

Root Coverage Procedures in Periodontal Surgery: Evolution, Techniques and Clinical Outcomes

Janvi¹, Sakshi Verma², Priyanka Chandela³

^{1,2,3}Department of Periodontics, PGIDS, Rohtak, Haryana, India

Corresponding author: janvisahu75@gmail.com

ABSTRACT

Gingival recession, defined as the apical migration of the gingival margin leading to root surface exposure, is a frequent mucogingival problem encountered in clinical periodontics. It results in esthetic concerns, dentinal hypersensitivity, and root caries risk. Over the decades, various surgical procedures have been developed to achieve predictable root coverage. The evolution of root coverage techniques reflects advances in understanding of wound healing, blood supply, and soft-tissue manipulation. This review presents an overview of the historical development, classifications, surgical approaches, and evidence-based outcomes of root coverage procedures. The focus is on the biological principles underpinning each technique, their clinical indications, and current trends toward minimally invasive, regenerative, and patient-centered approaches.

INTRODUCTION

Gingival recession (GR) is a common clinical finding affecting both esthetics and dental health. It is defined as the displacement of the gingival margin apical to the cemento-enamel junction, exposing the root surface.¹ The etiology is multifactorial — including traumatic tooth brushing, periodontal disease, thin periodontal biotype, orthodontic movement, and frenal pull. The primary objective of root coverage procedures is to restore the gingival margin to its original position, achieve a harmonious gingival contour, and improve esthetics and patient comfort.²

The evolution of root coverage surgery represents one of the most remarkable advances in periodontology, transitioning from simple positional flaps to microsurgical and regenerative approaches. This review traces the major techniques, their biologic rationale, and the current consensus in achieving predictable coverage.

Historical Background and Evolution

The earliest mucogingival surgeries focused on increasing the width of attached gingiva rather than covering roots. Sullivan and Atkins (1968) pioneered the **free gingival graft (FGG)**, harvesting tissue from the palate to augment keratinized gingiva.³ Although predictable for increasing tissue width, esthetic outcomes were compromised by color mismatch and limited root coverage.

The **lateral positioned flap (LPF)** introduced by Grupe and Warren in 1956 represented the first pedicle flap aimed at covering denuded roots by repositioning adjacent tissue.⁴ This technique preserved blood supply but was limited by donor site morbidity and availability of adjacent keratinized tissue.

In the 1980s, Raetzke's **envelope technique** and Langer & Langer's **subepithelial connective tissue graft (SCTG)** revolutionized the field.⁵ The SCTG, using a partial-thickness recipient bed and a palatal connective tissue graft, became the gold standard due to superior esthetics, color blend, and predictable outcomes.

Subsequently, modifications such as the **coronally advanced flap (CAF)** (Allen & Miller, 1989)⁶ and the **semilunar coronally repositioned flap** (Tarnow, 1986)⁷ improved simplicity and esthetic outcomes. These techniques capitalized on improved understanding of vascular dynamics, flap tension, and wound stability.

Classification Systems

Various classification systems aid in selecting the appropriate surgical technique:

- **Miller's Classification (1985)** remains the most widely used, based on the level of interproximal attachment and bone loss.
 - Class I & II defects allow 100% root coverage potential.
 - Class III & IV defects show partial or no coverage.⁸
- **Cairo's RT Classification (2011)** refines prognosis by using *clinical attachment level* and identifying *non-carious cervical lesions (NCCLs)*.⁹

These classifications are crucial for treatment planning and outcome prediction.

Surgical Techniques for Root Coverage

1. Pedicle Flap Procedures

Pedicle flaps use adjacent gingival tissue with intact blood supply. They include:

- **Laterally Positioned Flap (LPF):** Ideal for isolated recessions; maintains double blood supply but risks donor site recession.⁴
- **Coronally Advanced Flap (CAF):** The most popular technique for multiple recession defects. Proper flap thickness, tension-free advancement, and root conditioning enhance results.⁶
- **Semilunar Coronally Repositioned Flap:** A minimally invasive modification suitable for shallow recessions with adequate keratinized tissue.⁷

2. Free Gingival Graft (FGG)

FGG remains a reliable option for increasing attached gingiva in areas with shallow vestibules or high frenum.³ However, esthetics and partial root coverage remain limitations.

3. Subepithelial Connective Tissue Graft (SCTG)

The SCTG combined with CAF provides superior and long-term root coverage.⁵ The double-blood supply from both the overlying flap and recipient bed promotes predictable healing and excellent color integration. It remains the gold standard, particularly for Miller Class I and II defects.

4. Double Papilla Flap

Introduced by Cohen and Ross (1968), it combines tissue from adjacent papillae to cover isolated recessions. It offers improved esthetics and limited donor site morbidity but is technically demanding.

5. Guided Tissue Regeneration (GTR)

GTR membranes were introduced to promote regeneration of the periodontal attachment apparatus under the principle of selective cell repopulation. Tinti and colleagues (1992) demonstrated the potential for true regeneration in specific recession defects using resorbable barriers.¹⁰ Despite biological potential, technique sensitivity and membrane exposure risk limit routine use.

6. Acellular Dermal Matrix (ADM) and Xenogeneic Collagen Matrices

To overcome donor site morbidity, biomaterials such as ADM and porcine collagen matrices have been introduced. These scaffolds support tissue integration and reduce surgical time, though outcomes are slightly inferior to autogenous grafts.¹¹

7. Minimally Invasive and Microsurgical Techniques

Microsurgical approaches using magnification, fine sutures, and atraumatic instrumentation (e.g., Zucchelli & De Sanctis technique, 2000) provide enhanced precision, faster healing, and improved esthetics.¹² These are increasingly preferred for multiple adjacent recessions.

Biological Basis of Root Coverage

Successful root coverage depends on several biological principles:

- Adequate **vascular supply** through flap design and minimal tension.
- **Stability of the graft** and avoidance of dead space to prevent epithelial ingrowth.
- **Wound closure** by primary intention for optimal healing.
- **Patient-related factors** such as good plaque control, non-smoking status, and thick gingival phenotype.

Healing occurs by *creeping attachment*, epithelial migration, and new connective tissue adhesion rather than true cementogenesis in most cases. However, regenerative approaches incorporating biologic modifiers (e.g., enamel matrix derivatives, platelet concentrates) show potential for true periodontal regeneration.

Predictability and Clinical Outcomes

Meta-analyses confirm that SCTG combined with CAF yields the highest mean root coverage (85–95%), followed by ADM and collagen matrices (70–80%).¹³ The choice of technique depends on defect type, tissue biotype, and esthetic demand. Long-term stability is superior when keratinized tissue is increased and flap thickness exceeds 1 mm.¹⁴

Multiple adjacent recessions respond better to tunnel or CAF approaches, while isolated defects may be effectively treated with LPF or SCTG. The patient's smoking status and oral hygiene are critical determinants of long-term success.

Recent Advances

Recent innovations include:

- **Use of growth factors** such as platelet-rich fibrin (PRF) and recombinant platelet-derived growth factor (PDGF) to enhance healing.
- **Modified coronally advanced tunnel techniques** that preserve papillae and minimize incisions.
- **Digital planning and 3D-printed collagen matrices** for precision graft adaptation.

The trend is shifting toward minimally invasive, patient-friendly, and regenerative approaches that maximize esthetic harmony and functional stability.

CONCLUSION

Root coverage procedures in periodontal surgery have evolved dramatically, offering clinicians a wide spectrum of techniques to manage gingival recession. From traditional free grafts to contemporary microsurgical and biomaterial-based approaches, predictability has improved due to better understanding of wound healing, flap design, and biologic modulation. The combination of coronally advanced flap with connective tissue graft remains the benchmark, while newer regenerative materials offer promising alternatives. Future directions include biologically driven and digitally assisted procedures aimed at achieving complete, stable, and esthetically satisfying root coverage.

REFERENCES

- [1]. American Academy of Periodontology. Glossary of Periodontal Terms. 5th ed. Chicago: AAP; 2015.
- [2]. Pini Prato GP. Mucogingival deformities and treatment: Current status and future perspectives. *Periodontol* 2000. 2019;79(1):7-13.
- [3]. Sullivan HC, Atkins JH. Free autogenous gingival grafts. *Periodontics*. 1968;6:152-60.
- [4]. Grupe HE, Warren RF Jr. Repair of gingival defects by sliding flap operation. *J Periodontol*. 1956;27:92-5.
- [5]. Langer B, Langer L. Subepithelial connective tissue graft technique for root coverage. *J Periodontol*. 1985;56:715-20.
- [6]. Allen EP, Miller PD Jr. Coronal positioning of existing gingiva: Short-term results in the treatment of shallow marginal tissue recession. *J Periodontol*. 1989;60:316-9.
- [7]. Tarnow DP. Semilunar coronally repositioned flap. *J Clin Periodontol*. 1986;13:182-5.
- [8]. Miller PD Jr. A classification of marginal tissue recession. *Int J Periodontics Restorative Dent*. 1985;5(2):8-13.
- [9]. Cairo F, Nieri M, Cincinelli S, Mervelt J, Pagliaro U. Root coverage esthetic score: A system to evaluate the esthetic outcome of root coverage procedures. *J Periodontol*. 2011;82:165-73.
- [10]. Tinti C, Vincenzi G, Cortellini P, Pini Prato G. Guided tissue regeneration in the treatment of human facial recessions. *J Periodontol*. 1992;63:554-60.
- [11]. Aroca S, Keglevich T, Barbieri B, Gera I, Etienne D. Clinical evaluation of a collagen matrix to enhance root coverage with the coronally advanced flap. *J Periodontol*. 2009;80:1856-61.
- [12]. Zucchelli G, De Sanctis M. Treatment of multiple recession-type defects in patients with esthetic demands. *J Periodontol*. 2000;71:1506-14.
- [13]. Chambrone L, Tatakis DN. Periodontal soft tissue root coverage procedures: A systematic review from the AAP regeneration workshop. *J Periodontol*. 2015;86(2 Suppl):S8-S51.
- [14]. Tavelli L, Ravidà A, Tattan M, et al. Influence of flap thickness on root coverage outcomes. *J Periodontol*. 2019;90:198-206.