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Keywords

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Gingival recession is an intriguing and complex phenomenon. Recession frequently disturbs patients because of sensitivity and esthetics. Many surgical techniques have been introduced to treat gingival recession, including those involving autogenous tissue grafting, various flap designs, orthodontics, and guided tissue regeneration (GTR). This article describes different clinical approaches to treat gingival recession with emphasis on techniques that show promising results and root coverage.

Etiology and prevalence

Recession can be defined as the displacement of the [gingival margin](#) apically from the [cementoenamel junction](#) (CEJ), or from the former location of the CEJ where restorations have distorted the location or appearance of the CEJ. [Gingival recession](#) can be localized or generalized, and be associated with one or more surfaces.¹

Many people exhibit generalized [gingival](#) recession without any awareness of the condition and without symptoms. However, patients are often anxious about gingival recession for one or several reasons, including fear of tooth loss, [dentinal hypersensitivity](#), or poor esthetics. Because many possible contributing factors interact to contribute to gingival recession, it is difficult to predict whether further changes in gingival recession may occur at a given site.

Albandar and Kingman² studied the prevalence of gingival recession among subjects 30 to 90 years old. Using a sample of 9689 subjects, they projected that 23.8 million persons in the United States have one or more tooth surfaces with 3 mm or more gingival recession. Those investigators also found that the prevalence of 1 mm or more recession in persons 30 years and older was 58%, and increased with age. Males had significantly more gingival recession than females, and African Americans had significantly more gingival recession than members of other racial/ethnic groups. Recession also was more prevalent and severe at buccal than at interproximal surfaces of teeth.² Similarly, Gorman³ found that the frequency of gingival recession increased with age, and was greater in males than females of the same age. Malpositioned teeth and toothbrush trauma were found to be the most frequent [etiologic](#) factors associated with gingival recession.³ Recession associated with labially positioned teeth occurred in 40% of patients 16 to 25 years old, and increased to 80% of patients in the 36- to 86-year-old group.³ Those findings were corroborated by Gorman,⁴ who examined 4000 subjects and found that the incidence of gingival recession increased with age.

The indications for [surgical treatment](#) of gingival recession include reducing root sensitivity, minimizing cervical [root caries](#), increasing the zone of attached gingiva, and improving esthetics.

Connective tissue grafting

One goal of soft tissue grafting is root coverage. To accomplish that goal, many techniques and flap designs have been used, some of which do not require a donor site (pedicle grafts), while others do (free autogenous grafts). The success rates of root coverage procedures vary because coverage depends on several factors, including location and classification of the [gingival](#) recession and the technique used. The gingival dimension most commonly assessed is the height (distance between the soft tissue margin and the mucogingival line measured in millimeters). An increase in gingival height independent of the number of millimeters is considered a successful outcome of gingival augmentation procedures.⁵

Pedicle grafts

Pedicle grafts differ from free autogenous soft tissue grafts in that the base of the pedicle flap contains its own blood supply, which nourishes the graft and facilitates the reestablishment of vascular union with the recipient site. Pedicle grafts may be partial or full thickness.^{6,7} In a clinical human study, Wood and colleagues⁸ used reentry procedures to compare crestal radicular bone responses to full- and partial-thickness flaps. He concluded that regardless of the flap procedure, loss of crestal bone depended on thickness, with the thinnest radicular bone associated with greater postoperative [bone loss](#). The mean bone loss for full- and partial-thickness flaps was 0.62 mm and 0.98 mm, respectively.

The term *lateral sliding flap* was first introduced by Grupe and Warren.⁹ Miller and Allen¹⁰ have noted that that term now generally refers to the laterally positioned pedicle graft (LPPG). An LPPG cannot be

performed unless there is significant [gingiva](#) lateral to the site of recession. A shallow vestibule also may jeopardize outcomes. Although the use of the LPPG provides an ideal color match, it often is inadequate for the treatment of multiple recessions.

Pedicle grafts using an [edentulous](#) area as a donor site also have been proposed to correct gingival recession.¹¹ The procedure is particularly useful in cases where the attached gingiva on facial surfaces of two or three consecutive teeth is inadequate. That technique involves the development of partial-thickness flaps around the involved teeth, sliding the entire flap the width of half a tooth, and placing the interdental papillary tissues over the buccal surfaces of the affected teeth.¹²

Cohen and Ross¹³ proposed a double-papilla repositioned flap to cover defects where an insufficient amount of gingiva was present, or where there was an inadequate amount of gingiva in an adjacent area for a lateral sliding flap. The papillae from each side of the tooth are reflected and rotated over the midfacial aspect of the recipient tooth and sutured. The only advantage of this technique is the dual blood supply and denudation only of interdental bone. The disadvantages may include pulling of the [sutures](#) and tearing of the gingival papilla.^{13, 14, 15}

Coronally Positioned Grafts

Bernimoulin and colleagues¹⁶ first described the coronally positioned graft subsequent to [grafting](#) with a free graft (ie, a two-stage procedure).

First, a free autogenous soft tissue graft is placed apical to an area of denuded root. After healing, the flap is coronally repositioned. The requirements for the success of coronally positioned grafts include (1) the presence of shallow crevicular depths on proximal surfaces, (2) approximately normal interproximal bone heights, (3) tissue height within 1 mm of the CEJ on adjacent teeth, (4) adequate healing of the free graft before coronal positioning, (5) reduction of any root prominence within the plane of the adjacent [alveolar bone](#), and (6) adequate release of the flap to prevent retraction during healing. The second-stage procedure uses a split-thickness dissection with mesial and distal vertical releasing incisions until adequate flap mobility is obtained. The flap is sutured 0.5 to 1 mm coronal to the CEJ and covered with a [periodontal](#) dressing.¹⁷

[Coronally positioned flaps](#) were compared with lateral sliding flaps in the treatment of localized gingival recessions.^{18, 19} In a 6-month report, both techniques rendered satisfactory results, and no differences in [tissue coverage](#), sulcus depth, or gain of attached gingiva were reported. An average of 2.7 mm of soft tissue coverage was obtained, with average recession coverage of 67%. The only difference between the two techniques was an increase in root exposure of approximately 1 mm at the lateral sliding flap donor site, while no additional recession was observed with the coronally positioned flap. Results were stable for 3 years.

Allen and Miller²⁰ used single-stage coronally positioned flaps in the treatment of shallow marginal recession. The Miller class I defects had a minimum keratinized tissue width of 3 mm, with recession between 2.5 to 4 mm. The technique consisted of citric acid root treatment, a split-thickness flap extending into the vestibule, and surface [gingivoplasty](#) of the papillae to produce a bleeding bed. Flaps were sutured into position and dressed. Complete root coverage was attained in 84% of the sites, with a

mean root coverage gain of 3.2 mm. Similarly, Harris²¹ reported a 98% success rate of root coverage in class I defects by using the coronally positioned graft technique.

Tarnow²² described the semilunar coronally positioned flap technique. An incision is made that follows the curvature of the free marginal gingiva and extends into the papillae, staying at least 2 mm from the papilla tip on either side. The incision is made far enough apically to ensure that the apical portion of the flap rests on bone after repositioning. A split-thickness dissection of the flap is made and the flap is repositioned and held in place with light pressure and a periodontal dressing. The advantages of that technique include no tension on the flap after repositioning, no shortening of the vestibule, no reflection of the papillae (thereby avoiding esthetic compromise), and no [suturing](#).

Free autogenous soft tissue grafts

Both the epithelialized palatal graft and the subepithelial connective tissue graft offer a more versatile solution for root coverage than does the laterally positioned or coronally positioned pedicle flaps. There is adequate donor tissue, a shallow vestibule does not compromise the procedure, and multiple recessions can be treated. Two kinds of autogenous grafts can be used for root coverage. One consists of an epithelialized layer, while the other does not (or contains a small epithelialized collar).

Free Epithelialized Autogenous Gingival Grafts

Sullivan and Atkins²³ were the first to explore the feasibility and healing of the [free gingival graft](#). This procedure involves the preparation of a recipient site, which is accomplished by supraperiosteal dissection to remove [epithelium](#) and connective tissue to the [periosteum](#).

Some of the common areas for donor material include [edentulous](#) ridges, attached [gingiva](#), and palatal gingiva. Because of shrinkage during healing, donor tissue should be approximately 33% larger than the anticipated healed graft.²⁴ The grafts used should be approximately 0.8 to 1.3 mm in thickness to assure that there is an adequate connective tissue component.²⁵

In a 2-year study comparing graft versus no graft, [plaque](#) control was more important than the width of the attached gingiva in determining eventual breakdown and recession.²⁶ Investigators also found that the use of the free gingival graft was a predictable means of increasing the width of the attached gingiva. In a follow-up study 2 years later, the same investigators reported similar results except that 10% of the nongrafted cases showed additional soft tissue recession compared with grafted sites with equivalent plaque scores.²⁷

Free gingival [grafting](#) has been used as a single procedure to cover denuded root surfaces.²⁸ The recipient bed is extended one tooth-width lateral to the denuded roots, and 5 mm apical to the [gingival margin](#) of the denuded root. The investigators suggested that donor tissue cover the gingival bed and extend at least 3 mm apical to the margin of the denuded root, using a graft of approximately 1.5 mm uniform thickness. In 50 randomly selected cases, recessions less than 3 mm had 95.5% root coverage, recessions 3 to 5 mm had 80.6% coverage, and recessions more than 5 mm had 76.6% coverage.

Miller²⁹ described a technique for root coverage using a free soft tissue autograft with citric acid treatment. Predictable root coverage depended upon the severity and classification of [gingival recession](#). After [root planing](#), citric acid application was performed, followed by horizontal incisions at the level of the CEJ to preserve the [interdental papillae](#). Vertical incisions at proximal line angles of adjacent teeth facilitate completion of bed preparation. A thick palatal graft with a thin layer of submucosa was placed on a moderately bleeding bed and stabilized with [sutures](#) at the papillary and apical ends of the graft extending into periosteum. Results of 100 consecutively placed grafts showed 100% root coverage in class I defects and 88% coverage in class II. The average root coverage for all sites was 3.8 mm with a mean clinical attachment gain of 4.5 mm.

Although Miller reported a combined 90% success rate in achieving 100% root coverage, his 100 cases included 94 in the mandible and only 6 in the maxilla.

Connective Tissue Autogenous Grafts

The use of connective tissue grafts for root coverage was first reported by Langer and Langer.³⁰ A partial-thickness flap with two vertical incisions was elevated on the recipient site, followed by placement of the graft (which is collected from the [palate](#) by a double parallel incision technique). The flap is coronally positioned to attempt to cover the graft and benefit from a double blood supply. They reported an increase of 2 to 6 mm of root coverage in 56 cases over 4 years.

Raetzke³¹ described an envelope technique for obtaining root coverage using connective tissue grafts. In that technique, the collar of marginal tissue around a localized area of recession is excised, the root is debrided and planed, and a split-thickness envelope created around the denuded root surface. The graft was collected from the palate by means of the double parallel incision technique. The connective tissue graft is placed in the previously created envelope covering the exposed root surface. Overall, 80% of the exposed root surfaces were covered. Similarly, Allen³² reported an 84% success rate for root coverage using that same technique.

Jahnke and colleagues³³ compared the results of free gingival and connective tissue grafts for root coverage in nine patients. Paired defects were selected and assessed preoperatively, as well as 3 and 6 months postoperatively. Root coverage averaged for 43% for the free gingival graft group, and 80% for the connective tissue graft group. Borghetti and Louise,³⁴ in their split-mouth controlled clinical study, reported a 70% success rate of root coverage 1 year postoperatively.

Most of the studies that used the connective tissue grafts for root coverage did not attempt to remove the epithelial collar from the graft, but when Bouchard and colleagues³⁵ did so, no additional statistically significant benefits were observed (65% with collar, 70% without).

When the connective tissue graft was compared with the free gingival graft for root coverage, Paolantonio and colleagues³⁶ found in a 5-year postoperative study that the connective tissue graft provided a predictable percentage of root coverage (85%), while the free gingival graft presented only a 53% success rate. They concluded that connective tissue grafting is a long-term predictable procedure for root coverage.

A variety of techniques have been used to collect the connective tissue graft, including parallel incisions and free gingival knife methods with no significant difference in the percentage of root coverage.³⁷

Combination of one or more techniques

To increase the success rate of root coverage, many clinicians have attempted to combine different procedures ([Fig. 1](#), [Fig. 2](#), [Fig. 3](#), [Fig. 4](#), [Fig. 5](#)). Nelson³⁸ used connective tissue grafting with a double pedicle graft. A free connective tissue graft first was placed over the denuded root surface, followed by a double pedicle graft to partially cover the connective tissue graft. Twenty-nine defects were treated with that technique and monitored for 4 years. The mean root coverage was 88% (7–10 mm of recession), 92% (4–6 mm of recession), and 100% (≤ 3 mm of recession). Harris¹⁴ modified Nelson's technique with a split-thickness pedicle graft to cover the connective tissue graft. Thirty Miller class I and II defects were selected and the mean root coverage was 97%.



Fig. 1. Preoperative [gingival recession](#) on tooth #6.



Fig. 2. Connective tissue graft sutured in place around tooth #6.



Fig. 3. Combination of connective tissue graft and [coronally positioned flap](#) with [sutures](#) at tooth #6.



Fig. 4. Tooth #6 after 2 weeks of postoperative healing.



Fig. 5. Tooth #6 after 6 months of postoperative healing.

Wennström and Zucchelli⁵ compared a [coronally positioned flap](#) to a combination of a coronally positioned and connective tissue graft procedure. The treatment of 103 (Miller class I and II) defects was performed. The success rate for the combination group was 98.9%, while 97% was accomplished for the control group after a 2-year postoperative evaluation. The investigators concluded that the previous combination of coronally positioned flap and connective tissue graft was the treatment of choice to achieve root coverage.

Recent studies report that the addition of platelet-rich plasma to the combination of connective tissue grafting and coronally positioned grafts revealed no additional clinical benefits.^{39, 40} [Allografts](#) have also been tested to treat [gingival recession](#) and to eliminate the donor site. Results appear to be contradictory, possibly because the procedure is technique sensitive, especially when aimed at root coverage.^{41, 42}

Various tissue engineering techniques, including those involving the use of [enamel matrix derivative](#), have been used to enhance root coverage. However, minimal clinical significance has been reported in terms of root coverage.^{43, 44, 45}

Guided tissue regeneration (GTR) to treat gingival recession

Regeneration is defined as “a reproduction or reconstitution of a lost or injured part. It is, therefore, the biologic process by which the architecture and function of lost tissues are completely restored.”¹⁵ This implies regeneration of the tooth's [supporting tissues](#), including [alveolar bone](#), [periodontal ligament](#), and [cementum](#). Many studies have attempted to achieve regeneration, but success rates have varied from minimal or partial regeneration to almost complete regeneration.

The use of GTR has been suggested for treatment of recession. Tinti and Vincenzi⁴⁶ first reported a case where GTR using an expanded polytetrafluoroethylene (ePTFE) membrane was used to treat recession defects. Cortellini, Clauser, and Pini Prato⁴⁷ also demonstrated, histologically, that the root coverage obtained with an ePTFE membrane included new connective tissue attachment as well as new bone formation.

Different space-making solutions also have been used in combination with nonresorbable membranes (eg, titanium-reinforced, gold bar-reinforced, and gold frame-reinforced membranes) to increase the percentage of root coverage with GTR. In a human histologic study using titanium-reinforced membranes, there was evidence of new connective tissue attachment and new [bone growth](#) after 9 months.⁴⁸ The different membrane designs have resulted in 77% root coverage.⁴⁹

Roccuzzo and colleagues⁵⁰ used ePTFE membranes in combination with miniscrews for space-making and stabilization, reporting a mean root coverage of 84% in 12 cases. Jepsen and colleagues⁵¹ compared titanium-reinforced membranes and connective tissue grafts using the envelope technique. There was no statistically significant difference in the two treatment modalities (the mean root coverage was 87% for the GTR group and 86% for the connective tissue graft group). Wang and colleagues⁵² also compared GTR to subepithelial connective tissue [grafting](#). Using 16 patients with bilateral Miller class I and II recession, they concluded that both treatments presented with statistically significant improvement from

preoperative to postoperative measurements. The mean root coverage for the GTR group was 73%, and 84% for the subepithelial connective tissue graft.

To eliminate the need for a second surgical procedure to remove a nonresorbable membrane, the use of various bioabsorbable materials has been proposed. In one study, root coverage was obtained using a bioabsorbable polylactic acid membrane softened with citric acid ester (PLACA membrane).⁵³ In another study, the PLACA membrane resulted in a mean root coverage of 64%.⁵⁴ In comparing the use of a PLACA membrane to a nonresorbable ePTFE membrane, investigators found no statistically significant differences in the mean root coverage obtained by either technique (PLACA 82%; ePTFE 83%).⁵⁰ Similarly, Zucchelli and colleagues⁵⁵ showed similar results when they compared bioabsorbable to nonabsorbable membranes.

The choice of GTR or [gingival](#) grafting to obtain root coverage has been a controversial subject. For example, Pini Prato and colleagues⁵⁶ compared the results obtained with ePTFE membrane and a two-step mucogingival surgical procedure (involving a [free gingival graft](#) and coronally positioned flap). They reported mean root coverage for the GTR procedure of 72% versus mean root coverage for the two-step procedure of 70% (the differences were not statistically significant). Harris⁵⁷ also compared GTR with a bioabsorbable membrane versus connective tissue with double pedicle graft, and the difference was not statistically significant.

The combination of coronally positioned flap procedures and GTR was assessed in a clinical investigation.⁵⁸ The investigators found in their 6-month split-mouth randomized design that there was no statistically significant difference between GTR/coronally positioned flaps versus coronally positioned flaps alone. The mean root coverage was 56% and 69%, respectively. Another study reported similar results, with no statistically significant differences observed between the two treatment groups.⁵⁹ However, the later study reported a slight increase in the width of keratinized gingiva in the connective tissue group. Ricci and colleagues⁶⁰ also showed similar results after a 1-year postoperative evaluation, with no statistically significant differences between treatments (77% mean root coverage for the GTR group and 80% for the connective tissue group). Harris⁶¹ combined a connective tissue graft with a coronally positioned graft and compared it to GTR with a bioabsorbable membrane. No differences were observed between groups (92% for the GTR group and 95% for the connective tissue with coronally positioned graft). He also noticed a greater increase in the amount of keratinized gingival tissue for the connective tissue graft group. Trombelli and colleagues⁶² showed a significant difference in mean root coverage when comparing the GTR with a bioabsorbable membrane to a connective tissue graft procedure (48% root coverage for the GTR group and 81% root coverage for the connective tissue graft), and reported a significant increase in the amount of keratinized gingival tissue for the connective tissue graft when compared with the GTR group. However, in a more recent study,⁶³ when GTR was compared with connective tissue grafting with coronally positioned flaps, the investigators concluded that, in shallow recessions (1.5 to 3.5 mm), GTR techniques only provided 50% root coverage obtained 12 months postoperatively, while the connective tissue grafting techniques yielded 82% root coverage. Harris⁶⁴ supported the previous conclusion by reporting that 92% mean root coverage obtained 6 months postoperatively had been reduced to a 58% after a mean of 25 months' postoperative evaluation.

Summary

The treatment of [gingival recession](#) can be accomplished with a variety of procedures. However, the combination of connective tissue grafting with a [coronally positioned flap](#) has been shown to demonstrate the highest success rate. [Allograft](#) materials and GTR techniques also can be used to treat recessions, particularly when patients are reluctant to consent to providing [gingiva](#) donor sites.

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