and the sub-pedicle PRF matrix.
Out of 15 patients in the control group, 1 patient had minimal root coverage of 60%, and of 15 patients in the test group, 2 patients had minimal root coverage of 50% and 33%, respectively. The possible reason for minimal root coverage in the patients in both groups could have been inadequate maintenance of oral hygiene by the patients; as seen in Table 1, full mouth bleeding scores showed a statistically significant difference between the control and test groups at baseline. The possibility of gingival biotype playing an important factor in determining root coverage cannot be ignored. Our study used a laterally repositioned flap, thus warranting the presence of adequate attached gingiva in the site neighboring the surgical site, and all patients had adequate width of attached gingiva. Therefore, inflammation at the surgical site could have been the reason for the minimal overall difference in predictability of root coverage between the control and test groups. The possible causes of failure for the control group could be inadequate blood supply from surrounding tissues due to inadequate recipient site preparation. Also, possible failures of the test group could be PRF positioning at the cemento-enamel junction.

Table 2. Intragroup comparison of clinical parameters at baseline, 6 months, and 12 months in the control group: full mouth plaque scores (FMPS), full mouth bleeding scores (FMBS), probing sulcus depth at surgical site (PSDS), clinical attachment level at the surgical site (CALS), gingival position/recession height (GP), width of attached gingiva (WAGS), and thickness of attached gingiva (TAGS).

<table>
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<th>Baseline to 6 months</th>
<th>P value</th>
<th>6-12 months</th>
<th>P value</th>
<th>Baseline to 12 months</th>
<th>P value</th>
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<tr>
<td>FMPS</td>
<td>16.86±4.34</td>
<td>0.009</td>
<td>21.4±5.75</td>
<td>0.167</td>
<td>22.6±4.74</td>
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<td>FMBS</td>
<td>13.53±2.94</td>
<td>0.019</td>
<td>17.2±5.0</td>
<td>0.483</td>
<td>15.93±6.06</td>
<td>0.159</td>
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<td>PSDS</td>
<td>2.06±0.79</td>
<td>0.001</td>
<td>1.47±0.63</td>
<td>–</td>
<td>1.46±0.63</td>
<td>0.001</td>
</tr>
<tr>
<td>CALS</td>
<td>4.66±1.79</td>
<td>0.001</td>
<td>0.66±1.79</td>
<td>–</td>
<td>0.66±1.79</td>
<td>0.001</td>
</tr>
<tr>
<td>GP</td>
<td>2.53±1.18</td>
<td>0.001</td>
<td>0.33±0.89</td>
<td>–</td>
<td>0.33±0.89</td>
<td>0.001</td>
</tr>
<tr>
<td>WAGS</td>
<td>1.26±1.33</td>
<td>0.001</td>
<td>3.26±1.09</td>
<td>–</td>
<td>3.26±1.09</td>
<td>0.001</td>
</tr>
<tr>
<td>TAGS</td>
<td>1.26±0.8</td>
<td>0.001</td>
<td>3.2±0.77</td>
<td>–</td>
<td>3.2±0.77</td>
<td>0.001</td>
</tr>
</tbody>
</table>

Figure 5. Intragroup comparison of clinical parameters in the control group. FMPS – full mouth plaque score; FMBS – full mouth bleeding score; PSDS – probing sulcus depth at surgical site; CALS – clinical attachment level at surgical site; GP – gingival position (recession height); WAGS – width of attached gingiva at surgical site.
Table 3. Intragroup comparison of clinical parameters at baseline, 6 months, and 12 months in the test group: full mouth plaque scores (FMPS), full mouth bleeding scores (FMBS), probing sulcus depth at surgical site (PSDS), clinical attachment level at the surgical site (CALS), gingival position/recession height (GP), width of attached gingiva (WAGS), and thickness of attached gingiva (TAGS).

<table>
<thead>
<tr>
<th>Clinical parameter</th>
<th>Baseline to 6 months</th>
<th>P value</th>
<th>6-12 months</th>
<th>P value</th>
<th>Baseline to 12 months</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>FMPS</td>
<td>16.86±4.4</td>
<td>0.009</td>
<td>24.53±3.56</td>
<td>0.167</td>
<td>2.73±0.09</td>
<td>0.001</td>
</tr>
<tr>
<td>FMBS</td>
<td>16.3±0.2</td>
<td>0.001</td>
<td>20.40±4.35</td>
<td>0.003</td>
<td>17.6±4.98</td>
<td>0.181</td>
</tr>
<tr>
<td>PSDS</td>
<td>2.4±0.98</td>
<td>0.003</td>
<td>1.73±0.59</td>
<td>–</td>
<td>1.73±0.59</td>
<td>0.003</td>
</tr>
<tr>
<td>CALS</td>
<td>4.80±1.69</td>
<td>0.001</td>
<td>0.73±53</td>
<td>0.74</td>
<td>1.06±1.86</td>
<td>0.001</td>
</tr>
<tr>
<td>GP</td>
<td>2.4667±0.95</td>
<td>0.001</td>
<td>0.46±0.83</td>
<td>–</td>
<td>0.46±0.83</td>
<td>0.001</td>
</tr>
<tr>
<td>WAGS</td>
<td>1.9333±13</td>
<td>0.001</td>
<td>3.40±1.05</td>
<td>0.95</td>
<td>3.46±0.91</td>
<td>0.001</td>
</tr>
<tr>
<td>TAGS</td>
<td>1.4667±0.83</td>
<td>0.001</td>
<td>2.80±1.08</td>
<td>–</td>
<td>2.8±1.08</td>
<td>0.001</td>
</tr>
</tbody>
</table>

Figure 6. Intragroup comparison of clinical parameters in the test group. FMPS – full mouth plaque score; FMBS – full mouth bleeding score; PSDS – probing sulcus depth at surgical site; CALS – clinical attachment level at surgical site; GP – gingival position (recession height); WAGS – width of attached gingiva at surgical site.

Table 4. Percentage of root coverage in the control group and test group.

<table>
<thead>
<tr>
<th>Group</th>
<th>Percentage of root coverage at 6 months</th>
<th>P value</th>
<th>Percentage of root coverage at 12 months</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control group</td>
<td>91.55±22.32</td>
<td>0.53</td>
<td>91.56±22.32</td>
<td>0.53</td>
</tr>
<tr>
<td>Test group</td>
<td>86.22±24.20</td>
<td></td>
<td>86.20±24.24</td>
<td></td>
</tr>
</tbody>
</table>
jugulation resulting in initial root exposure, which has been reported in 53% of single recessions treated, with other reasons being PRF consistency and platelet concentration.

This study demonstrated that there was no statistically significant difference in probing sulcus depth reduction and clinical attachment level gain between the 2 groups. In the test group, the mean gain of clinical attachment level was 3.74 mm, whereas it was 4 mm in the control group. This non-significant change in clinical attachment level gain was similar to that found by Cheung et al, who compared coronally advanced flap with platelet concentrates [34]. Jankovic et al presented a randomized controlled trial on PRF and connective tissue graft with an coronally advanced flap, in which they observed an attachment gain of 2.96 mm for the connective tissue graft group and an attachment gain of 2.87 mm in the test group. In comparison with the Jankovic study, the present study had a higher clinical attachment gain [23].

In the present study, the increased width of keratinized tissue in the connective tissue graft group was related to the ability of connective tissue of palatal graft to induce keratinization of epithelium. Notably, gain in width of keratinized tissue obtained in the PRF group could be explained because of a tissue manifestation of the proliferation of gingival or periodontal fibroblast as a result of the influence of the growth factors from platelets entrapped in the fibrin mesh. However, other studies showed only modest gain in the width of keratinized gingiva when similar defects were treated with membranes [35]. The present study agrees with previous studies, which emphasize that utilizing connective tissue graft increases the width of attached gingiva.

Aroca et al reported inferior root coverage of about 80.7% at the test site (coronally advanced flap+ PRF) as compared with approximately 91.5% at the control site (coronally advanced flap), but an additional gain in gingival mucosal thickness was achieved, when compared to conventional therapy [36]. The initial thickness of the flap and the type of dissection at the recipient site will alter the connective tissue microcirculation and the diffusion of tissue fluid into the inter-positioned soft tissue graft. The importance of soft tissue thickness for root coverage with a coronally advanced flap has been stressed by Hwang et al in a systematic review on factors governing root coverage with a coronally advanced flap, in which they observed an attachment gain of 2.96 mm for the connective tissue graft and an attachment gain of 2.87 mm in the test group. In comparison with the Jankovic study, the present study had a higher clinical attachment gain [23].

In the present study, the increased width of keratinized tissue in the connective tissue graft group was related to the ability of connective tissue of palatal graft to induce keratinization of epithelium. Notably, gain in width of keratinized tissue obtained in the PRF group could be explained because of a tissue manifestation of the proliferation of gingival or periodontal fibroblast as a result of the influence of the growth factors from platelets entrapped in the fibrin mesh. However, other studies showed only modest gain in the width of keratinized gingiva when similar defects were treated with membranes [35]. The present study agrees with previous studies, which emphasize that utilizing connective tissue graft increases the width of attached gingiva.

The present study had a few limitations. First, the evaluators of the study were not blinded to the group the patients belong to, which could have resulted in bias at the time of evaluation. Second, the point of measurement for the thickness of the attached gingiva could have been standardized with the stent, as done in other studies [40,41]. Third, the patient selection criteria did not differentiate between those patients with a thin or thick gingival biotype. Despite these few limitations, this study has shown comparable levels of root coverage, clinical attachment gain, and gain in width and thickness of attached gingiva between the groups, which indicates that a sub-pedicle PRF matrix could be a definitive alternative to the criterion standard sub-pedicle connective tissue graft for root coverage.

Conclusions

The present study has demonstrated a significant increase in root coverage for the control and test groups, with complete root coverage of 93% for the control group and 87% for the test group. A significant gain in clinical attachment level for the control and test group was observed. At 12 months after surgery, a predictable increase in thickness and width of attached gingiva was also noted. We therefore conclude that PRF, when used beneath a modified Ruben’s mixed flap, can be considered as a definitive alternative to the sub-pedicle connective tissue graft.

Institutional Review Board Statement

The study was conducted according to the principles of the Declaration of Helsinki, and was approved by the Department of Periodontics, SRM Dental College, Ramapuram, Chennai, and the Institutional Review Board. IEC approval number: SRMU/M&HS/SMRDC/2012/M.D.S-PG Student/504.

Declaration of Figures’ Authenticity

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