RESEARCH PAPER

Clinical and Volumetric Outcomes of Laterally Closed Coronally Advanced Flap for Root Coverage: A 3D Perspective Case Report

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Received: 20th Feb, 2026 | **Revised:** 4th Mar, 2026 | **Accepted:** 25th Mar, 2026 | **Available Online:** 10th Apr, 2026

ABSTRACT

Gingival recession is a mucogingival deformity characterized by the displacement of the gingival margin apical to the cemento-enamel junction, leading to root surface exposure. It has multiple etiology such as periodontal inflammation, traumatic tooth brushing, thin periodontal phenotype, malpositioned teeth, and inadequate keratinized tissue. It will lead to dentin hypersensitivity, root caries, non-carious cervical lesions, compromised plaque control, and marked aesthetic concerns, especially in the mandibular anterior region. Treatment of Miller Class III recession defects remains challenging due to interproximal attachment loss and limited predictability of complete root coverage. Periodontal surgical procedures target is to improve root coverage, soft tissue thickness, and gingival phenotype. The Laterally Closed Coronally Advanced Flap (LCCAF) has raised as a minimally invasive technique that combines the benefits of lateral and coronal flap mobilization while maintaining vascular supply. A 28-year-old female presented with a 6-mm gingival recession in relation to tooth 32, absence of keratinized gingiva, thin gingival phenotype, and associated hypersensitivity. The defect was treated using LCCAF combined with a de-epithelialized free gingival graft and platelet-rich fibrin. Digital intraoral scans obtained at baseline, 2 weeks, 3 months, and 6 months demonstrated significant root coverage, increased soft-tissue volume, and improved gingival contour with progressive physiological remodeling. The combined surgical approach resulted in reduction of hypersensitivity and enhancement of tissue phenotype. Furthermore, 3D digital assessment offers a precise, non-invasive, and reproducible method for evaluating longitudinal volumetric soft-tissue changes following periodontal surgery. This case report underscores the effectiveness of LCCAF and the reliability of 3D digital evaluation for assessing soft tissue outcomes.

Keywords: Surgical Flaps; Tissue Grafts; Wound Healing; Dental Esthetics; Platelet-Rich Plasma.

How to cite this article: Aravinth M, Balaji A, Mari R, Sameera MM, Anumithra S. Clinical and Volumetric Outcomes of Laterally Closed Coronally Advanced Flap for Root Coverage: A 3D Perspective Case Report. Int J Drug Deliv Technol. 2026;16(32s):159-164. DOI: 10.25258/ijddt.16.32s.18

Source of support: Nil.

Conflict of interest: The authors declare no conflict of interest.

CASE REPORT:

A 28-year-old woman reported to the department of periodontology with chief complaint of receding gums in the lower anterior tooth over the past 6 months. She reported dentinal hypersensitivity and discomfort during

tooth brushing and no spontaneous bleeding was noted. There was no relevant medical and past dental history.

The patient exhibited a thin gingival phenotype. Occlusal analysis showed no pathological influence on the recession, as protrusion, laterotrusion, and occlusion were within normal limits. Her history included previous orthodontic treatment, which may have contributed to the recession and papillary deficiency. She was otherwise in good health, not on any medications, and maintained good oral hygiene except for the affected site.

Upon intraoral examination, Miller's class III gingival recession was seen in relation to tooth 32. There was a depth up to 6 mm and width up to 2.5 mm in the denuded root surface with inadequate width of attached gingiva. The keratinized gingiva was completely absent at this site, making oral hygiene maintenance difficult. The labial probing pocket depth was 1 mm, resulting in a total attachment loss of 7 mm. (Fig 1 A)

Informed consent was obtained for the surgical intervention and case study publication. To prevent further recession progression, the patient was advised to use only a soft toothbrush with limited pressure and circular brushing motions. Preoperative radiographic evaluation using an intraoral periapical radiograph (IOPA) was performed to assess interdental bone levels, which revealed a slight interproximal bone loss in relation to tooth 32. The crestal bone level was positioned apical to the cementoenamel junction, correlating with the clinical findings. No evidence of periapical pathology. Five days before surgery, a prophylaxis session was conducted, and all teeth underwent supragingival curettage.

Surgical Procedure:

Just before the surgical procedure began, PRF was prepared following the protocol outlined by Choukroun et al. (2001) [1]. Approximately 10 ml of venous blood was drawn from the antecubital vein using sterile technique and collected in a plain glass tube without any anticoagulant. The sample was then immediately centrifuged at 2,700 rpm for 12 minutes. [2] This process yielded three distinct layers, from which the middle layer—consisting of a fibrin clot situated between the top acellular plasma and bottom red blood cell layer—was carefully retrieved using sterile tweezers and scissors. The clot was then gently compressed with a sterile gauze to form a stable PRF membrane.

Following local anesthesia Delicate oblique incisions dissected the epithelium in the recession areas, while para marginal incisions were connected with horizontal incisions at the cementoenamel junction (CEJ). The horizontal incisions extended from the mesial side of tooth 43 to the mesial side of tooth 34, ensuring coronal flap advancement and a symmetrical post-healing appearance. (Fig 1 B) This incision design preserved the keratinized gingiva while allowing space for coronal repositioning.

Flap elevation was performed in three stages: a partial-thickness flap at the papillary regions, a full-thickness flap from the crestal bone to the mucogingival junction (MGJ) exposing the recession defect and adjacent bone, (Fig 1 C) and a partial-thickness dissection beyond the MGJ (4–5 mm) to reduce frenum tension. The laterally raised flap was sutured by simple interrupted sutures using 5/0 monofilament resorbable sutures.

A De-epithelialized Free Gingival Graft (DFGG) was harvested from the palatal side (Fig 1 D) of the distal 13 to the mesial 16, measuring approximately 40 mm in length, 8 mm in height, and 0.8 –1 mm in thickness. To ensure the maximum blood supply, the DFGG was split into two halves and then stabilized at the recipient site of teeth 32 and 41. (Fig 1 E) PRF membrane was placed over the graft to enhance healing. (Fig 1 F)

Subsequently, the coronally advanced flap was secured using double-crossed sling sutures. Care was taken to position the gingival margin at least 2 mm coronally to the CEJ. (Fig 1 G) The palatal donor site was allowed to heal by secondary intention, and no periodontal dressing was placed .

Postoperatively, the patient was prescribed non-steroidal anti-inflammatory drugs (Ibuprofen 400 mg) for seven days and an antibacterial mouthwash for 21 days. Sutures were removed after 14 days, and follow-up assessments were conducted at 2 weeks (2w), 3 months (3m), and 6 months (6m) post-surgery. Supragingival plaque was removed when necessary. (Fig 1 H - J)

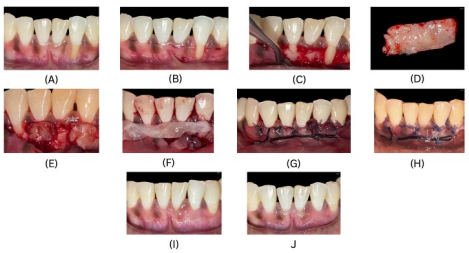

Fig 1: (A) Pre-operative clinical view showing Miller's Class III gingival recession in 32. (B) Horizontal incision design extending from 43 to 34. (C) Full-thickness flap elevated exposing the recession defect and adjacent bone. (D) De-epithelialized Free Gingival Graft (DFGG) was harvested from the palate & (E) Placement of DFGG at the recipient site. (F) PRF membrane positioned over the graft to enhance soft tissue healing. (G) Coronally advanced flap sutured using double-crossed sutures. Post-operative clinical outcomes at (H) 2 weeks, (I) 3 months & (J) 6 months.

In this case, digital intraoral scans were conducted at multiple time points: baseline (BL), 2 weeks (2w), 3 months (3m), and 6 months (6m) post-surgery. Scans were performed using the
intraoral scanner (3Shape, Denmark) by the same examiner to ensure consistency. Each scan encompassed the surgically treated tooth as well as at least two adjacent teeth on both the mesial and distal sides to provide adequate reference landmarks. (Fig 2 A - C)

The scanned data were saved in STL file format and imported into Geomagic Studio 2013 (Geomagic, Morrisville, USA) for digital measurement. For model alignment and superimposition, the "Best Fit Alignment" feature was used, with tooth surfaces (excluding contact areas) designated as the matching reference. The coordinate axes were standardized as follows: X-axis: Mesial-distal direction, Y-axis: Buccal-lingual direction, and Z-axis: Longitudinal axis of the tooth. (Fig 2 D & E)

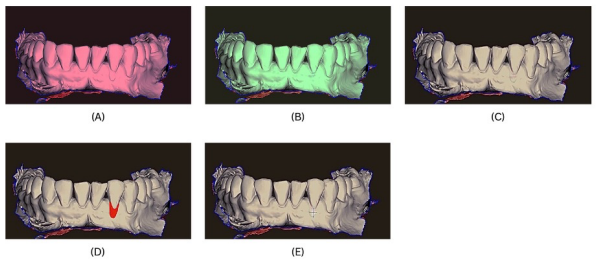

Fig 2: Digital scan images: (A) pre-op, (B) post-op & (C) Overlay of both comparison. (D) Manual trace of gingival area gain, (E) Digital measurements of HGR & WGR.

Digital Measurement Parameters in the Region of Interest (ROI)

The height of gingival recession (HGR) was defined as the vertical distance from the most apical point of the preoperative gingival margin to the cementoenamel junction (CEJ), measured in millimeters. The width of gingival recession (WGR) was measured as the horizontal distance between the mesial and distal gingival margins at the level of the CEJ. The gain of gingival height (GGH) was calculated as the vertical difference between the lowest points of the preoperative and postoperative gingival margins, representing the amount of soft-tissue height gained. The gain of gingival area (GGA) was determined as the difference in the surface area covered by gingiva between preoperative and postoperative scans, expressed in square millimeters. The gain of gingival volume (GGV) represented the volumetric increase in gingival tissue above the area gain between pre- and postoperative scans and was recorded in cubic millimeters. Finally, the gingival mean thickness (GMT) was calculated as the average thickness of the gingival tissue within the ROI, serving as an indicator of tissue integration and healing.

The study results revealed a gradual reduction in soft tissue dimensions over time following surgery. Gain of the Gingival Height (GGH) decreased from 2.8 mm at 2 weeks to 2.0 mm at 6 months, while Gain of the Gingival Area (GGA) decreased from 8.5 mm at 2 weeks to 6.0 mm at 6 months, and Gingival Volume (GVG) decreased from 9.8 mm at 2 weeks to 7.3 mm at 6 months reduced. Gingival Mean Thickness (GMT) declined from 1.15 mm to 0.95 mm over the same period. (Table 1) These findings suggest a measurable but expected shrinkage of the grafted tissue, highlighting the importance of long-term monitoring. (Table 2)

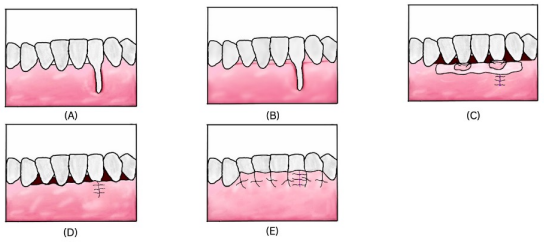

Fig 3: Schematic sequence of LCCAF technique from incision to flap closure. (A) Single deep Miller's Class III recession in the area of tooth 32. (B) Delicate paramarginal incisions in the area of the recessions connected with slightly rounded horizontal incisions at the level of the cemento-enamel junction (CEJ) given. (C) Lateral pedicle flap elevated and repositioned; secured with three interrupted sutures. (D) De-epithelized free gingival graft harvested & stabilized through transpapillary suture from the lingual side and PRF is placed over the graft, (E) Flap are coronally advanced and stabilized over the graft using a double-crossed sling suture technique.

Time Intervals	Gingival Height Gain (GHG, mm)	Gingival Area Gain (GAG, mm²)	Gingival Volume Gain (GVG, mm³)	Gingival Mean Thickness (GMT, mm)
Time Intervals	0	0	0	0
Time Intervals	2.8	9.2	10.5	1.15
Time Intervals	2.3	7.6	8.4	1.05
Time Intervals	2	6.4	7.2	1

Table 2 : Digital Volume-Based Measurements (From 3D Scan Comparison).

Time Intervals	Probing Depth (mm)	Recession Height (mm)	Recession Width (mm)	Clinical Attachment Loss (mm)
Time Intervals	1	6	2.5	7
Time Intervals	1	3.2	1.2	4.2
Time Intervals	1	2	0.6	3
Time Intervals	1	0.5	0.2	1.5

Table 1 : Clinical Measurements Over Time (Estimated from Clinical and 3D Images).

The overall schematic diagram is presented in (Fig 3 A-E) which illustrates the laterally closed coronally advanced flap technique.

DISCUSSION:

The era of Dentistry has witnessed a miraculous growth and development with the incorporation of new digital technologies. Gingival recession is a common clinical condition characterized by the apical displacement of the gingival margin, leading to root exposure, dentinal hypersensitivity, compromised esthetics, and increased risk of root caries and non-carious cervical lesions.[3] Various periodontal plastic surgery, including the coronally advanced flap (CAF), De-epithelialized Free Gingival Graft (DFGG), and lateral positioned flap (LPF) have been used for root coverage.[4] However, the success of these procedures largely depends on the extent of keratinized tissue, flap tension, and vascularization at the recipient site.

The Laterally Closed Coronally Advanced Flap (LCCAF) is a modified technique that enhances root coverage by combining lateral repositioning with coronal advancement, ensuring better blood supply and predictable outcomes.[5] Compared with traditional techniques, LCCAF offers advantages by reducing scar formation, reduces morbidity, and improves esthetic results.[6]

Platelet-rich fibrin (PRF) is a second-generation, autologous platelet concentrate rich in fibrin, platelets, leucocytes, cytokines, and circulating stem cells, as it promotes tissue healing.[7] PRF has demonstrated favorable outcomes in gingival recession management with reduced donor site.

Assessment of periodontal plastic surgery outcomes has traditionally relied on two-dimensional clinical measurements, which lack the precision required for evaluating volumetric soft-tissue changes. The introduction of three-dimensional (3D) imaging modalities, particularly digital intraoral scanning, has enabled accurate, reproducible, and quantitative evaluation of gingival volume, thickness, and stability over time [8, 9]. The ability to archive digital records further support/s longitudinal assessment and comparative research, underscoring the value of 3D imaging in enhancing objectivity and standardization in periodontal outcome evaluation [10].

Notably, three-dimensional (3D) imaging was utilized in this case report to objectively assess treatment outcomes such as HGR,WGR, GGH, GGV, GGA & GMT, offering precise volumetric analysis of soft tissue changes postoperatively.

Previous studies have demonstrated the benefits of integrating connective tissue grafts (CTG) with CAF. Aroca et al. conducted a trial comparing CAF with and without CTG, concluding that soft tissue grafting improved root coverage and increased gingival thickness. [5] However, the findings suggest that LCCAF alone achieved significant root coverage, potentially reducing donor site morbidity while maintaining clinical efficacy. Zucchelli and De Sanctis previously reported high success rates using a modified CAF technique, highlighting its effectiveness in achieving root coverage. [11] In contrast, Jepsen et al. noted that laterally positioned flaps might provide greater stability and lower relapse rates compared to vertically advanced approaches. [12]

Flap design is a crucial determinant of success in root coverage procedures. Unlike the traditional CAF, LCCAF redistributes tension more effectively, potentially reducing the risk of relapse. Tavelli et al. emphasized that tension-free flap adaptation enhances long-term stability, a concept reinforced by present case report, where volumetric analysis indicated stable soft tissue augmentation over time.[13]

Recent developments in digital imaging and 3D assessment techniques have significantly improved the evaluation of periodontal plastic surgery outcomes. Vallejos-Juárez et al. demonstrated that volumetric analysis offers a more precise quantification of soft tissue changes compared to conventional clinical measurements. [14] Similarly, Kuralt et al. reviewed digital assessment methods for gingival recession and concluded that 3D superimposition techniques provide superior accuracy over traditional probe-based evaluations. The incorporation of 3D imaging in the research enabled a highly standardized assessment of gingival volume changes and recession depth, minimizing observer variability.[15]

Additionally, Fageeh et al. demonstrated that intraoral scanning enhances reproducibility in gingival recession measurements, reducing examiner-dependent variability. [16] The present study aligns with these findings, as digital scanning contributed to a more standardized and reliable evaluation process.

The role of digital evaluation in periodontal procedures extends to assessing soft tissue stability following surgery. Xue et al. studied buccal soft tissue stability following a modified coronally advanced tunnel technique combined with a de-epithelialized gingival

graft (DGG). Their findings indicated stable gingival volume and thickness three months postoperatively. [17] Similarly, present case report highlights a stabilization phase after initial healing, reinforcing the efficacy of LCCAF in achieving long-term root coverage and soft tissue augmentation.

An important aspect of periodontal study is ensuring that digital evaluation methods follow a standardized process, making it easier to compare results across different studies. Kuralt et al. [15] emphasized the need for consistent methodologies in digital imaging. In our present case report, a standardized 3D imaging protocol was adopted to ensure consistency in evaluating gingival margin position and volumetric changes, allowing for more accurate comparisons with existing literature. Clinically, digital volumetric analysis offers an objective and reproducible tool for evaluating soft-tissue outcomes beyond conventional linear measurements. Future studies with larger sample sizes and longer follow-up are required to confirm the predictability and long-term stability of these findings.

CONCLUSION:

LCCAF is a promising advancement in root coverage techniques, combining lateral repositioning and coronal advancement for enhanced stability, esthetics, and reduced morbidity. It minimizes postoperative discomfort and eliminates the need for secondary surgical sites. Three-dimensional imaging improves precision, standardization, and reproducibility in assessing treatment outcomes. Its use allows accurate longitudinal comparisons and reduces examiner variability, highlighting its value as a reliable outcome assessment tool in periodontal plastic surgery. While LCCAF shows predictable root coverage and soft tissue stability, further long-term studies and comparative trials are needed to validate its effectiveness. Future research should refine surgical protocols and digital evaluation methods to establish LCCAF as a standardized, minimally invasive periodontal procedure.

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