

Decision making in root-coverage procedures for the esthetic outcome

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Root-coverage periodontal plastic surgery procedures have long been used for the treatment of gingival recession. Esthetics, dental hypersensitivity and the prevention of caries and non-carious cervical lesions are considered the main indications reported in the literature (16). In the 1960s and 1970s, mucogingival surgery was focused on treating the so-called mucogingival defects, in other words the lack of both thickness and height of keratinized tissue. At that time, Lang & Loe (27) demonstrated a relationship between the inflammatory state of marginal tissue and the amount of keratinized tissue, asserting the need for a critical amount of keratinized tissue to maintain a good state of health (16). With this rationale, the elective surgical technique was the free gingival graft (21, 28, 31, 33, 36). Later on, studies performed on animal and human subjects demonstrated that the critical aspect in maintaining a periodontally healthy condition is plaque control, despite the width of keratinized tissue (18). The indications for free gingival graft shifted from the augmentation of keratinized tissue to root coverage. Along with free gingival grafts, other pedicle flaps, essentially the laterally positioned flap described by Grupe & Warren (22), the coronally advanced flap, which was first introduced by Norberg (32) and later modified by Bernimoulin et al. (8) and Allen & Miller (2), and the coronally advanced flap associated with a connective tissue graft (35), were developed to reach this objective.

As the esthetic expectations and perceptions of patients have become increasingly more

demanding in the last decades, the ultimate goal of mucogingival surgery is not only root coverage but also an esthetic outcome, which results in the complete blending of tissue color and texture of the treated area with the adjacent soft tissues (19). For these reasons and in order to emphasize the esthetic purpose of these procedures, the American Academy of Periodontology (3) recently substituted the old term 'mucogingival surgery' with 'periodontal plastic surgery'.

Along with the development of root-coverage surgical techniques, criteria have been developed to improve evaluation of the esthetic outcomes. This evaluation can be subjective or objective. The objective evaluation is intended as a professional judgment based exclusively on clinical parameters and can be assessed using different methods (12, 24, 50). The subjective evaluation is intended as a judgment by the patient based on his/her personal perception and collected through questionnaires or visual analog scores (17, 44).

Until a few years ago, clinicians and researchers used complete root coverage (the gingival margin located at the cemento-enamel junction), healthy sulcus depth (≤ 2 mm), the presence of clinically attached gingiva and no bleeding on probing of the treated sites as primary outcomes of successful treatment for gingival recession (30). The recent consensus (37) underlined the lack of clinical trials that took into account the real needs and requests of the patient, often the main indication for root-coverage procedures. Moreover, few studies evaluated patients' esthetic satisfaction following therapy, mainly collecting their opinion in a non-standardized way (14). With procedures aiming to improve patient esthetics,

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patient-centered parameters should be the primary outcome variables.

The purpose of this paper is to suggest a decision-making process for selecting the appropriate surgical technique to achieve ideal esthetic outcomes, based on clinical and anatomic factors.

Objectives of periodontal plastic surgery

In literature, the predictability of root coverage in a mucogingival surgical procedure is measured in terms of the percentage of root coverage (i.e. the percentage of root previously exposed which is covered with soft tissues after the healing period) and the percentage of complete root coverage (namely the percentage of the treated defect in which the soft-tissue margin has been repositioned at the level of, or coronal to, the cemento-enamel junction). Very often, the most coronal millimeters of the exposed root are the only visible part of the recession when the patient smiles; therefore, its persistence after therapy may be considered an esthetic failure (51). For this reason, in a patient with high esthetic demand, obtaining complete root coverage is the primary objective. However, complete root coverage should not be considered as the sole factor for defining the outcome of gingival recession treatment (25). Another important aspect of the esthetic evaluation that should be considered is the appearance of tissue after surgery, in terms of color and camouflaging, between the treated area and the adjacent soft tissues. The final objective of an esthetic treatment should be to achieve complete root coverage with perfect blending in terms of color and texture. The above-mentioned considerations are incorporated with the introduction of the root-coverage esthetic score (15). Five variables (the level of the gingival margin, the marginal contour, the soft-tissue surface, the position of the mucogingival junction and the gingival color) are evaluated. A large, multicenter study among expert periodontists showed that the root-coverage esthetic score is a reliable method with which to assess final esthetics after periodontal plastic surgery, with a total inter-rater agreement of 0.92 indicating almost perfect agreement (12). Furthermore, to our knowledge, only one study (26) has tried to compare professional and patient esthetic satisfaction after root-coverage procedures. The results of this study showed that esthetic judgment of the periodontists may not always be consistent with patient satisfaction. Patients were influenced

more by the soft-tissue integration variables than by the percentage of root coverage; and patients appeared to rate the cosmetic results more favorably than did the professionals.

Surgical techniques

The most suitable surgical techniques to obtain good esthetic outcomes are the coronally advanced flap and subepithelial connective tissue graft procedures (16). The adjunctive use of amelogenins with the coronally advanced flap could improve root coverage and gain of clinical attachment level outcomes when compared with the coronally advanced flap alone. Amelogenins are mainly indicated for the treatment of deep and wide gingival recessions (16). The use of amelogenins or connective tissue graft substitutes has not been included in this decision-making process because of the currently limited evidence that they provide a further esthetic advantage when compared with the surgical techniques alone.

Coronally advanced flap procedures

Coronally advanced flap techniques can be applied for the treatment of single or multiple recession defects. In such techniques the residual gingival tissue, apical to the recession, is coronally advanced to accomplish root coverage. The coronally advanced flap is a very safe and reliable approach in periodontal plastic surgery and allows excellent blending between the surgical area and the adjacent tissues.

Coronally advanced flap for single recession defects

The flap is designed as follows: two horizontal beveled incisions (3 mm in length) are made that are mesial and distal to the recession defect and located at a distance from the tip of the anatomical papillae which is equal to the depth of the recession plus 1 mm; and two vertical beveled oblique incisions are made, starting at the end of the two horizontal incisions and extending to the alveolar mucosa (19). The resulting trapezoidal-shaped flap is elevated using a split–full–split approach in the coronal–apical direction: the surgical papillae are elevated split thickness (keeping the blade almost parallel to the bone) and the soft tissue apical to the root exposure is elevated full thickness by inserting a small periosteal elevator into the probable sulcus and proceeding in the apical direction

to expose 3 mm of bone apical to the bone dehiscence. The vertical incisions are elevated split thickness, keeping the blade parallel to the bone plane, thus leaving the periosteum to protect the underlying bone in the lateral areas of the flap. Apical to the bone exposure flap, elevation continues split thickness and ends when it is possible to move the flap passively in the coronal direction. In order to permit the coronal advancement of the flap, all muscle insertions present in the thickness of the flap must be eliminated. This is carried out by keeping the blade parallel to the external mucosal surface. Coronal mobilization of the flap is considered as 'adequate' when the marginal portion of the flap is able to reach without tension a level coronal to the cemento-enamel junction of the tooth with the recession defect. The facial soft tissue of the anatomic papillae coronal to the horizontal incisions is de-epithelized to create connective tissue beds to which the surgical papillae of the coronally advanced flap are sutured. The suture of the flap starts with two interrupted periosteal sutures performed at the most apical extension of the vertical releasing incisions; then, it proceeds coronally with other interrupted sutures, each of them directed from the flap to the adjacent buccal soft tissue, in the apical-coral direction. A sling suture permits stabilization of the surgical papillae over the interdental connective tissue bed and allows precise and tight adaptation of the flap margin over the underlying convexity of the crown.

Coronally advanced flap for multiple recession defects

The flap design consists of a horizontal incision extended to include one tooth or more on each side of the recessions to be treated to facilitate the coronal repositioning of the flap tissue over the exposed root surfaces. The horizontal incision consists of a variable number of interdental submarginal incisions, which form, together with the intrasulcular incisions at the mesial/distal margins of the recession defects, the surgical papillae of the envelope flap (40). The flap is raised using a split-full-split approach, in the same manner as already described for the coronally advanced flap for single recession defects. When suturing, a variable (in relation to the number of teeth included in the flap design) number of sling sutures are used to obtain a precise adaptation of the buccal flap on the convexity of the underlying crown surfaces and to permit the stabilization of every surgical papilla over the corresponding de-epithelized anatomic papilla.

When is the coronally advanced flap the first choice in surgical management of recession defects?

The coronally advanced flap is the most suitable surgical technique in patients with high esthetic expectation as it provides the best esthetic results. It is indicated when the keratinized tissue height apical to the root exposure(s) is $> 2\text{mm}$ (46). However, some anatomic factors limit its clinical applicability and efficacy, such as:

- the absence or only a minimal amount ($\leq 1\text{ mm}$) of keratinized tissue apical to the recession defect.
- the presence of interdental clinical attachment loss.
- the presence of a gingival cleft extending into the alveolar mucosa.
- high frenulum pull at the soft-tissue margin.
- deep root structure loss.
- buccally dislocated root.
- very shallow vestibulum depth.

Subepithelial connective tissue graft procedures

Coronally advanced flap + connective tissue graft

The coronally advanced flap + connective tissue graft consists of a pedicle flap covering a subepithelial connective graft. Since the mid-1990s, clinicians have introduced several modifications to the original bilaminar procedure described by Raetzke (35). These modifications relate both to the type of graft and to the design of the covering flap. The presence of the connective tissue graft acts as a stabilizer for the coronally advanced flap, resulting in increased root-coverage predictability. Furthermore, because of the increase in soft-tissue thickness, the adjunct of connective tissue graft allows better long-term maintenance of the root coverage result compared with the coronally advanced flap alone (34, 48). However, large grafts can impair the vascular exchange between the covering flap and the underlying receiving bed, thereby increasing the risk of flap dehiscence and unesthetic graft exposure. Recently (39, 47), it was suggested that the reduced apicocoronal dimension and thickness of the connective tissue graft could facilitate graft coverage by the flap, improve esthetic outcomes and reduce patient morbidity with no change in root-coverage predictability.

Modified coronally advanced tunnel technique

For the modified coronally advanced tunnel technique, first of all intrasulcular incisions are placed and mucoperiosteal flaps are raised using sharp

tunnel elevators (Stoma, Tuttlingen, Germany) (4–6). The flap is extended beyond the mucogingival junction and under each papilla to allow passive, tension-free mobilization in the coronal direction. The remaining collagen bundles on the inner surface of the flap are carefully cut using Gracey curettes until passive coronal displacement of the flap and papillae are obtained. A connective tissue graft, harvested immediately after the tunnel preparation, is inserted under the tunnelled flap starting from the deepest recession. Then, the graft is pulled laterally toward each end of the tunnel using mattress sutures. Finally, the flap is positioned coronally to the cemento-enamel junction using suspended sutures placed above the contact point, previously splinted with composite stops.

Connective tissue graft wall technique

A modification of the coronally advanced flap + connective tissue graft technique has been proposed by Zucchelli et al. (43) in gingival recession defects associated with interdental clinical attachment and soft-tissue loss. The surgical technique consists of the same coronally advanced flap design for the treatment of multiple recession defects, in this instance associated with a simplified papilla preservation technique (17), which is applied to area affected by clinical attachment level and bone loss. The buccal flap is raised using a split–full–split approach and the entire supracrestal soft tissue is pushed in the palatal/lingual direction until the tip of the interdental papilla is shifted in the most coronal position and it is possible to gain access to the bony defect. The palatal/lingual flap is not elevated. The remaining facial portion of the adjacent papillae is de-epithelialized and the granulation tissue filling the intrabony defect (if present) is removed. A connective tissue graft is then sutured at the base of the anatomic papillae of the two teeth neighboring the bony defect. After flap mobilization, sling sutures are used to anchor the surgical papillae to the corresponding anatomic papillae. Complete soft-tissue closure at the interdental space is achieved using a horizontal mattress suture at the base of the simplified papilla and a vertical mattress or single interrupted suture in a more coronal position.

When are subepithelial connective tissue graft procedures the first choice in surgical management of recession defects?

Subepithelial connective tissue graft procedures are indicated when coronally advanced flap alone cannot be performed for the above-mentioned anatomic

limiting conditions. Such procedures represent the first choice when an increase in soft-tissue thickness, as well as complete root coverage, is indicated. They are also the first choice in the presence of interproximal clinical attachment level loss.

Decision-making process

The decision-making process starts from the clinical observation of the defects and it is structured in progressive nodes that will guide the clinician to select the most suitable surgical technique (Fig. 1).

NODE 1: non-carious cervical lesion

Non-carious cervical lesions are frequently associated with gingival recessions, especially those induced by toothbrushing trauma (41). Non-carious cervical lesions are defined as the loss of hard tissue localized in the cervical third of the tooth that may result in loss of the cemento-enamel junction, which represents the anatomic reference point for evaluating root coverage. The major concern related to loss of the landmark of the cemento-enamel junction is the difficulty in determining the maximum level of root coverage. One method used to determine maximum root coverage, based on calculation of the ideal height of the anatomic interdental papilla (45, 51), was demonstrated to be reliable in predicting the position of the soft-tissue margin after root-coverage surgery. According to this method it is possible to restore, using a composite restoration made at the maximum level of root coverage, the ideal length and convexity of the clinical crown, thus providing a stable and smooth substrate for the surgically advanced flap (41). An example of non-carious cervical lesions treated with a composite restoration at the maximum level of root coverage is shown in Fig. 2.

NODE 2: interdental clinical attachment level loss

Interdental clinical attachment level loss is a major prognostic factor associated with predictability of root coverage by periodontal surgery (11, 13, 29). There is little data available in the literature, but recent studies demonstrate that complete root coverage can be achieved even in the presence of interdental clinical attachment level loss. In 2010, Aroca et al. (4) conducted a randomized clinical trial, with a 12-month follow-up, on 20 patients undergoing a modified coronally advanced tunnel technique, with or

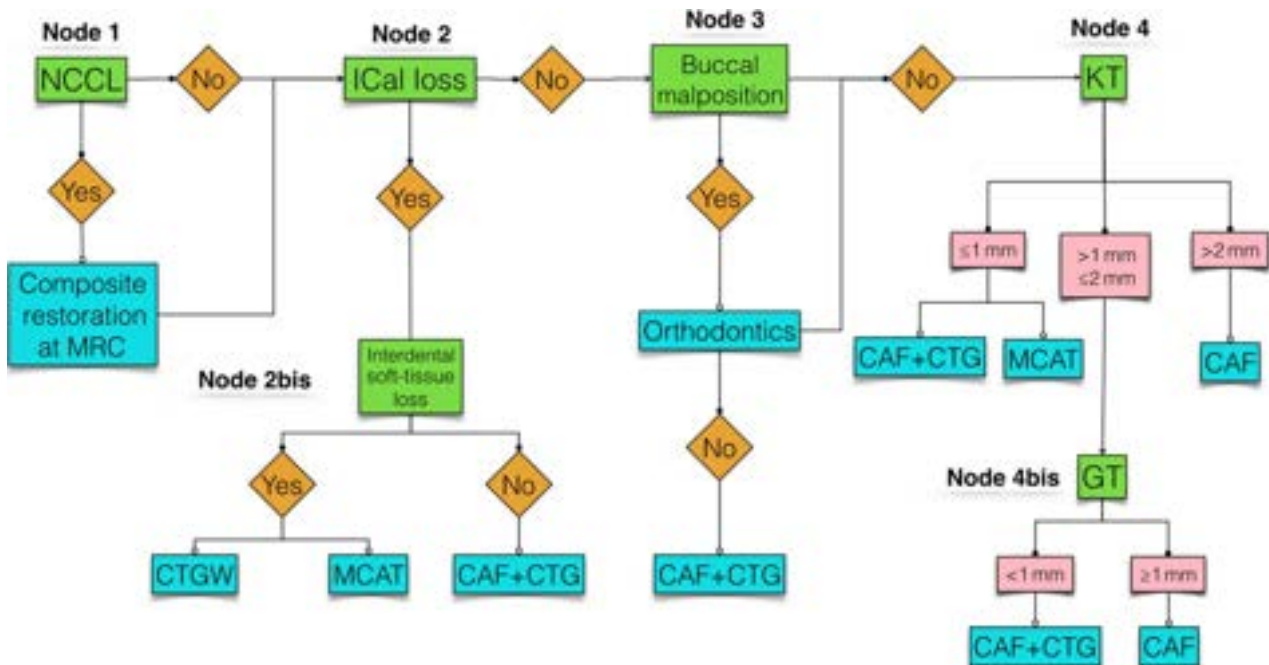


Fig. 1. The decision-making process structured in progressive nodes. CAF, coronally advanced flap; CAF+CTG, coronally advanced flap + connective tissue graft; CTGW, connective tissue graft wall; GT, gingival thickness; KT,

keratinized tissue; ICal, interdental clinical attachment level; MCAT, modified coronally advanced tunnel; MRC, maximum root coverage level; NCCL, non-carious cervical lesion.

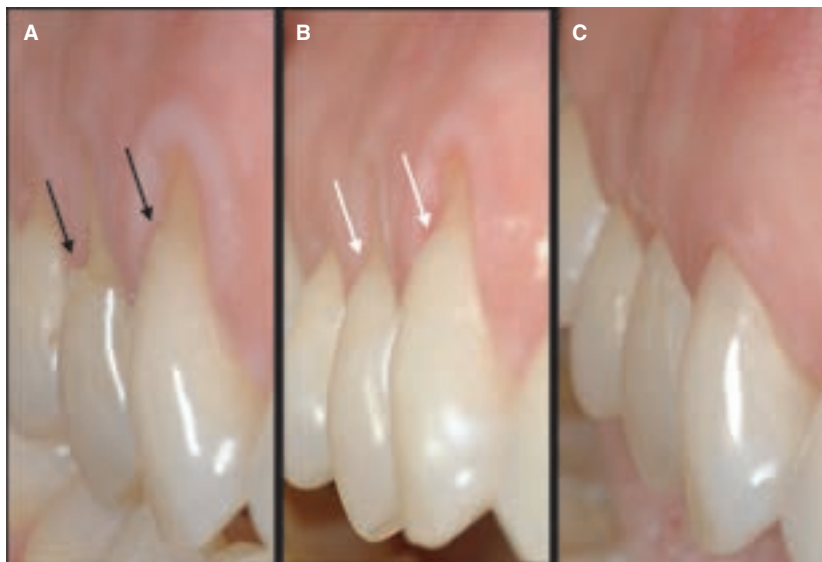


Fig. 2. NODE 1. Non-carious cervical lesion. (A) Gingival recessions with non-carious cervical lesions at the buccal aspect of the canine and first premolar (arrows). (B) Composite restorations at the maximum root coverage level (arrows). (C) Healing 1 year after root coverage surgery.

without the adjunctive use of amelogens, in the treatment of Miller Class III multiple recession defects; complete root coverage was obtained in 38% of cases. More recently, a randomized clinical trial (10) conducted on 29 patients showing isolated recession type 2 gingival recession defects reported at 6 months, complete root coverage, in 57% of cases, after treatment with a coronally advanced flap + connective tissue graft and complete root coverage, in 29% of cases, after treatment with a coronally advanced flap only. Additionally, when interdental

clinical attachment level loss was ≤ 3 mm, complete root coverage was obtained in 80% of cases following treatment with a coronally advanced flap + connective tissue graft. The long-term results of this study, over 3 years, confirmed the stability of the clinical outcomes achieved (11).

NODE 2bis: interdental soft-tissue loss

In the presence of interdental clinical attachment level loss, the presence of interdental soft-tissue



Fig. 3. NODE 2. Interdenal clinical attachment level loss. The coronally advanced flap + connective tissue graft technique is selected as surgical treatment. (A) Recession defect associated with interdenal clinical attachment level loss. (B) Lateral view. (C) Radiograph showing bone loss with suprabony and infrabony components. (D) The trapezoidal coronally advanced flap is elevated using a split–full–split approach. Note the bony defects with no loss of

the interdenal soft tissue. (E) The connective tissue graft is sutured at the level of the cementoamel junction. (F) The coronally advanced flap covers, in excess, the connective tissue graft. (G) One-year clinical outcome showing root coverage. Composite restorations are carried out to reduce the diastema. (H) Lateral view showing root coverage and increase in gingival thickness. (I) Radiographic healing.

loss must be taken into consideration. While application of the coronally advanced flap + connective tissue graft was not able to demonstrate (10) an improvement in the distance between the contact point and papilla tip parameter at 6 months, the modified coronally advanced tunnel technique showed (4) an improvement, of 59%, in the distance between the contact point and papilla tip at 1 year. Furthermore, in a case report presented by Zucchelli et al. (43) the connective tissue graft wall technique showed root coverage along with improvement in interproximal soft- and hard-tissue levels.

For these reasons, in the presence of interdenal clinical attachment level loss with no interdenal soft-tissue loss, the coronally advanced flap + connective tissue graft is indicated (Fig. 3). However, when interdenal clinical attachment level loss is also associated with interdenal soft-tissue loss, the connective tissue graft wall technique or the modified coronally advanced tunnel technique should be the first surgical choice. The connective tissue graft wall technique is better suited for the treatment of single recession defects (Fig. 4), while the modified coronally advanced tunnel technique is better suited for

the treatment of multiple gingival recession defects (Fig. 5).

NODE 3: buccal malposition of the root(s)

Buccal malposition of teeth may be the result of excessive tooth/teeth proclination beyond the cortical bone as a consequence of specific anatomic conditions, or created (or worsened) by orthodontic movement. In these cases, the occurrence of gingival recession is often associated with poor mucogingival characteristics (e.g. the apical third of the root may become transparently visible through the extremely thin alveolar mucosa, the keratinized tissue apical and lateral to the root surface may be lost completely and the soft tissue apical to the root exposure may become probable). As a result of these poor mucogingival conditions and root malpositioning, root-coverage surgical techniques become very challenging and complete root coverage is unpredictable (1, 42). The orthodontic repositioning of root(s) within the limits of the alveolar bone may alter the prognosis of root-coverage procedures as the surgical procedure becomes easier to perform as a result of the improved quality and quantity of the keratinized tissue apical and lateral to the

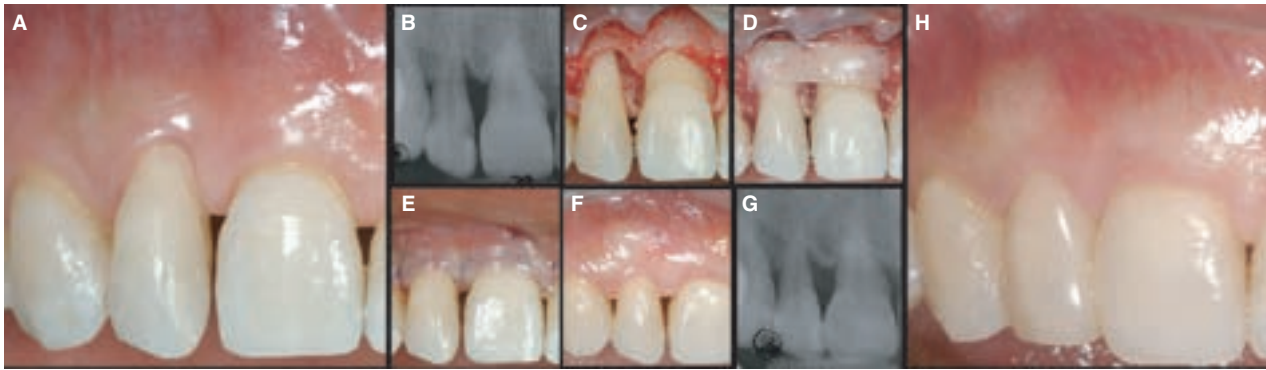


Fig. 4. NODE 2bis. Loss of interdental clinical attachment level with loss of interdental soft tissue. A connective tissue graft wall technique is selected as surgical treatment for a single type recession defect. (A,B) Clinical and radiographic images showing a single recession defect associated with interdental soft-tissue loss and bone loss with suprabony and infrabony components. (C) The bony defects after flap elevation. (D) Suture of the connective tissue graft at the base of the anatomic papillae of the two

teeth neighboring the bony defect. The connective tissue graft acts as a soft-tissue wall on the suprabony and infrabony components of the bony defect. (E) The coronally advanced flap covers, in excess, the connective tissue graft. Primary healing of soft tissue is achieved interdentally above the bony defect. (F) One-year clinical outcome showing complete root coverage. (G) Radiographic healing. (H) Clinical aspect after composite restorations and closure of the residual interdental spaces.

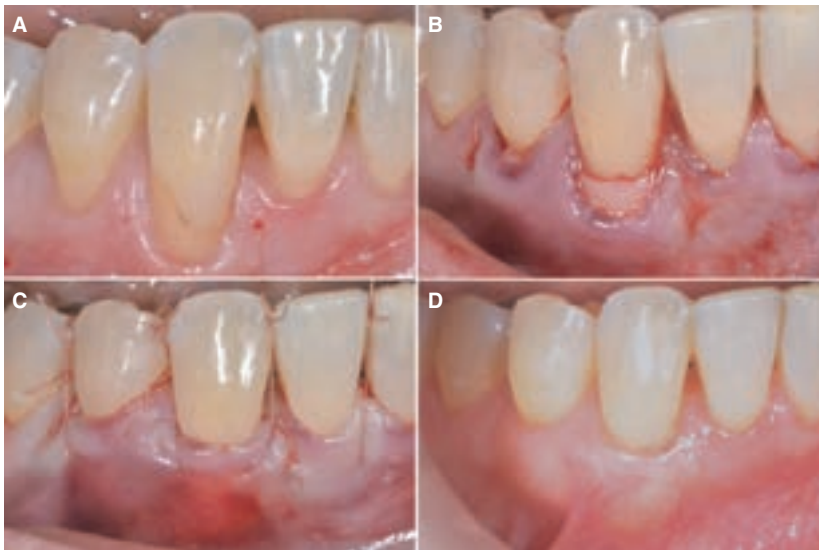


Fig. 5. NODE 2bis. Loss of interdental clinical attachment level with loss of interdental soft tissue. A modified coronally advanced tunnel technique is selected as surgical treatment for multiple gingival recession defects. (A) Baseline clinical situation in a patient affected by multiple gingival recession in the lower jaw associated with clinical attachment level loss with loss of interdental soft tissue. (B) Connective tissue graft placed under the tunnelized flap. (C) Coronally advanced tunnelized flap, suspended with the connective tissue graft completely submerged. (D) One-year clinical outcome showing complete root coverage.

exposed root (1, 42, 49). In fact, it is seen that when a buccally displaced root is moved lingually, under optimal plaque control, the gingival dimensions on the labial aspect increase both in the buccal-lingual and coronal-apical dimensions (20, 38). Once the buccal malposition has been corrected, the root coverage surgical technique is selected according to the baseline amount of keratinized tissue apical to the exposed root (see NODE 4).

However, sometimes orthodontic repositioning of the buccally displaced root cannot be performed for anatomic reasons, such as limited dimension of buccal-lingual bone, in which there is a risk of inducing lingual bone dehiscence or because the patient does

not wish to undergo orthodontic treatment. In these unfavorable cases, the first technique of choice is the coronally advanced flap + connective tissue graft, which should be performed with removal of the submucosal labial tissue (42) in order to render the root-coverage procedure more predictable. Nevertheless, in these cases, unesthetic graft exposure is highly likely. For these reasons, whenever possible in the presence of gingival recession associated with buccal displacement of the root(s), it is recommended to perform an orthodontic treatment before root-coverage surgery in order to improve complete root-coverage predictability and the final esthetic result.

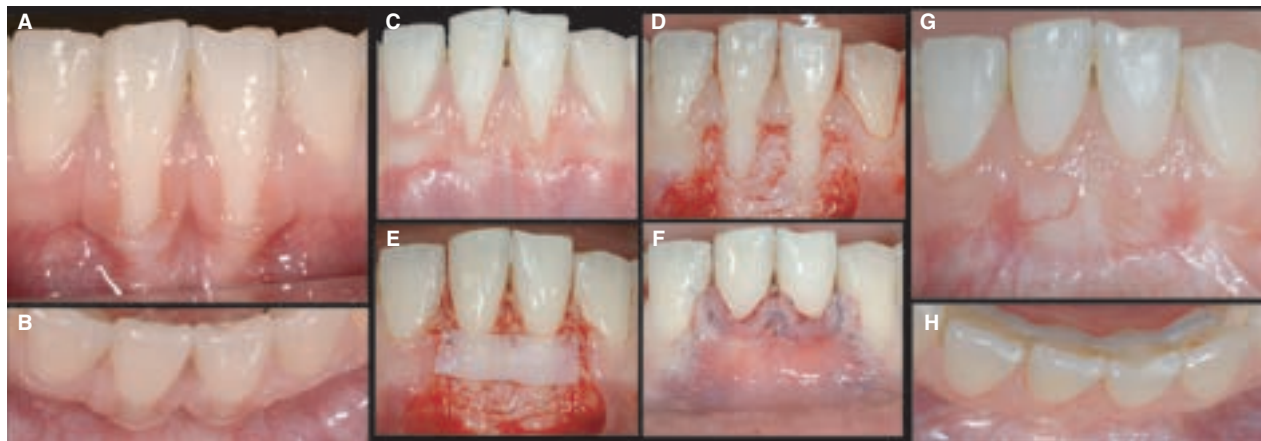


Fig. 6. NODE 3. Buccal malposition. Orthodontic repositioning and coronally advanced flap + connective tissue graft surgical treatment. (A) Recession defects associated with a buccal malposition. (B) Occlusal aspect showing buccal displacement of the exposed roots. (C) Post-orthodontic clinical situation: the recession defects are smaller and a remarkable increase in quantity and quality of keratinized tissues is noticeable apical and lateral to the root exposures. A coronally advanced flap + connective tissue graft technique is selected for the surgical treatment. (D) Root

exposures after flap elevation. (E) Suture of the connective tissue graft at the cemento-enamel junction. Note that the height of the connective tissue graft (4 mm) does not reach the buccal bone crest. The thickness of the connective tissue graft is less than 1 mm. (F) The coronally advanced flap covers in excess the connective tissue graft. (G) One-year clinical outcome showing complete root coverage. (H) Occlusal aspect showing the increase in soft-tissue thickness. The teeth previously affected by gingival recessions are well aligned with respect to the neighboring teeth.

An example of gingival recession defects associated with buccal displacement of the roots treated with orthodontic root repositioning followed by coronally advanced flap + connective tissue graft, is shown in Fig. 6.

NODE 4: keratinized tissue apical to the exposed root

In the absence (or after restorative treatment) of non-carious cervical lesions, interdental clinical attachment and soft-tissue loss, and in the absence (or after orthodontic treatment) of buccal displacement of the exposed root, selection of the root-coverage surgical procedure is mainly influenced by the baseline amount of keratinized tissue apical to the exposed root.

Very little data are available on the critical amount of remaining keratinized tissue, apical to the root exposure, necessary to provide stability of the coronally repositioned gingival margin in order to withstand the postsurgical inflammation and to facilitate patient plaque control. Clinical experience of the authors and a long-term case-series study (in press) in which 267 gingival recessions have been treated, suggest the use of the following criteria:

- Keratinized tissue height ≤ 1 mm. In this situation, the coronally advanced flap + connective tissue graft (Fig. 7) or the modified coronally

advanced tunnel (Fig. 8) are the techniques of choice. The rationale is to improve the stability and prevent shrinkage of the marginal tissue coronally advanced with the additional use of a dense and collagen-rich connective tissue graft. The lack, or minimal amount, of baseline keratinized tissue height makes exposure of unesthetic graft quite probable with both techniques. While the coronally advanced flap + connective tissue graft can be used for both single and multiple gingival recessions, the modified coronally advanced tunnel technique is indicated more for the treatment of multiple gingival recessions.

- Keratinized tissue height > 2 mm. In this situation the coronally advanced flap is the technique of choice. In fact, 3 mm of keratinized tissue can be considered adequate to be tightly and well adapted to the convexity of the crown; this will favor formation of blood clot and stabilization between the root surface and the coronally displaced soft tissue. Both of these factors are critical in preventing marginal soft-tissue shrinkage. Furthermore, 3 mm of keratinized tissue can be considered as adequate for effective patient plaque control and toothbrushing.

In the presence of keratinized tissue of 1 to ≤ 2 mm in height, gingival thickness has to be taken into consideration.



Fig. 7. NODE 4. Baseline amount of keratinized tissue apical to the root exposure. Coronally advanced flap for multiple gingival recession + site-specific connective tissue graft. (A) Frontal view of the same case shown in Fig. 1. Gingival recession affects teeth of the first quadrant. Non-carious cervical lesions are present at the buccal aspect of the canine and first premolar and molar. (B) After execution of composite restorations at the maximum root coverage level of the canine, first premolar and molar. (C) Coronally advanced flap for multiple gingival recession

defects is selected as the root coverage surgical procedure. The site-specific adjunct of connective tissue graft is related to the baseline amount of keratinized tissue. (D) Small (4 mm in height) and thin (< 1 mm in thickness) connective tissue grafts, applied at the maximum root coverage level, do not reach the buccal bone crest. (E) The coronally advanced flap covers in excess the connective tissue grafts. (F) One-year healing showing root coverage and increase in keratinized tissue height. For the increase in gingival thickness see Fig. 1C.



Fig. 8. NODE 4. Baseline amount of keratinized tissue apical to the root exposure. The modified coronally advanced tunnel technique is selected as surgical treatment for multiple gingival recession defects. (A) Frontal view showing the baseline clinical situation in a patient affected by

multiple gingival recession in the upper jaw. (B) Tunnelized coronally advanced flap stabilized with suspended sutures around the contact point. (C) Root coverage and increase in keratinized tissue height are shown after 2 years of healing.

NODE 4bis: gingival thickness

- Gingival thickness < 1 mm. In this situation, coronally advanced flap + connective tissue graft is the technique of choice. Based on Huang et al. (23) and Baldi et al. (7), the chance of achieving complete root coverage is positively related to gingival thickness. More recently (9), a randomized clinical trial conducted on 32 patients concluded that, at sites with gingival thickness ≤ 0.8 mm, coronally advanced flap + connective tissue graft resulted in better outcomes in terms of complete root coverage and recession reduction with

respect to coronally advanced flap alone. In this clinical situation (keratinized tissue of 1 to ≤ 2 mm in height and gingival thickness of < 1 mm) the keratinized tissue height apical to the exposed root, even if not adequate to perform the coronally advanced flap alone, provides enough stability to the gingival margin coronally displaced and thus reduces the risk of exposure of unesthetic graft. The adjunct use of connective tissue graft increases soft-tissue thickness and makes the long-term root-coverage outcome more predictable.

- Gingival thickness ≥ 1 mm. In this situation the coronally advanced flap is the technique of choice because there is no need to increase gingival thickness further by adding a connective tissue graft to the coronally advanced flap.

Conclusions

There is still a lack of studies evaluating the esthetic outcomes, beyond complete root coverage, of periodontal plastic procedures, despite esthetic concerns representing the main indication for the treatment of gingival recession. There is also a lack of studies comparing the esthetic outcome achieved using different surgical procedures. A decision-making process with esthetic outcome as the main goal of therapy has been suggested in the present study. Three main surgical procedures have been included: the coronally advanced flap; the coronally advanced flap + connective tissue graft; and the modified coronally advanced tunnel technique. The selection of the most suitable surgical technique should be performed in a step-by-step manner through the following nodes: presence of non-carious cervical lesions; presence of interdental clinical attachment level loss, with or without loss of interdental soft tissue; and presence of buccal displacement of the root (s). In the absence (or after treatment) of the clinical conditions described in these nodes the selection of the surgical procedure is influenced primarily by the baseline amount of keratinized tissue apical to the exposed root and secondarily by gingival thickness. The selection of the surgical technique, based on the patient's esthetic concern and a reproducible patient esthetic outcome assessment (taking into account complete root coverage and soft-tissue variables), should be introduced. This selection should also take into account the need to minimize patient morbidity.

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