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REVIEW ARTICLE

CONTEMPORARY PERIODONTAL PLASTIC SURGERY FOR GINGIVAL RECESSION: A NARRATIVE REVIEW OF EVIDENCE AND LONG-TERM CLINICAL OUTCOMES

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Abstract

Background: Gingival recession is a prevalent mucogingival condition characterized by the apical displacement of the gingival margin beyond the cementoenamel junction (CEJ), resulting in root surface exposure. This condition is associated with esthetic concerns, dentin hypersensitivity, root caries, and increased plaque retention. Advances in periodontal plastic surgery, microsurgical techniques, and regenerative biomaterials have significantly enhanced the predictability and outcomes of root coverage procedures.

Although many consider gingival recession to be a cosmetic problem, there is a critically important factor to consider. The connective tissue to which the gingiva is attached is the only tissue that prevents bacterial infiltration and therefore plays a crucial role in maintaining periodontal support.

Objective: This narrative review aims to critically summarize current evidence on the etiology, classification, and contemporary surgical management of gingival recession, with particular emphasis on periodontal plastic surgical techniques and regenerative approaches.

Methods:A literature review was conducted using PubMed, Scopus, Web of Science, and Google Scholar. Articles published between 2000 and 2025 were included if they evaluated surgical management of gingival recession. The review incorporated randomized controlled trials, systematic reviews, and key landmark studies.

Results: Coronally advanced flap (CAF) combined with subepithelial connective tissue graft (SCTG) remains the most predictable approach for root coverage, demonstrating high success rates and long-term stability. Tunnel techniques offer excellent esthetic outcomes with reduced surgical morbidity and minimal scarring. Biomaterials such as collagen matrices and acellular dermal matrices represent viable alternatives in selected cases, primarily by eliminating donor-site morbidity, although their predictability remains lower compared with autogenous grafting techniques.

Conclusion: Contemporary periodontal plastic surgery provides reliable and predictable treatment options for gingival recession, particularly in Miller Class I and II defects. Treatment success depends on accurate diagnosis, appropriate case selection, gingival phenotype, vascular supply, and meticulous surgical technique. Future advances in tissue engineering, biologically active materials, and minimally invasive surgical techniques may further improve clinical outcomes while reducing patient morbidity.

INTRODUCTION

Gingival recession is one of the most common mucogingival deformities encountered in clinical periodontology and is defined as the apical displacement of the gingival margin beyond the cementoenamel junction (CEJ), resulting in exposure of the root surface[1,2].

The condition may affect single or multiple teeth and is commonly associated with esthetic concerns, dentin hypersensitivity, root caries, cervical abrasion, and increased plaque accumulation.[3,4] In addition functional complications, gingival recession may negatively influence patient comfort and smile esthetics, particularly in the anterior region.

Epidemiological studies indicate that gingival recession affects a substantial proportion of the adult population, with prevalence and severity increasing progressively with age.[14] Growing patient awareness of dentofacial esthetics and periodontal health has significantly increased the demand for predictable root coverage procedures and minimally invasive periodontal plastic surgery. As a result, management of gingival recession has become an important component of contemporary

mucogingival therapy. According to the 2017 World Workshop classification developed by the American Academy of Periodontology (AAP) and the European Federation of Periodontology (EFP), gingival recession is classified among mucogingival deformities and conditions.[5] Clinically, recession defects are frequently associated with thin periodontal phenotype, alveolar bone dehiscence, shallow vestibular depth, reduced width of keratinized tissue, and unfavorable tooth positioning.[7,14]

These anatomical characteristics may significantly influence both disease progression and treatment predictability. The etiology of gingival recession is considered multifactorial. Several contributing factors have been identified, including traumatic tooth brushing, periodontal inflammation, anatomical predisposition, orthodontic tooth movement, occlusal stress, and iatrogenic factors related to restorative or periodontal procedures.[12,14,27] Among these, traumatic brushing and thin gingival phenotype are consistently reported as major risk factors associated with localized recession defects.[14,27]

Miller's classification system remains one of the most widely used clinical methods for evaluating recession defects and estimating the potential for complete root coverage.[6,11]

However, more recent classification systems incorporating interproximal attachment loss and periodontal phenotype have improved the diagnostic understanding of recession defects and treatment prognosis.[3] Over recent decades, periodontal plastic surgery has evolved considerably from traditional mucogingival procedures toward microsurgical and regenerative approaches designed to improve wound stability, vascular supply, esthetic integration, and patient-centered outcomes.[8,23,28]

Contemporary treatment modalities include coronally advanced flap (CAF), subepithelial connective tissue grafting (SCTG), tunnel techniques, free gingival grafts, and biomaterial-based therapies such as collagen matrices and acellular dermal substitutes.[16,20,21,23] These techniques have substantially improved the predictability of root coverage procedures, particularly in Miller Class I and II recession defects. Despite significant clinical advances, complete and stable root coverage remains challenging in cases involving deep recession defects, interproximal attachment loss, reduced vestibular depth, or unfavorable tooth anatomy.[6,19] In addition, long-term success is strongly influenced by patient-related and site-specific factors including gingival phenotype, oral hygiene, smoking status, and surgical technique.[14,29,32] Therefore, careful diagnosis, proper case selection, and evidence-based surgical planning are essential for achieving stable functional and esthetic outcomes.

The aim of this narrative review is to critically evaluate current evidence regarding the etiology, classification, and surgical management of gingival recession, with particular emphasis on periodontal plastic surgical procedures, regenerative biomaterials, and factors affecting long-term treatment predictability.

2. MATERIALS AND METHODS

This study was designed as a structured narrative review. The objective was to synthesize and critically appraise the available literature on periodontal plastic surgical management of gingival recession, rather than to conduct a systematic review or meta-analysis. An electronic literature search was performed using the following databases:

- PubMed/MEDLINE
- Scopus
- Web of Science
- Google Scholar

The search focused on publications addressing gingival recession and periodontal plastic surgery. Relevant studies were identified using a keywords including:

- "gingival recession"
- "periodontal plastic surgery"
- "root coverage"
- "coronally advanced flap"
- "subepithelial connective tissue graft"
- "tunnel technique"
- "collagen matrix"
- "guided tissue regeneration"

The search was limited to articles published in English between 2000 and 2025.The initial search identified 324 records. After removal of duplicates and screening of titles and abstracts, 87 articles were reviewed in full text and 46 studies were included in the final narrative synthesis.

3. RESULTS

The selected publications were reviewed and synthesized to evaluate the current evidence regarding the etiology, surgical management, regenerative approaches, and prognostic determinants associated with gingival recession therapy. The included literature consisted primarily of randomized controlled clinical trials, systematic reviews, longitudinal clinical investigations, and landmark studies in periodontal plastic surgery and mucogingival therapy. For clarity, the findings were organized into four major thematic areas: (1) etiology and risk profile, (2) comparative effectiveness of surgical techniques, (3) biomaterials and regenerative approaches, and (4) prognostic factors influencing treatment outcomes.

3.1 Etiology and Risk Profile

The reviewed literature confirms that gingival recession is a multifactorial condition influenced by anatomical, traumatic, inflammatory, and behavioral factors.[2,14,22] Among the anatomical characteristics most frequently associated with recession development are thin gingival phenotype, reduced width of keratinized tissue, shallow vestibular depth, and prominent root anatomy.[2,30]

These factors appear to increase tissue susceptibility to mechanical trauma and compromise long-term periodontal stability. Traumatic tooth brushing remains the etiologic factor most consistently associated with localized recession defects.[27]

Excessive brushing force, improper brushing technique, and use of hard-bristled toothbrushes have all been implicated in the initiation and progression of soft tissue recession. The role of orthodontic tooth movement and occlusal trauma remains less clearly defined. Although these factors may contribute to recession development under certain clinical conditions, most studies consider them secondary or modifying influences rather than primary etiologic causes.[14,30]

Periodontal inflammation also plays an important role by accelerating soft tissue breakdown and impairing periodontal support.[22]

Table 1. Etiologic Factors and Level of Consensus in the Literature

Etiologic Factor	Role in Recession	Level of Agreement in Literature
Traumatic tooth brushing	Primary initiating factor	High consensus
Thin gingival phenotype	Predisposing factor	High consensus
Reduced keratinized tissue width	Predisposing factor	High consensus
Shallow vestibular depth	Contributing factor	High consensus
Orthodontic tooth movement	Secondary/modifying factor	Moderate consensus
Occlusal trauma	Controversial contributor	Low–moderate consensus
Periodontal inflammation	Disease-modifying factor	High consensus

3.2 Comparative Effectiveness of Surgical Techniques

Among the available root coverage procedures, coronally advanced flap (CAF) combined with subepithelial connective tissue grafting (SCTG) consistently demonstrates the highest level of predictability and long-term clinical stability.[4,16,31,47] Numerous clinical studies have reported superior root coverage outcomes, significant increases in gingival thickness, and enhanced soft-tissue stability when this technique is employed. The favorable biological response associated with SCTG is largely attributed to its ability to improve vascularization and reinforce the gingival phenotype. Furthermore, long-term follow-up investigations have shown that CAF combined with SCTG provides more stable results and lower recurrence rates of recession compared with most alternative treatment modalities. The technique is therefore widely regarded as the reference standard against which newer root coverage procedures are evaluated. CAF alone remains an effective treatment option for shallow recession defects, particularly in patients presenting with a favorable gingival phenotype and an adequate width of keratinized tissue. However, its predictability decreases in cases involving a thin periodontal phenotype, reduced soft-tissue thickness, or advanced recession defects.[4,16] Clinical outcomes achieved with CAF alone may also be more susceptible to long-term relapse because of the limited capacity for soft-tissue augmentation. Tunnel-based procedures have gained increasing popularity because of their minimally invasive nature and superior esthetic integration. These techniques preserve papillary integrity, minimize surgical trauma, and reduce postoperative scarring, making them particularly suitable for the treatment of multiple adjacent gingival recessions.[26,33] Preservation of the interdental tissues also contributes to improved blood supply and enhanced wound healing. Nevertheless, treatment outcomes remain highly technique-sensitive, and complete root coverage is not always achieved as consistently as with connective tissue graft–based procedures.[7,21]Biomaterial-based approaches, including collagen matrices and acellular dermal matrices, offer the important advantage of eliminating donor-site morbidity and reducing patient discomfort associated with graft harvesting. These materials may represent valuable alternatives when autogenous donor tissue is limited or when patients prefer less invasive treatment options. However, the majority of available evidence indicates that their long-term predictability and stability remain inferior to those achieved with autogenous connective tissue grafting.[20,22] Consequently, connective tissue grafts continue to be considered the most reliable option for achieving optimal root coverage and durable periodontal soft-tissue augmentation.

Table 2. Comparative Evidence of Root Coverage Techniques

Technique	Root Coverage Predictability	Esthetic Outcome	Morbidity	Long-term Stability	Evidence Consensus
CAF alone	Moderate–High	Moderate	Low	Moderate	High
CAF + SCTG	Very High	High	Moderate	Excellent	Very high consensus
SCTG alone	High	High	High	Excellent	High consensus
Tunnel technique	Moderate–High	Very High	Low	Good	Moderate consensus
Collagen matrix	Moderate	High	Very Low	Moderate	Moderate consensus
Acellular dermal matrix	Moderate	High	Low	Moderate	Moderate consensus
GTR / biologics	Variable	Moderate	Moderate	Variable	Low consensus

3.3 Biomaterials and Regenerative Approaches

The use of biomaterials and regenerative adjuncts has expanded considerably in contemporary periodontal plastic surgery. Several studies reported that collagen matrices and acellular dermal substitutes significantly reduce postoperative morbidity by eliminating the need for a palatal donor site.[20,24]

These materials may improve patient comfort and shorten surgical time, particularly in cases requiring treatment of multiple recession defects.

Despite these advantages, the available evidence suggests that biomaterial-based procedures generally provide lower root coverage predictability compared with autogenous SCTG, especially in Miller Class I and II recession defects.[20,24,32]

In addition, long-term tissue stability remains more favorable with connective tissue grafting procedures. Regenerative approaches such as guided tissue regeneration (GTR) and enamel matrix derivatives have shown variable clinical outcomes.[15,28]

Although these techniques may enhance biologic healing and periodontal regeneration, their effectiveness appears to depend heavily on flap stability, defect morphology, surgical skill, and patient-related factors.[28]

Current evidence does not consistently demonstrate superiority over conventional connective tissue grafting techniques.

Table 3. Summary of Biomaterials and Regenerative Strategies

Approach	Main Advantage	Main Limitation	Evidence Strength
Collagen matrix	No donor site morbidity	Lower predictability	Moderate
Acellular dermal matrix	Reduced morbidity	Cost and variability	Moderate
Guided tissue regeneration	Regenerative potential	Technique sensitivity	Low–moderate
Enamel matrix derivatives	Biological enhancement	Inconsistent outcomes	Moderate

3.4 Prognostic Factors Influencing Outcomes

Treatment outcomes in gingival recession therapy are strongly influenced by both patient-related and site-specific factors rather than surgical technique alone.[2,14,31] The literature consistently identifies gingival phenotype, keratinized tissue width, interproximal attachment level, oral hygiene, smoking status, and defect morphology as major determinants of treatment success. A thick gingival phenotype and adequate keratinized tissue width are generally associated with improved wound stability and greater likelihood of complete root coverage. In contrast, smoking, poor plaque control, and interproximal attachment loss are consistently linked with reduced healing potential and compromised clinical outcomes.[2,14,22] Mandibular anterior recession defects are often considered particularly challenging because of limited vestibular depth, shallow soft tissue dimensions, and increased muscular tension in this region.[31] These anatomical limitations may negatively affect flap stability and long-term treatment predictability.

Table 4. Prognostic Factors Affecting Root Coverage Outcomes

Factor	Effect on Outcome	Level of Evidence Consensus
Thick gingival phenotype	Improves predictability	High
Adequate keratinized tissue	Improves stability	High
Intact interproximal attachment	Enables complete coverage	High
Smoking	Impairs healing	High
Poor oral hygiene	Reduces success	High
Mandibular anterior location	Reduces predictability	High
Interproximal attachment loss	Limits root coverage	High

3.5 Overall Synthesis of Evidence

The overall body of evidence demonstrates a relatively consistent hierarchy regarding the predictability of root coverage procedures. Coronally advanced flap combined with subepithelial connective tissue grafting remains the most reliable and well-documented approach for achieving stable long-term root coverage outcomes.[16,20,24,31,47]

Connective tissue grafting alone and CAF alone may provide favorable results in selected cases, whereas tunnel techniques offer excellent esthetic integration but demonstrate greater variability in complete root coverage outcomes.

Biomaterial-based procedures and regenerative adjuncts remain valuable alternatives, particularly when reduction of donor-site morbidity is a primary concern. However, their long-term predictability generally remains lower than that achieved with autogenous connective tissue grafts.[20,24]

Importantly, the reviewed studies consistently emphasize that successful clinical outcomes depend not only on the selected surgical technique but also on defect morphology, tissue phenotype, vascular supply, surgical execution, and patient compliance.[2,14,31]

The present review also includes clinical case documentation with follow-up periods extending beyond 20 years, demonstrating the long-term stability of connective tissue grafting procedures. The first case illustrates successful root coverage and stable periodontal health following treatment of a localized recession defect.

The second case demonstrates long-term augmentation of keratinized tissue and maintenance of favorable restorative and periodontal conditions over time. Collectively, these cases support the long-term effectiveness and predictbility of connective tissue–based periodontal plastic surgical procedures.

Clinical Case 1

Figure 1. Preoperative clinical presentation showing severe gingival recession on the upper right cuspid with absence of attached gingiva and marked vascularity at the gingival margin.

Figure 2. 2 vertical incisions, one on the mesial of the cuspid and a second one on the distal. Both incisions were at least 1mm away from the line angles of the tooth to prevent blood supply issues with the flap. Flap reflection demonstrating extensive fenestration and root exposure of 10mm's.

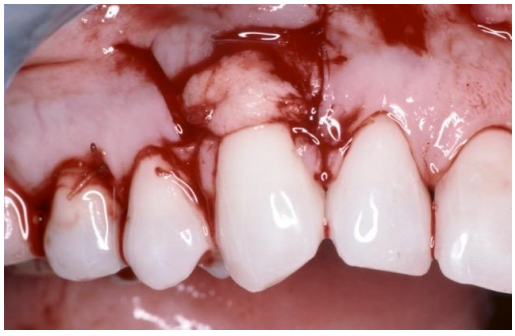

Figure 3. Placement of the connective tissue graft from the palatal donor site. The graft was stabilized with 5-0 chromic gut absorbable sutures.

Figure 4. Multiple 5-0 Chromic gut absorbable sutures were used to stabilize the flap The connective tissue was 100% covered for primary closure.

Figure 5. One-year postoperative result demonstrating successful root coverage, improved gingival contour, and satisfactory esthetic healing.

Figure 6.Approximately 20-year postoperative follow-up showing stable periodontal health, continued coronal migration of the gingival margin, and shallow probing depths

Clinical Case 2

Figure 1. 1980's patient referred for periodontal evaluation. #18, #19, #20 and #21. The treatment plan is for provisionals to be placed on 318 and #19. Surgery to be undertaken using Biologic Shaping techniques. Visually one can see almost no Attached Gingiva as well as need for shaping of provisionalized teeth.

Figure 2. Outline of free gingival graft to be taken.

Figure 3. Graft removed using a #15 blade. Thickness of the graft is approximately 11/2mm's thick.

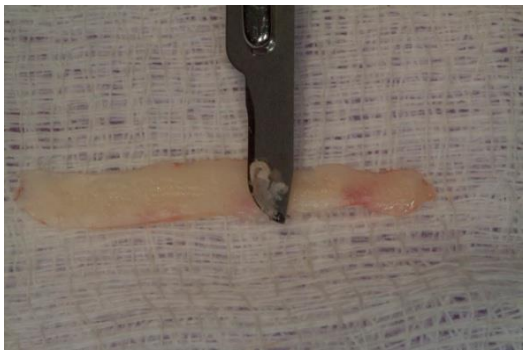

Figure 4. Removing the epithelium as part of the graft was to be placed under the reflected flap,the remaining portion to be placed at the margin of the bone.

Figure 5. Graft placed using 5-0 Chromic gut absorbable sutures attached to periosteum. The graft is now immovable.

Figure 6. Connective tissue covered in the posterior with flap. Both bicuspids had a margin connective tissue graft placed.

Figure 7. Approximately 20-year postoperative result demonstrating stable gingival tissues and healthy supragingival restorative margins with excellent long-term esthetics.

4. DISCUSSION

The present narrative review demonstrates the significant evolution of periodontal plastic surgery over recent decades, progressing from conventional mucogingival procedures toward minimally invasive and biologically driven approaches aimed at improving both functional and esthetic outcomes. Advances in microsurgical techniques, soft tissue management, and regenerative biomaterials have substantially improved the predictability of root coverage procedures and patient-centered treatment outcomes.

Among contemporary surgical procedures, coronally advanced flap (CAF) combined with subepithelial connective tissue grafting (SCTG) continues to demonstrate the highest level of predictability for complete root coverage and long-term tissue stability.[4,16,31] Numerous clinical studies have reported favorable outcomes associated with SCTG, including increased gingival thickness, improved keratinized tissue width, enhanced vascularization, and long-term maintenance of soft tissue stability. Longitudinal observations have also described the phenomenon of "creeping attachment," characterized by gradual coronal migration of the gingival margin after healing.[16,31,46] Minimally invasive tunnel-based approaches have gained increasing popularity because they preserve papillary integrity and avoid vertical releasing incisions, thereby reducing postoperative morbidity and improving esthetic integration.[23,33] These procedures are particularly advantageous in the management of multiple adjacent recession defects and in highly esthetic regions. However, despite favorable esthetic outcomes, the literature does not consistently demonstrate superior complete root coverage compared with CAF combined with connective tissue grafting.[7,23] Furthermore, tunnel procedures are highly technique-sensitive and require advanced surgical experience to achieve predictable results. The introduction of biomaterial-based substitutes, including collagen

matrices and acellular dermal matrices, has expanded treatment possibilities in periodontal plastic surgery.[21,24] These materials eliminate the need for a second surgical site and significantly reduce patient morbidity and postoperative discomfort. Nevertheless, most comparative studies indicate that autogenous connective tissue grafts continue to provide superior long-term predictability, particularly in advanced recession defects and thin periodontal phenotypes.[20,24,32]

The limitations of CAF + SCTG should also be acknowledged. Although considered the current gold standard, the procedure requires harvesting autogenous connective tissue from the palate, which increases surgical complexity, operative time, and postoperative morbidity. Donor-site discomfort, bleeding, and delayed healing may negatively affect patient acceptance and satisfaction. In addition, the quantity of available donor tissue may be limited in patients requiring treatment of multiple recession defects. Economic considerations may further influence treatment selection, as advanced microsurgical procedures often require specialized instruments, increased clinical time, and operator expertise. Conversely, commercially available biomaterials may reduce surgical morbidity but are frequently associated with higher material costs and less predictable long-term outcomes.

Limitations associated with biomaterials include variable tissue integration, reduced volumetric stability, and inconsistent root coverage outcomes.Adjunctive regenerative approaches such as guided tissue regeneration (GTR) and enamel matrix derivatives have also been investigated as methods to enhance biologic healing and periodontal regeneration.[15,28] Although these techniques may improve wound maturation and connective tissue attachment under favorable conditions, their clinical outcomes remain highly dependent on flap stability, defect morphology, blood supply, and surgical execution. Current evidence does not consistently demonstrate clear superiority over conventional connective tissue grafting procedures.[28]

The reviewed literature further emphasizes that treatment outcomes are strongly influenced by patient-related and site-specific factors rather than surgical technique alone.[2,14,22] Gingival phenotype, vestibular depth, interproximal attachment level, tooth position, smoking status, and oral hygiene are consistently reported as critical determinants of treatment success. Mandibular anterior recession defects remain particularly challenging because of limited vestibular depth, high muscle tension, and reduced soft tissue thickness, all of which may compromise flap stability and healing.[31]

Several limitations of the present review should be acknowledged. As a narrative review, this study does not include quantitative meta-analysis or statistical synthesis of outcomes. In addition, heterogeneity among the included studies with respect to recession classification systems, surgical techniques, follow-up duration, and outcome assessment limits direct comparison between investigations.[7,21]

Furthermore, long-term evidence supporting newer regenerative materials and biologic adjuncts remains limited when compared with the extensive evidence available for autogenous connective tissue grafting. Future research should focus on tissue engineering strategies, growth factor–based therapies, stem-cell applications, and development of next-generation biomaterials aimed at improving regenerative potential while minimizing patient morbidity.[15,28] Additional well-designed randomized clinical trials with long-term follow-up are necessary to establish standardized protocols and evaluate long-term stability of contemporary regenerative approaches.

Overall, the current body of evidence supports coronally advanced flap combined with subepithelial connective tissue grafting as the gold standard for treatment of Miller Class I and II gingival recession defects because of its superior predictability, long-term stability, and favorable esthetic outcomes.[16,31] Alternative minimally invasive and biomaterial-based approaches remain valuable in selected clinical situations, particularly when reduction of donor-site morbidity and improvement of patient comfort are important treatment considerations.

5. CONCLUSION

Gingival recession is a complex mucogingival condition that requires careful diagnosis and individualized treatment planning based on defect morphology, periodontal phenotype, and patient-related risk factors. Successful treatment outcomes depend not only on the selected surgical technique but also on accurate case selection, meticulous surgical execution, adequate plaque control, and long-term supportive periodontal maintenance.

Although minimally invasive and regenerative approaches continue to evolve and expand therapeutic possibilities, autogenous subepithelial connective tissue grafting remains the most predictable and well-documented method for achieving stable long-term root coverage and enhancement of periodontal soft tissue

quality. Contemporary periodontal plastic surgery should therefore combine evidence-based surgical principles with patient-specific treatment strategies in order to optimize both functional and esthetic outcomes.

Abbreviations

- **AAP** – American Academy of Periodontology
- **ADM** – Acellular Dermal Matrix
- **CAF** – Coronally Advanced Flap
- **CEJ** – Cementoenamel Junction
- **CTG / SCTG** – Connective Tissue Graft / Subepithelial Connective Tissue Graft

DECLARATIONS

Competing Interests

The authors declare no conflict of interest.

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Ethical Approval

Informed consent was obtained from all patients. Retrospective clinical case documentation was reviewed and approved in accordance with ethical standards.

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