

Effect of Plasma rich in growth factor with bridge flap in management of Miller's class I and II gingival recession defects: a comparative clinical study

Abhaya Chandra Das

Siksha 'O' Anusandhan University

Sourav Panda

sauravpanda@soa.ac.in

Siksha 'O' Anusandhan University

Mohit Das

Siksha 'O' Anusandhan University

Manoj Kumar

Siksha 'O' Anusandhan University

Rashmita Nayak

Siksha 'O' Anusandhan University

Massimo Del Fabbro

Università degli Studi di Milano

Tejas Pande

Siksha 'O' Anusandhan University

Research Article

Keywords: PRGF, gingival recession, gingival defects, platelet concentrate, clinical study, periodontal plastic surgery

Posted Date: August 6th, 2026

DOI: <https://doi.org/10.21203/rs.3.rs-10351640/v1>

License: © ⓘ This work is licensed under a Creative Commons Attribution 4.0 International License.

[Read Full License](#)

Additional Declarations: No competing interests reported.

Abstract

Background

The present study evaluated the additive outcome of Plasma Rich in Growth Factor (PRGF) combined with the Double Laterally Sliding Bridge Flap (DLSBF) procedure for treatment of mandibular anterior recession defects

Methodology:

Ninety-five defects in thirty patients aged 25–60 years with Miller's class I and II gingival recession in mandibular anterior teeth were recruited. 50 gingival recession sites in fifteen patients were managed with DLSBF + PRGF (test group), while 45 recession sites in 15 patients were managed with DLSBF alone. Clinical parameters, including the width of keratinized gingiva (WKG), relative attachment level (RAL), recession depth (RD), recession width (RW), probing pocket depth (PPD), gingival thickness (GT) and percentage of root coverage (PRC), were evaluated at all follow-ups of 3 and 6 months. Patient reported outcomes (PRO), including postoperative pain, swelling, and bleeding, were also assessed. The statistical analysis was done using the paired *t*-test, Mann-Whitney U test and the Wilcoxon signed-rank test, with a statistical significance set at $p < 0.05$.

Results

Compared with DLSBF alone, the DLSBF + PRGF group demonstrated marked improvements in RAL ($p = 0.049$), GT ($p < 0.001$) and PRC ($p = 0.019$) after 6 months. PRC was significantly greater in the DLSBF + PRGF group ($72.83 \pm 20.53\%$) than in the DLSBF group ($64.63 \pm 21.03\%$). Moreover, the adjunctive use of PRGF was linked with significantly lower postoperative pain, bleeding and swelling during the early healing period.

Conclusion

The adjunctive use of PRGF with the DLSBF technique improved clinical outcomes in multiple gingival recession treatments compared with DLSBF alone. PRGF enhanced the gingival thickness, attachment gain and root coverage while decreasing the postoperative morbidity, suggesting that it is a valuable biological adjunct for periodontal root coverage procedures.

Introduction

Gingival recession is the shift of the gingival margin from its position on the crown to a location apical to the cement-enamel junction (CEJ), resulting in the oral exposure of the root. It is quite prevalent among individuals across all age groups and ethnicities, with a reported prevalence exceeding 60% in the

general population. Untreated gingival recession can lead to pain, dentinal hypersensitivity, root caries, plaque retention, gingival bleeding and compromised aesthetics, which can negatively affect the patients' well-being and oral health-related satisfaction [1].

Among these consequences, aesthetic concerns have gained more importance with the growing patient demand for minimally invasive and aesthetically pleasing periodontal therapy. Subsequently, the objectives of contemporary mucogingival surgery have changed beyond achieving root coverage alone to restoring a harmonious gingival contour and more favorable tissue aesthetics [2]. Acknowledging this shift in the treatment philosophy, the American Academy of Periodontology (AAP) introduced the term "Periodontal plastic surgery" to replace "Mucogingival surgery," highlighting procedures aimed at correcting or eliminating developmental, traumatic and anatomical defects of the gingiva and alveolar mucosa [3, 4].

Gingival recession has a multifactorial etiology. Anatomical and morphological factors include thin periodontal phenotype, alveolar bone dehiscence, tooth position, inadequate keratinized tissue and root prominence, which predispose to recession. Functional and environmental factors such as traumatic tooth brushing, occlusal and non-occlusal parafunctional habits, orthodontic tooth movement, high frenal attachment, smoking, poorly contoured restorations, periodontitis, plaque-induced inflammation, systemic conditions and advancing age further influence its development [5–7]. Numerous classifications have been proposed to classify the gingival recession defects. Miller's classification is the most extensively used due to its prognostic value for root coverage procedures. Recently, the 2017 World Workshop introduced a revised classification based on the extent of the interproximal attachment loss, gingival phenotype and the characteristics of the exposed root surface, replacing the term periodontal biotype with periodontal phenotype to better replicate the clinical presentation.

Traditionally, successful root coverage was defined by complete root coverage, absence of inflammation or bleeding on probing, shallow probing depths and increased width of attached gingiva. However, current treatment outcomes increasingly highlight patient-reported outcome measures (PROMs), consisting of postoperative pain, aesthetics, comfort and patient satisfaction, alongside traditional clinical parameters [7]. The importance of attached gingiva in maintaining and aiding in optimal oral hygiene and gingival health is a highly debated topic in the literature. While early reports suggest that adequate attached gingiva is important for maintaining plaque control and gingival health, further investigations reported that periodontal stability can also be maintained in areas with minimal attached gingiva, only if meticulous oral hygiene is practiced [8, 9]. Yet, inadequate attached gingiva, shallow vestibular depth, aberrant frenal attachment and gingival recession continue to characterize important mucogingival problems requiring surgical intervention.

Various surgical methods are listed for the treatment of gingival recession in the periodontal literature. The lateral sliding flap marked the start of root coverage procedures, followed by modifications including the double papilla flap, free gingival graft, connective tissue graft (CTG) and coronally advanced flap (CAF) techniques [10–13]. Presently, CAF + CTG is the gold standard owing to its predictable recession

coverage and superior long-term stability [14]. However, CTG requires a second surgical site which increase patient morbidity, postoperative discomfort and limits treatment in cases with insufficient donor tissue. Moreover, CAF alone is contraindicated when the apical keratinized tissue is less than 1 mm, the vestibule is shallow or a high frenal attachment is present.

These limitations are especially common in the mandibular anterior region, where reduced attached gingiva and a shallow vestibule often complicate root coverage procedures. In such situations, the DLSBF offers an attractive single-stage alternative by simultaneously augmenting the width of the attached gingiva and coronally repositioning the gingival margin. The technique combines the principles of the CAF with the modified Edlan-Mejchar vestibuloplasty, offering improved patient comfort, decreased surgical morbidity and favorable aesthetic outcomes, especially in Miller's CI I and II recession defects with intact interdental hard and soft tissues [15].

Recently, Autologous Platelet Concentrates (APC) have emerged as valuable biological adjuncts for promoting periodontal wound healing and regeneration [16, 17]. Among them, PRGF is a first-generation APC that contains growth factors like vascular endothelial growth factor (VEGF), Fibroblast growth factor (FGF), platelet-derived growth factor (PDGF) and many more. which collectively promotes angiogenesis, fibroblast proliferation, collagen synthesis and tissue regeneration [18–20]. Unlike the conventional platelet-rich plasma preparations, PRGF is leukocyte-free and hence reduces the release of pro-inflammatory cytokines. Activation with calcium chloride initiates fibrin polymerization and sustained release of growth factors that enhance soft tissue healing [21]. Experimental studies have demonstrated that PRGF enhances proliferation and differentiation of gingival fibroblasts and osteoblasts and may exert greater stimulatory effects on gingival fibroblasts than platelet-rich fibrin (PRF) [22, 23].

The adjunctive use of PRGF in root coverage procedures has shown encouraging results. A study [24] compared CAF combined with PRGF to CAF alone and reported greater mean root coverage after three months in the PRGF group ($61 \pm 23.5\%$) than in the CAF-alone group ($43 \pm 34.9\%$), although both groups demonstrated significant improvements from baseline, with no significant difference in the width of keratinized tissue. This improvement could be attributed to the nuanced effect of PRGF on the proliferation of gingival fibroblasts [25].

Considering the biological potential of PRGF and the clinical advantages of DLSBF in managing recession defects with inadequate attached gingiva and shallow vestibules, the purpose of the present comparative clinical study was to compare the clinical efficacy of DLSBF with and without PRGF for the management of gingival recession in the mandibular anterior teeth.

Materials and Methods

Study Design and Ethical Approval

This comparative clinical study was carried out in the Department of Periodontics, Institute of Dental Sciences, Bhubaneswar, India, between August 2020 and December 2022. The study was carried out in adherence to the Declaration of Helsinki (1975, revised 2000) and was granted approval by the Institutional Ethics Committee (Registration No. DRI/IMS_SH/SOA/18122/2020). All participants were informed about the study and formal written consent was obtained before recruitment.

A priori calculation of sample size indicated that a minimum of 40 recession sites per group would provide 80% power to detect a 1-mm difference in RAL between the groups at a significance level of $p \leq 0.001$. 50 recession sites were to be included in each group to compensate for possible dropouts.

Study Population

Fifty systemically healthy patients presenting with multiple gingival recession defects in the mandibular anterior sextant were screened. Participants fulfilling the eligibility criteria were assigned to both groups at random. A single experienced operator performed all the surgeries while clinical measurements were recorded by a calibrated examiner.

Inclusion Criteria

- * Patients aged 20–45 years.
- * Presence of at least two Miller's Class I or II gingival recession defects in the mandibular anterior sextant.
- * Systemically healthy individuals.
- * Good oral hygiene with Plaque Index (PI) < 1.5 and Oral Hygiene Index (OHI) score < 1.

Exclusion Criteria

- * Previous periodontal surgery at the study site.
- * Antibiotics taken within the last 3 months.
- * Patients having cervical restorations or root caries.
- * Tobacco smoking or smokeless tobacco use.
- * Systemic diseases such as diabetes mellitus or hypertension.
- * Medications associated with gingival enlargement.
- * Presence of trauma from occlusion.

Treatment Groups

The recession defects were randomly assigned:

DLSBF + PRGF group (n = 50 sites in 15 patients): Double Lateral Sliding Bridge Flap combined with PRGF.

DLSBF group (n = 45 sites in 15 patients): Double Lateral Sliding Bridge Flap alone.

Preparation of PRGF

Venous blood (10 mL) was drawn into collection tubes containing anticoagulant (3.8% sodium citrate) and subjected to centrifugation using the PRGF-Endoret® System V (BTI Biotechnology Institute, Vitoria-Gasteiz, Spain). Centrifugation of the samples was done at $580 \times g$ for 8 minutes, yielding two plasma fractions. Fraction 2 (F2) consisted of the 2 mL plasma layer immediately above the buffy coat and was used for clinical application. The Fraction 1 (F1) consisted of the remaining plasma. PRGF was activated immediately before application using 10% calcium chloride (0.2 mL), causing fibrin clot formation and growth factor release.

Clinical Parameters

All clinical parameters were measured using a UNC-15 periodontal probe. The clinical examinations were performed at baseline, 3 months and 6 months. The following parameters were recorded:

- Plaque Index (PI) [26].
- Gingival Index (GI) [27].
- Relative Attachment Level (RAL), measured from a customized acrylic stent to the base of the periodontal pocket.
- Probing Depth (PD).
- Gingival Recession Depth (RD), measured from the cemento-enamel junction (CEJ) to the gingival margin.
- Gingival Recession Width (RW), measured 1 mm apical to the CEJ in the mesiodistal direction.
- Width of Keratinized Gingiva (WKG)
- Percentage of Root Coverage (PRC)
- Gingival Thickness (GT), assessed by direct transgingival probing and categorized as thin (< 1.5 mm) or thick (≥ 1.5 mm).
- Patient-reported outcomes (pain, swelling, and bleeding) were also recorded postoperatively.

Pre-surgical Phase

Following enrolment, all participants were subjected to full-mouth scaling and root planing (SRP) followed by standardized oral hygiene measures instruction. Re-evaluation was performed four weeks later before surgical intervention.

Surgical Procedure

Adequate anesthesia was obtained at the site of the treatment before the surgical procedure. The gingival recession defects in both treatment groups were treated with the DLSBF procedure, which combined the modified Edlan-Mejchar vestibuloplasty with CAF. For DLSBF, a horizontal incision was placed parallel to the mucogingival junction at a distance corresponding to at least twice the recession height plus 2 mm to ensure an adequately vascularized flap. A partial-thickness flap was then raised in a corono-apical direction, followed by a second horizontal periosteal incision 2–4 mm apical to the first. Crevicular incisions were made around the involved teeth, the papillae were de-epithelialized, and the remaining attached gingiva was released to allow tension-free coronal advancement.

Following meticulous root planing, 24% ethylenediaminetetraacetic acid (EDTA) was applied to the exposed root surface for conditioning. In the test group, PRGF was laid down over the conditioned root before flap advancement. Further, the flap was advanced coronally and steadied with 6 – 0 Vicryl sutures. The surgical site was then protected with a periodontal dressing (Coe-Pak™, GC America, Alsip, IL, USA).

Postoperative Care

Patients received diclofenac sodium (50 mg) along with paracetamol (325 mg) two times daily for three days and no systemic antibiotics were prescribed. Participants were instructed to consume a soft, cold diet during the first postoperative day, avoid trauma or lip retraction at the surgical site, and maintain plaque control by rinsing twice daily with 0.12% chlorhexidine gluconate beginning 30 minutes after tooth brushing until mechanical plaque control resumed. After periodontal dressing removal, patients were advised to use a soft-bristled toothbrush and follow the Charter's brushing technique [28].

The patients were instructed to report after one week for suture removal. Professional supragingival scaling and regular oral hygiene instructions were provided at every follow-up visit.

Follow-up and Outcome Assessment

Postoperative pain was assessed on the day of surgery (Day 1) and on Days 3, 7, and 10 using patient-reported outcomes. Swelling and bleeding were evaluated on Days 3, 7, and 10. Clinical periodontal parameters were reassessed at 3 and 6 months after surgery by the blinded examiner using the same standardized measurement protocol.

Statistical analysis

Statistical Package for the Social Sciences (SPSS) software (Version 15.0; IBM/SPSS Inc., Chicago, IL, USA) was used for analysis. All clinical parameters were expressed as mean $\pm$ standard deviation (SD).

The primary outcome measures were reduction in RD, RW, PRC, while the secondary outcome measure was the increase in WKG. Additional clinical parameters assessed included PD, RAL and GT. Intra-group comparisons between the baseline and 6-month follow-up were performed using the paired *t*-test for normally distributed data and the Wilcoxon signed-rank test for non-normally distributed variables. Intergroup comparisons were carried out using the independent Mann-Whitney U test where appropriate. All the clinical parameters were compared both within and between the groups. Mean changes from baseline were tested against the null hypothesis and all the enrolled participants completed the study. A statistically significant difference was reported when $p < 0.05$.

Results

Demographic Patient Data:

Among all enrolled patients, only 30 patients completed the study till the last follow-up. The DLSBF group consisted of 15 patients with 45 recession sites managed using the DLSBF alone, while the DLSBF + PRGF group consisted of 15 patients with 50 recession sites managed using DLSBF in combination with PRGF (Figure 1). The baseline demographic characteristics and clinical parameters were matched in the two groups, with no significant differences observed at baseline (Table 1).

Variable (mean $\pm$ SD)	DLSBF + PRGF Group (15 patients, 50 sites)	DLSBF Group (15 patients, 45 sites)	P value
Age (years)	29.93 $\pm$ 5.82	27.40 $\pm$ 6.39	0.73
Gender, n	Male: 6 (40.0%) Female: 9 (60.0%)	Male: 12 (80.0%) Female: 3 (20.0%)	0.026*
PPD (mm)	1.72 $\pm$ 0.45	1.78 $\pm$ 0.56	NS
RAL (mm)	7.90 $\pm$ 0.76	7.80 $\pm$ 0.96	NS
GI	1.94 $\pm$ 0.31	1.64 $\pm$ 0.48	NS
PI	2.01 $\pm$ 0.47	1.87 $\pm$ 0.63	NS
RD (mm)	3.18 $\pm$ 0.60	3.09 $\pm$ 0.73	NS
RW (mm)	1.90 $\pm$ 0.46	1.68 $\pm$ 0.63	NS
WKG (mm)	1.44 $\pm$ 0.76	1.60 $\pm$ 0.50	NS
GT (mm)	1.04 $\pm$ 0.20	1.22 $\pm$ 0.42	NS
Tooth type, n (%)	Central incisor: 28 (56.0%) Lateral incisor: 21 (42.0%) Canine: 1 (2.0%)	Central incisor: 29 (64.4%) Lateral incisor: 14 (31.1%) Canine: 2 (4.4%)	0.46

SD, standard deviation; PPD, probing pocket depth; RAL, relative attachment level; GI, gingival index; PI, plaque index; RD, recession depth; RW, recession width; WKG, width of keratinized gingiva; GT, gingival thickness; NS, not statistically significant.

Table 1: Baseline demographic and clinical characteristics of the study participants

Intergroup Comparisons

DLSBF + PRGF group showed marked improvements compared to the DLSBF-alone group in RAL ($p = 0.001$), WKG $p = 0.006$, GT ($p < 0.001$) and PRC ($p = 0.005$) at the end of 3-month follow-up (Table 2).

At 6 months, significantly better outcomes in the DLSBF + PRGF group were seen for RAL ($p = 0.049$), GT ($p < 0.001$) and PRC ($p = 0.019$). Although both groups showed improvement in RW, the between-group difference was not statistically significant ($p = 0.228$), indicating comparable reduction in recession width following treatment (Tables 2 and 3).

The changes in clinical parameters from baseline to 3 and 6 months are presented in Table 3. Compared with DLSBF alone, the adjunctive use of PRGF resulted in greater gains in RAL, WKG, and GT, together with a greater reduction in RD at both follow-up intervals.

Clinical Parameter	Group	n (sites)	3 Months (Mean ± SD)	6 Months (Mean ± SD)	Within-group P value
WKG (mm)	DLSBF + PRGF	50	3.86 ± 0.69	3.50 ± 0.68	<0.001*
	DLSBF	45	3.44 ± 0.55	3.20 ± 0.66	<0.001*
	Intergroup P value		0.002*	0.069	—
RAL (mm)	DLSBF + PRGF	50	4.76 ± 0.72	5.32 ± 0.82	<0.001*
	DLSBF	45	5.37 ± 0.94	5.71 ± 1.03	<0.001*
	Intergroup P value		0.001*	0.049*	—
PPD (mm)	DLSBF + PRGF	50	1.30 ± 0.46	1.36 ± 0.49	0.564
	DLSBF	45	1.49 ± 0.55	1.47 ± 0.63	1.000
	Intergroup P value		0.085	0.527	—
RD (mm)	DLSBF + PRGF	50	0.50 ± 0.61	0.96 ± 0.73	<0.001*
	DLSBF	45	0.87 ± 0.69	1.16 ± 0.80	<0.001*
	Intergroup P value		0.856	0.845	—
RW (mm)	DLSBF + PRGF	50	0.24 ± 0.43	0.56 ± 0.50	<0.001*
	DLSBF	45	0.38 ± 0.49	0.51 ± 0.51	<0.001*
	Intergroup P value		0.148	0.653	—
GT (mm)	DLSBF + PRGF	50	2.36 ± 0.53	2.50 ± 0.61	<0.001*
	DLSBF	45	1.40 ± 0.50	1.13 ± 0.34	<0.001*
	Intergroup P value		<0.001*	<0.001*	—
PRC (%)	DLSBF + PRGF	50	85.50 ± 17.32	72.83 ± 20.53	0.001*
	DLSBF	45	73.33 ± 20.46	64.63 ± 21.03	0.012*
	Intergroup P value		0.005*	0.019*	—

WKG, width of keratinized gingiva; RAL, relative attachment level; PPD, probing pocket depth; RD, recession depth; RW, recession width; GT, gingival thickness; PRC, percentage of root coverage.

Table 2: Intra-group and intergroup comparison of clinical parameters at 3 and 6 months after treatment

Clinical Parameter	Time Point	Group	n (sites)	Mean Change $\pm$ SD	Intergroup P value	Intragroup P value (DLSBF)	Intragroup P value (DLSBF + PRGF)
RAL gain (mm)	3 months	DLSBF	45	2.42 $\pm$ 1.16	0.002*	0.011*	<0.001*
		DLSBF + PRGF	50	3.14 $\pm$ 0.93			
	6 months	DLSBF	45	2.09 $\pm$ 1.24	0.039*	—	—
		DLSBF + PRGF	50	2.58 $\pm$ 0.95			
WKG gain (mm)	3 months	DLSBF	45	1.84 $\pm$ 0.42	<0.001*	0.008*	<0.001*
		DLSBF + PRGF	50	2.42 $\pm$ 0.88			
	6 months	DLSBF	45	1.60 $\pm$ 0.50	0.006*	—	—
		DLSBF + PRGF	50	2.06 $\pm$ 0.84			
RD reduction (mm)	3 months	DLSBF	45	2.22 $\pm$ 0.64	0.002*	0.003*	<0.001*
		DLSBF + PRGF	50	2.68 $\pm$ 0.62			
	6 months	DLSBF	45	1.93 $\pm$ 0.58	0.027*	—	—
		DLSBF + PRGF	50	2.22 $\pm$ 0.68			
RW reduction (mm)	3 months	DLSBF	45	1.31 $\pm$ 0.56	0.005*	0.014*	<0.001*
		DLSBF + PRGF	50	1.66 $\pm$ 0.56			
	6 months	DLSBF	45	1.18 $\pm$ 0.58	0.228	—	—

		DLSBF + PRGF	50	1.34 ± 0.52			
GT gain (mm)	3 months	DLSBF	45	0.18 ± 0.78	<0.001*	0.005*	0.071
		DLSBF + PRGF	50	1.32 ± 0.55			
	6 months	DLSBF	45	-0.09 ± 0.60	<0.001*	—	—
		DLSBF + PRGF	50	1.46 ± 0.61			

RAL, relative attachment level; WKG, width of keratinized gingiva; RD, recession depth; RW, recession width; GT, gingival thickness; SD, standard deviation

Table 3: Intergroup comparison of changes in clinical parameters and intragroup comparisons following treatment

Patient-Reported Outcomes

Postoperative Pain

The mean postoperative pain scores in the DLSBF group were 2.67 ± 3.13 , 2.13 ± 3.25 , 0.93 ± 1.67 , and 0.27 ± 0.46 on postoperative Days 1, 3, 7, and 10, respectively. Corresponding values for the DLSBF + PRGF group were 0.93 ± 1.66 , 0.53 ± 1.41 , 0.00 ± 0.00 , and 0.00 ± 0.00 .

Although pain values were consistently lower in the DLSBF + PRGF group throughout the postoperative period, a statistically significant intergroup difference was observed only on Day 10 ($p = 0.003$), whereas differences at Days 1, 3, and 7 were not statistically significant (Table 4).

Postoperative Bleeding

The mean bleeding scores in the DLSBF group were 2.00 ± 0.93 , 1.13 ± 0.74 , and 0.27 ± 0.46 on postoperative Days 3, 7, and 10, respectively. In comparison, the DLSBF + PRGF group exhibited lower bleeding scores of 0.87 ± 0.92 , 0.00 ± 0.00 , and 0.00 ± 0.00 at the corresponding time points.

Statistically significant reductions in postoperative bleeding were observed in the PRGF group on Days 3 ($p = 0.003$) and 7 ($p < 0.001$). By Day 10, bleeding had almost completely resolved in both groups, and the intergroup difference was no longer clinically meaningful (Table 4).

Postoperative Swelling

The mean swelling scores in the DLSBF group were 2.27 ± 1.34 , 0.87 ± 0.99 , and 0.27 ± 0.59 on postoperative Days 3, 7, and 10, respectively, whereas the corresponding scores in the DLSBF + PRGF group were 1.07 ± 0.80 , 0.40 ± 0.63 , and 0.27 ± 0.46 .

Although postoperative swelling was consistently lower in the DLSBF + PRGF group, the differences between groups were not statistically significant at Days 3, 7, or 10 (Table 4).

Outcome	Time Point	DLSBF + PRGF (<i>n</i> = 15) Mean $\pm$ SD	DLSBF (<i>n</i> = 15) Mean $\pm$ SD	p-value
Pain (VAS)	Day 1	0.93 ± 1.66	2.67 ± 3.13	0.110
	Day 3	0.53 ± 1.41	2.13 ± 3.25	0.055
	Day 7	0.00 ± 0.00	0.93 ± 1.67	0.035*
	Day 10	0.00 ± 0.00	0.27 ± 0.46	0.003*
Bleeding	Day 3	0.87 ± 0.92	2.00 ± 0.93	0.003*
	Day 7	0.00 ± 0.00	1.13 ± 0.74	<0.001*
	Day 10	0.00 ± 0.00	0.27 ± 0.46	0.035*
Swelling	Day 3	1.07 ± 0.80	2.27 ± 1.34	0.010*
	Day 7	0.40 ± 0.63	0.87 ± 0.99	0.178
	Day 10	0.27 ± 0.46	0.27 ± 0.59	0.757

VAS, Visual Analogue Scale; SD, standard deviation.

$p < 0.05$ indicates statistical significance.

Table 4: Comparison of patient-reported postoperative outcomes between the DLSBF + PRGF and DLSBF groups

Intra-group Comparisons

Both treatment groups demonstrated significant clinical improvements from baseline to 3 and 6 months. A statistically significant reduction in RD was observed following treatment ($p < 0.05$). Significant gains were also recorded in RAL, WKG and PRC in both groups ($p < 0.001$). PD remained stable throughout the study, indicating maintenance of periodontal health following both treatment modalities.

Discussion

Gingival recession is a multi-causal condition characterized by apical shift of the marginal gingiva leading to oral exposure of the root that may result in dentin hypersensitivity, root caries, increased

plaque accumulation, and aesthetic concerns, thereby negatively affecting patients' quality of life [29]. Its prevalence increases with age and is influenced by ethnicity, tooth location, periodontal phenotype, traumatic tooth brushing, inadequate alveolar bone support, thin gingival tissues, tooth malposition, and other local anatomical factors [30–33]. Although several studies have investigated the adjunctive use of PRGF with different root coverage procedures, no previous study has evaluated its use in combination with DLSBF. As far as we know, our study is probably the first to compare the clinical efficacy of DLSBF with and without PRGF for the management of Miller Class I and II gingival recession defects.

The present comparative clinical study demonstrated significant clinical improvements in both treatment groups over a period of 6 months. However, the use of PRGF as an adjunct resulted in significantly superior gains in the RAL, WKG, GT, RD and PRC. These findings suggest that PRGF improves the regenerative potential of DLSBF and enhances overall clinical outcomes.

The biological rationale for these findings is supported by the unique properties of PRGF. Unlike conventional platelet-rich plasma preparations, PRGF is obtained through controlled slow centrifugation, allowing effective separation of the platelet-rich plasma while removing leukocytes, therefore reducing the release of pro-inflammatory cytokines [34–37]. A fibrin scaffold is formed by activated PRGF that steadily releases growth factors, including PDGF, VEGF and FGF over several days. These bioactive molecules promote neo-vascularization, collagen production, matrix synthesis, thereby helping maturation of tissues, leading to accelerated soft tissue healing and regeneration [38, 39].

The findings of our study were in accordance with those of Ahrari et al. [40], who reported significantly superior improvements in the RAL, RD, WKG, and PRC when PRGF was used in conjunction with the tunnel technique compared with the tunnel technique alone. Likewise, Jenabian et al. [41] reported significant improvements in RD, CAL, GT and keratinized tissue width following the use of PRGF as an adjunct with CTG and CAF; however, the PD remained unchanged.

On the contrary, Abolfazi et al. [42] observed significant improvements in both treatment groups after the use of PRGF with a double pedicle graft but reported no significant differences between groups at 1-, 3- and 6- month follow-up. Similarly, Lafzi et al. [43] found no additional benefits of PRGF when compared with CTG and CAF. These discrepancies may be attributed to differences in surgical techniques, defect characteristics, baseline tissue dimensions, sample size, PRGF preparation protocols, and duration of follow-up.

The greater decrease in recession depth seen in the present study as compared with the reports by Jenabian et al. [41] and Lafzi et al. [43] may be related to the surgical characteristics of the DLSBF technique. Furthermore, despite a considerably lower baseline width of keratinized gingiva than that reported in previous studies, a significant increase in keratinized tissue was achieved in both treatment groups, indicating that the DLSBF technique itself effectively augments keratinized tissue, while PRGF further enhances soft tissue maturation.

The mean PRC achieved in this study (85.5% in the DLSBF + PRGF group and 72.8% in the DLSBF group) was higher than that reported by Jenabian et al. [41] and comparable to the favorable outcomes reported in previous studies evaluating platelet concentrates in root coverage procedures [43, 44]. A key finding of our study was the significantly increased gain in GT observed in the PRGF group at the 6-month follow-up. An increase in GT suggests predictability of root coverage outcomes and a lower likelihood of recession recurrence when observed over a long-term period.

An important finding of this study was the significantly better increase in GT observed in the PRGF group at 6 months. Increased GT has been linked to enhanced long-term stability of root coverage procedures and reduced risk of recession recurrence. The steady release of growth factors from the PRGF fibrin matrix likely contributed to improved fibroblast proliferation, soft tissue maturation and collagen deposition, therefore explaining the favorable increase in GT. These findings are similar to the previous evidence showing the regenerative capability of Autologous platelet concentrates in periodontal plastic surgery and periodontal regeneration [45–50].

The present study has certain limitations, such as the follow-up period being limited to six months and including only Miller's Class I and II recession defects, confining extrapolation of the findings to more advanced recession defects. Moreover, histological evaluation was not performed; hence, true periodontal regeneration and the nature of the attachment obtained could not be confirmed. Future randomized clinical trials (RCTs) with larger sample sizes, extended follow-up periods, inclusion of Cairo recession types, and histological or advanced imaging assessments are required to confirm the predictability and biological benefits of PRGF used as an adjunct to DLSBF.

Conclusion

The use of PRGF with DLSBF showed better clinical outcomes when compared with DLSBF alone for the management of Miller's Class I and II gingival recession defects. The addition of PRGF improved the PRC, RAL, GT and WKG significantly, while providing enhanced postoperative healing and patient comfort. These findings suggest that PRGF is a favorable biological adjunct for periodontal plastic surgery and may facilitate more consistent treatment outcomes and patient acceptance of root coverage procedures, especially in anatomically challenging mandibular anterior recession defects. Further well-designed RCTs with extended follow-up in more patients and histological evaluation are required to assess the long-term regenerative potential of PRGF in periodontal plastic surgery.

Abbreviations

CAF

Coronally Advanced Flap

CEJ

Cemento–Enamel Junction

CTG

Connective Tissue Graft
DLSBF
Double Laterally Sliding Bridge Flap
EDTA
Ethylenediaminetetraacetic acid
FGF
Fibroblast Growth Factor
GI
Gingival Index
GT
Gingival Thickness
OHI
Oral Hygiene Index
PD
Probing Depth
PDGF
Platelet-Derived Growth Factor
PI
Plaque Index
PPD
Probing Pocket Depth
PRC
Percentage of Root Coverage
PRGF
Plasma Rich In Growth Factors
PROMs
Patient Reported Outcome Measures
RAL
Relative Attachment Level
RD
Recession Depth
RW
Recession Width
SD
Standard Deviation
SPSS
Statistical Package for the Social Sciences
VEGF
Vascular Endothelial Growth Factor
WKG

Declarations

Ethics approval and consent to participate:

The study was conducted in accordance with the Declaration of Helsinki (1975, revised 2000) and was approved by the Institutional Ethics Committee of the Institute of Medical Sciences, Siksha 'O' Anusandhan (Deemed to be University), Bhubaneswar, India (Registration No. DRI/IMS_SH/SOA/18122/2020). Written informed consent was obtained from all subjects involved in the study prior to participation.

Consent for publication:

Not Applicable

Competing Interests:

The authors declare they have no competing interests.

Funding:

This research received no external funding.

Author Contribution

Conceptualization, A.C.D. and S.P.; methodology, A.C.D., S.P., and M.D.; formal analysis, A.C.D. and S.P.; investigation, A.C.D., M.D., and M.K.; data curation, A.C.D., M.K., and R.N.; writing—original draft preparation, A.C.D. and S.P.; writing—review and editing, S.P., M.D.F., M.D., M.K., R.N., and T.P.; visualization, A.C.D. and S.P.; supervision, S.P. and M.D.F. All authors have read and agreed to the published version of the manuscript.

Acknowledgement:

Nil

Data Availability

The data supporting the findings of this study are available from the corresponding author upon reasonable request.

References

1. Chambrone L, Tatakis DN. Periodontal Soft Tissue Root Coverage Procedures: A Systematic Review from the AAP Regeneration Workshop. J Periodontol. 2015;86:S8–51. 10.1902/jop.2015.130674.
2. Js R, M AA, Cross-Sectional. Study of Dentine Hypersensitivity. J Clin Periodontol. 2002;29:997–1003. 10.1034/j.1600-051x.2002.291104.x.
3. De Sanctis M, Zucchelli G. Coronally Advanced Flap: A Modified Surgical Approach for Isolated Recession-Type Defects: Three-Year Results. J Clin Periodontol. 2007;34:262–8. 10.1111/j.1600-051X.2006.01039.x.
4. The American Academy of Periodontology 2001 Annual Report. Journal of Periodontology. 2001, 72, 1801–1815. 10.1902/jop.2001.72.12.1801
5. Stefanini M, Jepsen K, de Sanctis M, Baldini N, Greven B, Heinz B, Wennström J, Cassel B, Vignoletti F, Sanz M, et al. Patient-Reported Outcomes and Aesthetic Evaluation of Root Coverage Procedures: A 12-Month Follow-up of a Randomized Controlled Clinical Trial. J Clin Periodontol. 2016;43:1132–41. 10.1111/jcpe.12626.
6. Maynard JG, Wilson RDK. Physiologic Dimensions of the Periodontium Significant to the Restorative Dentist. J Periodontol. 1979;50:170–4. 10.1902/jop.1979.50.4.170.
7. A Study of the Width of Attached Gingiva. - Bowers – 1963 - The Journal of Periodontology - Wiley Online Library <https://aap.onlinelibrary.wiley.com/doi/abs/10.1902/jop.1963.34.3.201> (accessed on 18 November 2020).
8. Lang NP, Löe H. The Relationship Between the Width of Keratinized Gingiva and Gingival Health. J Periodontol. 1972;43:623–7. 10.1902/jop.1972.43.10.623.
9. *Clinical Periodontology and Implant Dentistry*; Lindhe J, Karring T, Lang NP, editors; 4th ed.; Blackwell: Oxford, UK; Malden MA. 2003; ISBN 978-1-4051-0236-0.
10. Toothbrushing and Gingival Recession - Litonjua – 2003. - International Dental Journal - Wiley Online Library: <https://onlinelibrary.wiley.com/doi/abs/10.1111/j.1875-595X.2003.tb00661.x> (accessed on 18 November 2020).
11. Wennstrom JL, Zucchelli G. Increased Gingival Dimensions. A Significant Factor for Successful Outcome of Root Coverage Procedures? A 2-Year Prospective Clinical Study. J Clin Periodontol. 1996;23:770–7. 10.1111/j.1600-051X.1996.tb00608.x.
12. Grupe HE, Warren RF. Repair of Gingival Defects by a Sliding Flap Operation. J Periodontol. 1956;27:92–5. 10.1902/jop.1956.27.2.92.
13. Pennel BM, Tabor JC, King KO, Towner JD, Fritz BD, Higgason JD. Free Masticatory Mucosa Graft. J Periodontol. 1969;40:162–6. 10.1902/jop.1969.40.3.162.
14. Björn H. Coverage of Denuded Root Surfaces with a Lateral Sliding Flap. Use of Free Gingival Grafts. Odontol Revy. 1971;22:37–44.
15. Cohen DW, Ross SE. The Double Papillae Repositioned Flap in Periodontal Therapy. J Periodontol. 1968;39:65–70. 10.1902/jop.1968.39.2.65.

16. A Direct Technique with a Double Lateral Bridging Flap for Coverage of Denuded Root Surface. and Gingiva Extension - Marggraf – 1985 - Journal of Clinical Periodontology - Wiley Online Library: <https://onlinelibrary.wiley.com/doi/abs/10.1111/j.1600-051X.1985.tb01355.x> (accessed on 18 November 2020).
17. Nunn ME, Miyamoto T. Coronally Advanced Flaps (CAF) plus Connective Tissue Graft (CTG) Is the Gold Standard for Treatment of Miller Class I and II Gingival Defects. *J Evid Based Dent Pract.* 2013;13:157–9. 10.1016/j.jebdp.2013.10.012.
18. Panda S, Satpathy A, Chandra Das A, Kumar M, Mishra L, Gupta S, Srivastava G, Lukomska-Szymanska M, Taschieri S, Del Fabbro M. Additive Effect of Platelet Rich Fibrin with Coronally Advanced Flap Procedure in Root Coverage of Miller's Class I and II Recession Defects—A PRISMA Compliant Systematic Review and Meta-Analysis. *Materials* 2020, 13, 4314. 10.3390/ma13194314
19. Panda S, Karanxha L, Goker F, Satpathy A, Taschieri S, Francetti L, Chandra Das A, Kumar M, Panda S, Del Fabbro M. Autologous Platelet Concentrates in Treatment of Furcation Defects—A Systematic Review and Meta-Analysis. *Int J Mol Sci.* 2019;20. 10.3390/ijms20061347.
20. Anitua E. Plasma Rich in Growth Factors: Preliminary Results of Use in the Preparation of Future Sites for Implants. 2000, 8.
21. Anitua E, Sanchez M, Merayo-Llodes J, De la Fuente M, Muruzabal F, Orive G. Plasma Rich in Growth Factors (PRGF-Endoret) Stimulates Proliferation and Migration of Primary Keratocytes and Conjunctival Fibroblasts and Inhibits and Reverts TGF-B1 –Induced Myodifferentiation. *Invest Ophthalmol Vis Sci.* 2011;52:6066. 10.1167/iovs.11-7302.
22. Howell TH, Martuscelli G, Oringer J. Polypeptide Growth Factors for Periodontal Regeneration. *Curr Opin Periodontol.* 1996;3:149–56.
23. Anitua E, Sánchez M, Zalduendo MM, de la Fuente M, Prado R, Orive G, Andía I. Fibroblastic Response to Treatment with Different Preparations Rich in Growth Factors. *Cell Prolif.* 2009;42:162–70. 10.1111/j.1365-2184.2009.00583.x.
24. Lafzi A, Chitsazi MT, Farahani RM, Faramarzi M. Comparative clinical study of coronally advanced flap with and without use of plasma rich in growth factors in the treatment of gingival recession. *Am J Dent.* 2011;24(3):143–7. PMID: 21874932.
25. Vahabi S, Vaziri S, Torshabi M, Rezaei Esfahrood Z. Effects of Plasma Rich in Growth Factors and Platelet-Rich Fibrin on Proliferation and Viability of Human Gingival Fibroblasts. *J Dent (Tehran).* 2015;12:504–12.
26. Turesky S, Gilmore ND, Glickman I. Reduced Plaque Formation by the Chloromethyl Analogue of Vitamin C. *J Periodontol.* 1970;41:41–3. 10.1902/jop.1970.41.41.41.
27. Löe H. The Gingival Index, the Plaque Index and the Retention Index Systems. *J Periodontology.* 1967;38:610–6. <https://doi.org/10.1902/jop.1967.38.6.610>.
28. Hansen F, Gjermo P. The Plaque-Removing Effect of Four Toothbrushing Methods. *Scand J Dent Res.* 1971;79:502–6.

29. Chambrone L, Faggion CMJ, Pannuti CM, Chambrone LA. Evidence-Based Periodontal Plastic Surgery: An Assessment of Quality of Systematic Reviews in the Treatment of Recession-Type Defects. *J Clin Periodontol*. 2010;37:1110–8. 10.1111/j.1600-051X.2010.01634.x.
30. Loe H, Anerud A, Boysen H. The Natural History of Periodontal Disease in Man: Prevalence, Severity, and Extent of Gingival Recession. *J Periodontol*. 1992;63:489–95. 10.1902/jop.1992.63.6.489.
31. Susin C, Haas AN, Oppermann RV, Haugejorden O, Albandar JM. Gingival Recession: Epidemiology and Risk Indicators in a Representative Urban Brazilian Population. *J Periodontol*. 2004;75:1377–86. 10.1902/jop.2004.75.10.1377.
32. Kassab MM, Cohen RE. The Etiology and Prevalence of Gingival Recession. *J Am Dent Assoc*. 2003;134:220–5. 10.14219/jada.archive.2003.0137.
33. Abboud M, Grüner M, Koeck B. Anterior Crowding–Just an Esthetic Problem? *J Orofac Orthop*. 2002;63:264–73. 10.1007/s00056-002-0033-5.
34. Solakoglu Ö, Heydecke G, Amiri N, Anitua E. The Use of Plasma Rich in Growth Factors (PRGF) in Guided Tissue Regeneration and Guided Bone Regeneration. A Review of Histological, Immunohistochemical, Histomorphometrical, Radiological and Clinical Results in Humans. *Annals Anat - Anatomischer Anzeiger*. 2020;231:151528. 10.1016/j.aanat.2020.151528.
35. Nishiyama K, Okudera T, Watanabe T, Isobe K, Suzuki M, Masuki H, Okudera H, Uematsu K, Nakata K, Kawase T. Basic Characteristics of Plasma Rich in Growth Factors (PRGF): Blood Cell Components and Biological Effects. *Clin Exp Dent Res*. 2016;2:96–103. 10.1002/cre2.26.
36. Anitua E, Andia I, Ardanza B, Nurden P, Nurden A. Autologous Platelets as a Source of Proteins for Healing and Tissue Regeneration. *Thromb Haemost*. 2004;91:4–15. 10.1160/TH03-07-0440.
37. Lemons PP, Chen D, Whiteheart SW. Molecular Mechanisms of Platelet Exocytosis: Requirements for α -Granule Release. *Biochem Biophys Res Commun*. 2000;267:875–80. 10.1006/bbrc.1999.2039.
38. Anitua E. Plasma Rich in Growth Factors: Preliminary Results of Use in the Preparation of Future Sites for Implants. 2000, 7.
39. Anitua E, Sánchez M, Orive G. Potential of Endogenous Regenerative Technology for in Situ Regenerative Medicine. *Adv Drug Deliv Rev*. 2010;62:741–52. 10.1016/j.addr.2010.01.001.
40. Ahrari F, Keshavarzi F, Bijani A, Jenabian N. Efficacy of Application of Plasma Rich in Growth Factors Along with the Tunnel Technique for Treatment of Gingival Recession: A Clinical Trial. *J Dent (Shiraz)*. 2020;21:275–83. 10.30476/DENTJODS.2020.83590.1052.
41. Jenabian N, Motallebnejad M, Zahedi E, Sarmast N, Angelov N. Coronally Advanced Flap and Connective Tissue Graft with or without Plasma Rich in Growth Factors (PRGF) in Treatment of Gingival Recession. *J Clin Exp Dent*. 2018;0–0. 10.4317/jced.54573.
42. Abolfazli N, Asadollahi A, Faramarzi M, Saleh Saber F. Efficacy of Double Pedicle Graft with and without PRGF in Treating CI I and CI II Gingival Recessions. *J Periodontol Implant Dent*. 2018;7:44–9. 10.15171/jpid.2015.009.
43. Lafzi A, Faramarzi M, Shirmohammadi A, Behrozian A, Kashefimehr A, Khashabi E. Subepithelial Connective Tissue Graft with and without the Use of Plasma Rich in Growth Factors for Treating

- Root Exposure. *J Periodontal Implant Sci.* 2012;42:196. 10.5051/jpis.2012.42.6.196.
44. Jankovic S, Aleksic Z, Milinkovic I, Dimitrijevic B. The Coronally Advanced Flap in Combination with Platelet-Rich Fibrin (PRF) and Enamel Matrix Derivative in the Treatment of Gingival Recession: A Comparative Study. *Eur J Esthet Dent.* 2010;5:260–73.
 45. Panda S, Karanxha L, Goker F, Satpathy A, Taschieri S, Francetti L, Das AC, Kumar M, Panda S, Fabbro MD. Autologous Platelet Concentrates in Treatment of Furcation Defects—A Systematic Review and Meta-Analysis. *IJMS*2019, 20, 1347. 10.3390/ijms20061347
 46. Panda S, Sankari M, Satpathy A, Jayakumar D, Mozzati M, Mortellaro C, Gallesio G, Taschieri S, Del Fabbro M. Adjunctive Effect of Autologous Platelet-Rich Fibrin to Barrier Membrane in the Treatment of Periodontal Intrabony Defects. *J Craniofac Surg.* 2016;27:691–6. 10.1097/SCS.0000000000002524.
 47. Del Fabbro M, Karanxha L, Panda S, Bucchi C, Nadathur Doraiswamy J, Sankari M, Ramamoorthi S, Varghese S, Taschieri S. Autologous Platelet Concentrates for Treating Periodontal Infrabony Defects. *Cochrane Database Syst Reviews.* 2018. 10.1002/14651858.CD011423.pub2.
 48. DENTAL SUPPLEMENT, Testori T, Panda S, Clauser T, Scaini R, Zuffetti F, Capelli M, Taschieri S, Mortellaro C, Del Fabbro M. Short Implants and Platelet-Rich Fibrin for Transcrestal Sinus Floor Elevation: A Prospective Multicenter Clinical Study. *J Biol Regul Homeost Agents.* 2019;33:121–35.
 49. Del Fabbro M, Panda S, Taschieri S. Adjunctive Use of Plasma Rich in Growth Factors for Improving Alveolar Socket Healing: A Systematic Review. *J Evid Based Dent Pract.* 2019;19:166–76. 10.1016/j.jebdp.2018.11.003.
 50. Del Fabbro M, Lolato A, Panda S, Corbella S, Satpathy A, Das AC, Kumar M, Taschieri S. Methodological Quality Assessment of Systematic Reviews on Autologous Platelet Concentrates for the Treatment of Periodontal Defects. *J Evid Based Dent Pract.* 2017;17:239–55. 10.1016/j.jebdp.2017.04.006.

Figures



Figure 1

Representative clinical photographs of the double laterally sliding bridge flap (DLSBF) procedure with and without platelet-rich growth factors (PRGF). **(a–d)** DLSBF + PRGF group: preoperative view, flap elevation, PRGF membrane placement, and 6-month postoperative outcome. **(e–h)** DLSBF group: preoperative view, flap elevation, flap stabilization with sutures, and 6-month postoperative outcome