Treatment of the gingival recession — literature review of current progress

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Many root coverage techniques, such as a lateral pedicle flap, double papilla flap, free gingival graft, connective tissue graft, guided tissue regeneration (GTR) procedure, etc., have been widely applied to the treatment of gingival recession in clinical dental practice. Although they all provide various degrees of successful root coverage, many disadvantages still remain for each respective method. Some procedures need very complicated and technically demanding steps and thus are not always predictable, while others require a 2-stage operation or 2 surgical sites and thus commonly lead to slow healing of the wound. These procedures usually result in complications of postoperative hemorrhage and cause moderate to severe pain and discomfort after the surgical intervention. Difficult and intensive postoperative care is also quite commonly encountered during the early phase of the wound-healing period with these procedures. Others disadvantages are those which may either produce situations impairing the blood supply to the graft on the donor site or resulting in a poor color match (poor esthetics) of the graft tissue to the adjacent gingival. In this report, a short, a literature review concerning current treatments for gingival recession is conducted. (Chin Dent J, 24(2) : 71-78, 2005)

Key words: gingival recession, coronally positioned pedicle flap, connective tissue graft, enamel matrix derivative, guided tissue regeneration.

In clinical dentistry, gingival recession is a common annoying problem. Patients usually complain of hypersensitivity of the teeth and poor esthetics, and it may be a retentive factor for dental plaque, which can cause root caries. There are many etiologic factors1,2 that can lead to gingival recession: sequelae of periodontal disease, improper use of tooth brushing (mechanical forces), iatrogenic factors, anatomical factors, and complications after periodontal surgery. In 1985, Miller3 proposed a classification system of gingival recession, which is probably the one most widely used today for selecting a treatment modality and determining therapeutic outcomes. His classification of gingival recession is based on the remaining gingival tissues surrounding affected teeth (see reference 3 for details).

Many different approaches for the treatment for gingival recession have been reported in the literature without a consistent consensus1,4. This is possibly due to the poor esthetics or other clinical complications associated with each of the various clinical procedures used for managing this problem. There are currently 4 common basic categories for root coverage1: pedicle grafts, free gingival grafts, connective tissue grafts, and guided tissue regeneration techniques with a membrane barrier. In addition, combinations of different procedures are also popular in many clinical practices and literature reports.
Current mucogingival plastic surgical techniques for treating gingival recession
Laterally positioned pedicle graft

The best-known technique among pedicle grafts is the laterally positioned pedicle graft introduced by Grupe and Warren\(^5\) and later modified by Grupe\(^6\). The success rate of this root coverage procedure was found to be in the range of 69% ~ 72%\(^1\). The main advantages\(^1\) of the laterally positioned pedicle graft are that it is relatively easy and not time-consuming, it produces excellent esthetic results, and a second surgical site is not mandatory. The disadvantages, however, include that it is applicable only for single-site recession, there is a possible danger of gingival recession, dehiscence, or fenestration at the adjacent donor site, and an adequate amount of keratinized tissue at a neighboring donor site and a deep vestibule are needed. There are also other alternative procedures for a laterally positioned flap, such as a double papilla graft (Cohen and Ross\(^4\)) and an obliquely rotated graft (Pennel\(^8\)). The double papilla graft has very limited usefulness due to its poor predictability, although the esthetic result is excellent. The obliquely rotated graft has the same disadvantages as the laterally position pedicle flap, although it can avoid other tension-releasing incisions as does the laterally positioned pedicle flap.

Free gingival graft

The free gingival graft procedure involves a combination of 2 tissue components (keratinized epithelial and connective tissue) obtained from the palate or an edentulous ridge and its placement in the gingival recession area. Hattler\(^9\) was the first to utilize keratinized gingiva of the interdental papillae to cover denuded root surfaces. The technique was popularized later by Sullivan and Atkins\(^10\) and was further refined by other investigators including Sugarman\(^11\) and Staffileno and Levy\(^12\). Results obtained from different studies indicated that the mean root coverage treated with a free gingival graft was 88%, with the total root covering varying from 70% to 90% of the treated sites\(^13\). The promising advantages of this technique are that it is a relatively easy technique, it can be applied to both single and multiple recessions, it does not depend on adjacent sites for donor tissue, and its usage is not relevant to vestibular depth. The disadvantages are that it creates a second donor site wound that is prone to bleeding, pain, and slow healing and it produces an esthetically less-pleasing result of the healed tissue, such as pale color and an irregular surface of the graft site, especially if the rugae of the palatal mucosa are included in a large piece of donor tissue.

Subepithelial connective tissue graft (sCTG)

Because of these drawbacks of free gingival graft mentioned above, the use of free connective tissue grafts for root coverage was introduced by Edel\(^16\) in 1974. The technique was presented by Langer and Calagna\(^17\) as a subepithelial connective tissue graft, and was further described in detail by Langer and Langer\(^19\). This method is suitable for covering recessions of both single and multiple adjacent teeth and is especially indicated when esthetics is a primary consideration. Another version of a connective tissue graft was later modified by Nelson\(^20\) and Harris\(^21\). Nelson modified the original technique by using a pedicle flap to cover the connective tissue graft and called it a subpedicle connective tissue graft, while Harris\(^21\) further modified this technique by using a bilateral pedicle flap to cover the connective tissue graft. He called this technique double pedicle flaps with a connective tissue graft.

The predictability of connective tissue graft procedures is generally excellent. For any given site, Nelson reported a mean root coverage of 88%\(^20\), while both Levine\(^23\) and Harris\(^21\) reported ~97% root coverage. Long-term results (27.5 months) of subepithelial connective tissue grafts have recently been shown to be effective (98.4%) in obtaining root coverage in 100 patients with 146 Miller class I or II recession defects\(^23\). The subepithelial connective tissue graft was reported to be a predictable method to obtain root coverage (with a mean root coverage of 91.1%) of recession defects on molars\(^24\) and on other sites (95.8%)\(^25\). There were an improvement in recession depth (from 4.4 to 0.5 mm), an increase in the quantity of keratinized tissue (from 0.9 to 3.1 mm), a decrease in probing depth (from 3.0 to 2.3 mm), and a decrease in attachment level loss (from 7.4 to 2.8 mm)\(^24\).

The main advantages of this current procedure are that: it maintains a blood supply to the graft and therefore has a good predictability of success; it provides good esthetics with preservation of the original flap tissue; the donor site wound is less
hemorrhagic and painful, and can be healed by primary closure; and it is simultaneously applicable to both single and multiple recessions. However the critical disadvantage is the fact that this technique is technically demanding and more time-consuming.

Little is known about the histologic results of applying connective tissue with a partial-thickness double pedicle graft (sCTG) in humans. Gottlow and Wilderman and Wentz found that root coverage was achieved by a combination of epithelium and new connective tissue attachment after treatment with pedicle grafts. Epithelium attachment ranged from 40% to 50% and the remaining part healed using connective tissue attachment. Sugerman, reporting on a histologic evaluation of a receded human tooth treated with a free soft tissue graft, demonstrated that a new connective tissue attachment was only found in the apical one-fourth of the successfully covered recession defect. Other histologic studies demonstrated 2 different healing patterns including new connective tissue attachment and long junctional epithelial attachment.

Guided tissue regeneration (GTR) technique

In looking for a new attachment or regeneration of tissues at the site of recession, recent clinical studies have proposed the guided tissue regeneration (GTR) technique for the treatment of gingival recession. Tinti and collaborators are pioneers of this treatment modality. They have introduced techniques for GTR to obtain root coverage in an attempt to re-establish a connective tissue attachment on exposed root surfaces. Pini Prato et al. also exploited guided regeneration techniques to simultaneously treat osseous defects, exposed roots, and mucogingival problems. The predictability and success rate of the GTR procedures used for treating gingival recession were addressed in many recent studies and varied from 45% to 81% with more than 100% improvement in the width of the keratinized gingiva. The main advantages of this procedure include good esthetics, a reasonable potential for true regeneration of the lost periodontal attachment, and the absence of the need for a second donor site. The disadvantages are that it requires 2 surgical stages when nonresorbable membranes are used; it is potentially more expensive; more effort is required to care for the wound postoperatively; and the percentage of root coverage is not usually optimal due to common membrane exposure and colonization of oral microbiota on the membrane. Favorable outcomes for root coverage have recently been reported using bioabsorbable membranes. However, the amount of root coverage obtained with a coronally positioned flap (CPF) was greater than that observed with GTR. Unfavorable clinical results were reported in a shallow recession study using a CPF in combination with a bioresorbable membrane. The GTR procedure was also reported to produce a mean root coverage of 75.1% in comparison with a mean root coverage of 97.1% in the connective tissue graft with a partial-thickness double pedicle flap. The less-favorable clinical outcome with the GTR method was further confirmed in a recent meta-analysis. Various histomorphometric measurements of the new attachment following treatment of human buccal recession by means of the GTR procedure were analyzed by Cortellini et al., Lee et al., and Harris. New cementum with inserted collagen fibers and new connective tissue attachment was shown in 1 study, and in another, it was shown to apically cover 48% of the distance between the notch of the root instrumentation and the gingival margin. In contrast, only a long junctional epithelial attachment without regeneration of the periodontal tissues was noted by Harris. Furthermore, the application of this technique is still restricted to a single gingival recession due to the limitation of membrane design, properties of the membrane material, and a high postoperative exposure rate of the membrane.

Despite various successful results obtained from the different techniques described above, many disadvantages still seem to persist with each respective method. These various disadvantages are quite common especially in those procedures involving a 2-stage operation or 2 surgical sites, or in very complicated and technically demanding steps, and in those that may impair blood supply to the graft. These problems can be exaggerated in cases with an extensive width of root exposure.

Combination of a CPF with an acellular dermal matrix

Due to the presence of many disadvantages associated with CTG, that procedure combined with an acellular dermal matrix allograft (ADMA) and a coronally positioned pedicle flap (CPF) has been
evaluated as a substitute for free CTGs in various periodontal procedures\(^7\), including root coverage. Root coverage using an ADM graft material and a coronally positioned flap has thus initially been applied to treat cases with gingival recession. Henderson et al.\(^8\) reported 3 successfully treated cases using this technique, for which a mean root coverage of 97\% was achieved, resulting in 100\% coverage of 9 of 11 teeth. Results of another similar study also demonstrated that complete root coverage was obtained on 2 of 3 recession defects\(^9\). The results from these case series conform to the available evidence on the use of ADM graft material in root coverage procedures. Further comparisons between ADMA and CTGs combined with CPF were made to see if ADMA can replace CTG during root coverage procedures. In 1 study, 14 teeth with denuded roots were randomly treated with either an ADMA or CTG covered by coronally advanced flaps in 7 patients. At 12 months, the root coverage gain was 4.57 mm (89.1\%) versus 4.29 mm (88.7\%) for the ADMA and CTGs, respectively\(^7\).

An extensive case study including 107 recession defects in 50 patients who received root coverage therapy treated with an ADMA (test group) versus a CTG (control) were recently reported\(^9\). The results of that study showed that there was no statistically significant difference in the mean root coverage obtained (96.2\% for the control vs. 95.8\% for the test). The results of both procedures resulted in similar amounts of root coverage, and both were esthetically acceptable to patients. Thus, recession defects might be successfully covered using either an ADMA or CTG, with no practical difference. The histological evaluation showed similar healing outcomes with either a CTG or an ADMA. Verhoeff's staining demonstrated that the acellular dermal matrix had been incorporated into the gingival tissue\(^9\). In addition, multiple recession sites could also be successfully treated with the same surgical technique (with a mean root coverage of 95\%) in a randomized clinical investigation, irrespective of orientation of the ADMA\(^9\). The long-term stability of the root coverage results obtained with a graft using an ADMA was also demonstrated by Harris\(^8\). This latter study indicated that the mean extents of root coverage at 12 weeks and 18.6 months postoperatively were 91.7\% and 87.0\%, respectively. Based on evidence shown earlier in this report, the root coverage obtained with an ADMA is predictable, esthetic, and stable over time. However, limited augmentation on the attached masticatory mucosa with this technique has rarely been reported clinically. Determining whether or not this combined method simultaneously provides additional advantages for the induction of keratinized masticatory mucosa during root coverage requires further documentation.

**Combination of a CPF with an enamel matrix derivative**

Most of the current literature suggests that the sCTG has the highest percentage of mean root coverage with the least variability. Again, due to several unresolved disadvantages with this technique, an enamel matrix derivative (EMD) has recently been introduced in the periodontal field to overcome short-comings associated with this and currently available regenerative techniques\(^9\). Previous studies demonstrated that the enamel matrix derivative (EMD) has the ability to improve clinical parameters\(^50\-54\). EMD is an extract of enamel matrix and contains amelogenins of various molecular weights. There is evidence to show that amelogenins are involved not only in enamel formation, but also in formation of the periodontal attachment during tooth formation\(^59\-62\). A meta-analysis including 8 trials for periodontal tissue regeneration in intrabony defects showed that EMD (Emdogain)-treated sites displayed statistically significant probing attachment level (PAL) improvements (with a mean difference of 1.3 mm) and probing pocket depth (PPD) reductions (of 1 mm) when compared to flap surgery\(^9\). Despite the overall efficacy of EMD regeneration therapy, a significant variation (similar to the results for GTRs) in clinical outcomes was observed\(^52\). Meanwhile, the current literature also discloses no evidence of clinically important differences between GTR and Emdogain treatments in terms of probing attachment level gain and probing depth reduction\(^52, 63\-65\). Preliminary histologic investigations with surgically created defects and experimental periodontal lesions illustrated the potential of EMD to induce formation of acellular cementum and promote significant formation of the supporting periodontal tissues in human and animal experiments\(^66\, 68\). However, recent human histologic studies have questioned both the consistency of the histologic outcomes and the ability of EMD to predictably stimulate formation of acellular cementum and bone\(^66, 69\). Non-functional
orientation of the newly formed periodontal ligament collagen fibers was often observed. These findings, coupled with the inconsistent bone growth, bring into question both the ability of EMD to predictably induce true periodontal regeneration in patients and the consistency of the histologic outcome.

Although different root coverage procedures have been used to treat cases of gingival recession defects involving single or multiple exposed root surfaces, a therapeutic advantage may be highly beneficial if periodontal regeneration can be achieved in addition to coverage of the root with gingiva. Recent applications of combining either CPF or CTG with the EMD technique have been newly introduced to treat gingival recession for reasons of both esthetics and root hypersensitivity, and for increasing healthy, thick keratinized gingival tissue. An innovative approach that uses an EMD in conjunction with a periosteal CTG has also been used for root coverage in a patient with multiple gingival facial recessions (class III). This technique achieved satisfactory coverage of the root surfaces and effectively improved the patient's aesthetic appearance for 12 and 18 months in this special clinical situation. This technique thus achieved stable, healthy keratinized tissue coverage of the root surfaces and effectively clinically improved the esthetics.

Histological evaluations of the current procedure (a combination of a CTG and an EMD preparation) were performed on Miller's class II and III gingival recessions in 4 clinically successful root coverage patients. The results of that study revealed that a combination of connective tissue grafts and EMD resulted mainly in a fibrous adhesion between the CT and root surface. Formation of new cementum and new bone was only observed in the most-apical end of the grafted area (similar to that for conventional flap surgery). The development of a long junctional epithelium, a typical healing result of open flap debridement, has commonly been identified in human histologic EMD studies, although this was not observed in another study.

Double laterally rotated bilayer flap

Recently, a de novo procedure, a double laterally rotated bilayer flap, was developed as an alternative simple root coverage technique with the advantages of involving only 1 operative site, consisting of relatively easy procedures, having a better color match to the adjacent gingiva, and promising a blood supply and maintenance of an adequate zone of keratinized tissue. Basic surgical techniques including 2 partial-thickness flaps and releasing incisions on either side of the surgical sites were designed (see reference 77 for details), 1 each on the mesial and distal sides of the gingival defect.

**SUMMARY AND CONCLUSIONS**

Traditionally, the beneficial effects of a laterally positioned pedicle graft are that it is a relatively easy method, produces good esthetic results, and requires only 1 surgical site. A subpedicle connective tissue graft, in addition to similar advantages listed for the earlier procedure, provides other benefits of ensuring an enriched blood supply to the connective tissue graft, being less painful, and producing fewer hemorrhagic complications at the operative site. The new method proposed in this report utilizes part of the sound principles of both a laterally positioned pedicle graft and a subepithelial connective tissue graft as modified by Nelson and Harris. Another technique that uses a double pedicle plus a connective tissue graft has been described by Harris et al., but it differs from the procedures developed by us. The previous technique involves the preparation of 2 surgical sites (a palatal donor site and a recipient bed). The success rate of those procedures is still sometimes limited due to a non-predictable or an inadequate blood supply to the connective tissue graft.

This newly developed mucogingival surgical method provides in situ de-epithelialized flaps and thus offers an optimal blood supply and clinical tissue color matching without the drawback of the need for secondary surgery. The new design also avoids many other common disadvantages, in addition to those mentioned above, such as a demanding technique and the need for meticulous care after surgery. These drawbacks are especially true when using a palatal free gingival graft, subepithelial connective tissue graft, or even guided tissue regeneration. However, there are still many limitations which need to be resolved before this new technique can be applied. For instance, the gingival tissue apical to the area of recession should be sufficiently thick. A cause-effect relationship has been reported to exist between tissue
thickness and successful coverage\textsuperscript{28,79}, especially for the success of the root coverage in the guided tissue regenerative procedure\textsuperscript{45}. Furthermore, deep periodontal pockets and excessive bone loss should not extend beyond the mucogingival junction at the interdental area of the affected tooth. Finally, separate surgical procedures are still needed in the presence of multiple adjacent recessions.

The main characteristic feature of the double laterally-rotated bilayer flap procedure is the fact that the donor and recipient sites are in the same areas. Palatal surgery for free connective tissue can be avoided. The patient experiences less discomfort during the early healing period. In addition, the primary flap (the underlying flap) of this technique potentially has a dual blood supply from both the rotated surface flap and the periosteal bed. The postulation of a dual blood supply is interesting and needs to be demonstrated by further angiographic investigations, etc., if this procedure is to be used in cases of adjacent multiple gingival recessions. In conclusion, a new procedure has been created for correcting mild to moderate gingival recession (Miller’s class I and II), and the opinions of the current literature related to root coverage procedures are also reviewed. Determining the advantages of the double laterally-rotated pedicle flap that overlaps the epithelium-covered pedicle and the epithelium-denuded flaps which provide a dual blood supply, in contrast to those which have only one in the subepithelial connective tissue grafts, requires more-extensive clinical evaluation. Furthermore, more investigations about its long-term clinical success rate and histologic evidence of healing patterns relative to those conventional methods are still mandatory.

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Root coverage


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