

Criteria for the Selection of Root Coverage Procedures. Part 1: Intention, Indication, Methods

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A successful root coverage procedure requires a clearly defined intention. This is illustrated by a control circuit. This means that a controlled variable (therapy) remains directionless as long as the objective (treatment outcome) is not defined. Even though the diagnosis 'recession' is of major importance, it does not solely determine the medical necessity for a surgical intervention. There must be additional findings to ethically justify the surgical procedure. Therapy based on clinical findings is only possible when all evidence-based methods are mastered. The following review focuses on information on objectives, indications and procedures currently present in the literature.

Key words: root coverage, coronally advanced flap, lateral sliding flap, envelope technique, subepithelial connective tissue graft, guided tissue regeneration, enamel matrix derivative, platelet-rich plasma

INTRODUCTION

Methods for root coverage were described around fifty years ago (Grupe and Warren, 1956; Cohen and Ross, 1968). These almost always involved coronally or laterally positioned mucoperiosteal flaps which can be described as *single-layer techniques*. The publications by Raetzke (1985) as well as Langer and Langer (1985) were the first to describe *two-layer techniques*, in which the recession is not merely covered by the flap but additionally by a subepithelial connective tissue graft (CTG). This was a decisive turning point since greater predictability was achieved with this method.

The third group is *guided tissue regeneration* (GTR), which has been used to cover recessions since the 1990s (Tinti and Vincenti, 1990; Pino Prato et al, 1996).

Additional measures, such as chemical conditioning of the root surface or the use of biological me-

diators, may complement these three groups of techniques (Heinz et al, 1999; Bouchard et al, 2001; Sculean and Schwarz, 2004).

Coverage of recession defects is possible with all these methods, although the results achieved vary considerably. In a concrete individual case, this heterogeneity leads to great uncertainty about which method to select. Based on existing literature, this review therefore sets out to present information about the objectives, indications and different methods and to match them to treatments related to the individual patient and to clinical findings (see Part 2).

OBJECTIVES OF ROOT COVERAGE

The intention of root coverage is complete restoration of all anatomical structures in the area of recession. This is evident histologically as regenera-



Figs 1a and 1b Example of the clinical objectives of root coverage.



Fig 1a Pre-operative view of a medium-sized, wide Miller class III recession (Miller, 1985) at tooth 13 with early signs of abrasion and cervical caries.



Fig 1b Condition one year after root coverage with a free connective tissue graft and coronally advanced flap. The recession is completely covered, the keratinised gingiva is wide enough and is slightly lighter in colour than the local gingiva. Form and surface texture as well as the garland-shaped course of the marginal gingiva do not differ from that of the adjacent gingiva. Teeth 14 and 15 have since been fitted with galvano-ceramic crowns.

tion of the periodontal attachment with the formation of new cementum, periodontal ligament and bone. Clinically this is the aim of Miller (1985) and Harris (1994), as defined below (Fig 1):

- coverage of the recession up to the cemento-enamel junction
- probing depth < 2 mm
- no bleeding on probing
- wide enough keratinised gingiva (≥ 3 mm)
- smallest possible colour difference from the local gingiva
- physiological shape and surface of the gingiva in the former recession area.

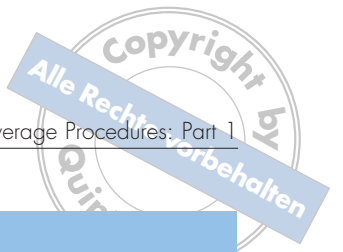
To date it has not been proved that a successful clinical outcome is always associated with regeneration. This is why the combination of regeneration and complete root coverage must be regarded as the ideal goal, but clinically complete or partial coverage with a long junctional epithelium or connective tissue attachment should be seen as a realistic goal.

INDICATIONS FOR ROOT COVERAGE

Coverage is only indicated when other findings exist in addition to the recession. This could be referred to as 'recession plus indication' (Erpenstein and Halben, 2004). These additional findings are usually:

- increased cervical sensitivity
- existing cervical caries/fillings
- abrasion in the cervical region
- wedge defects
- pre-prosthetic coverage to avoid over-extended crowns
- recurrent mucogingival defects (e.g. Stillman clefts, mucosal erosions)
- aesthetic impairment (objective and subjective).

As complete coverage can only be expected with Miller class I and II recessions, surgical treatment should be confined to these recessions (Miller, 1985) (Fig 2). Clinically they usually present inflammation-free, mainly facial loss of attachment without accompanying periodontitis. If, however, the marginal gingiva in the area of the recession is inflamed, supragingival and subgingival scaling



Figs 2a to 2d Classification of recessions according to Miller (1985).

Fig 2a Miller class I: short narrow and short wide recession without crossing the mucogingival border. Interdental bone and interdental gingiva are fully retained. Complete coverage is possible.

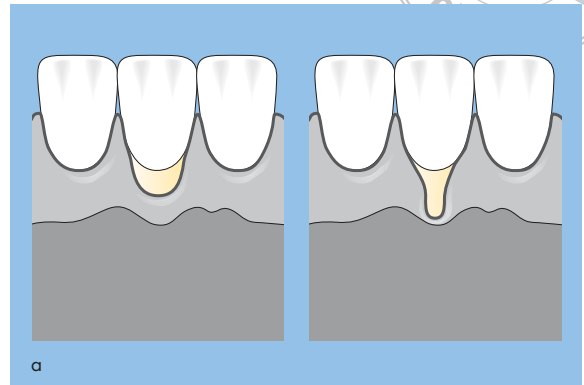


Fig 2b Miller class II: medium and long wide/narrow recession crossing the mucogingival border with the interdental bone and interdental gingiva fully retained. Complete coverage is possible.

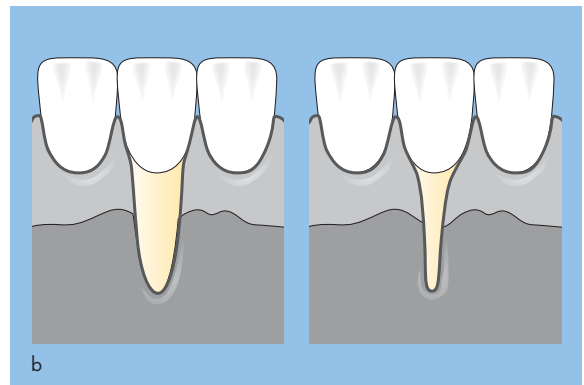


Fig 2c Miller class III: recessions as in classes I and II, but with partial loss of interdental gingiva and bone. Only partial coverage is possible (dotted line).

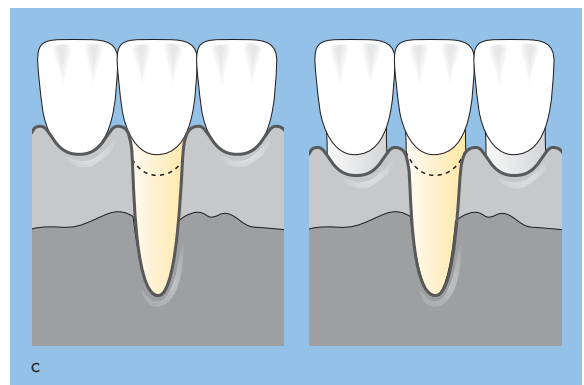
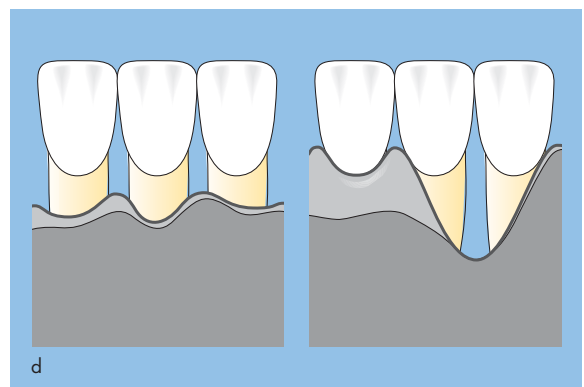


Fig 2d Miller class IV: recessions in cases of advanced horizontal and vertical bone destruction. Coverage is not possible.





is necessary prior to the procedure in order to ensure that the gingiva is inflammation-free at the time of surgery. Singular, multiple or, less commonly, generalised recessions may be encountered. The extent of the recession can be defined by measurements of length and width.

In terms of length (distance: cemento-enamel junction – zenith of marginal gingiva), recessions are classified as short/flat (< 3 mm), medium (3 to 5 mm) and long/deep (> 5 mm). The width of the recession is defined as the distance between the mesial and distal gingival margin level with the cemento-enamel junction. The treatment-relevant threshold is a width of ≥ 4 mm. In principle, the above-mentioned methods can be used for all these forms. However, singular and multiple class I and II recessions are the preferred indications and are the focus of the following review.

METHODS

Numerous methods of root coverage are available to clinicians. These have developed from the groups of methods outlined in the introduction, as a result of variations in the type of incision and flap advancement in combination with grafts and membranes (Table 1).

Mucoperiosteal Pedicle Flaps: Single-layer Techniques

Techniques in this group simply involve covering the recession with a mucoperiosteal flap, in other words, with a single layer. The precondition for application of single-layer methods is keratinised gingiva in the donor area that is thick enough and wide enough. According to Baldi et al (1999), a flap thickness of 0.8 mm is a critical threshold, below which only partial coverage can be expected. A coronally advanced flap, either in the form of a trapezoidal flap or a semilunar bi-pedicle flap, is most commonly used (Fig 3). Whereas several adjacent recessions can be covered with a trapezoidal flap, the semilunar flap is mostly used for singular, at best two adjacent recessions because of the apically interrupted vascular supply. The lateral sliding flap is less commonly used as a single-layer technique. It was presented in its original form by Grupe and Warren (1956). The prerequisite for this method is a sufficiently wide and thick gingiva on the adjacent tooth. The indication

is limited to singular recessions. A disadvantage of the lateral sliding flap with the original type of incision is the exposed harvesting site extending up to the marginal gingiva. As it heals via open granulation, renewed recession can occur in the harvested area. This disadvantage was confronted by Grupe (1966) and later by Zuccheli et al (2004) with a modified type of incision. Another disadvantage is the tension arising at the base of the flap when the flap is moved, although this can be avoided by a relieving incision (cut-back) (Bouchard et al, 2001) (Fig 4). The double lateral repositioned flap described by Cohen and Ross (1968) may be described as obsolete because the suture over the avascular root surface very often becomes dehiscent. The advantages of single-layer methods are a simple operative technique, good aesthetics and minimal strain on the patient in comparison with two-layer techniques.

Split Pedicle Flaps with Subepithelial Connective Tissue Graft: Two-layer Techniques

Two-layer techniques are characterised by the fact that a connective tissue graft is laid between the flaps (split flaps) and the root surface. This improves nutrition of the graft over the avascular root surface. Furthermore, it may be assumed that two-layer coverage of the root surface promotes wound stability, in other words mechanical effects acting on the flap surface do not influence adhesion of the fibrin clot to the root surface during the early phase of wound healing or less than with single-layer techniques (Wikeshj  and Nilveus, 1990; Haney et al, 1993). As a result, apical growth of the gingival epithelium, hence a long epithelial attachment, is prevented. The CTG can be harvested with or without a ridge of epithelium, although the latter method predominates.

The covering split flap most commonly takes the form of a coronally advanced flap (Langer and Langer, 1985) (Fig 5). Lateral sliding flaps (Nelson, 1987) or a double papilla flap (Harris, 1992) may also be used to cover the CTG (Figs 6 and 7). All these variants require one or more vertical incisions. Methods without vertical incision are the envelope technique (Raetzke, 1985) for short recessions (≥ 3 mm) and the extended envelope technique (Bruno, 1994) for medium recessions (3–5 mm), in which the horizontal incision is lengthened up to the adjacent teeth or beyond; in comparison with the original envelope technique,



Table 1 Methods of root coverage

Mucoperiosteal pedicle flap = single-layer technique
<ul style="list-style-type: none"> • rotational flap – lateral sliding flap – double papilla flap*
<ul style="list-style-type: none"> • coronally advanced flap – trapezoidal flap with vertical incisions – semilunar flap
Split pedicle flaps with subepithelial connective tissue graft = two-layer technique
• coronally advanced split flap + CTG
• laterally advanced split flap + CTG
• double papilla flap + CTG
• envelope technique + CTG
Guided tissue regeneration
• non-absorbable membranes
• bio-absorbable, prefabricated membranes
• bio-absorbable membranes produced at the chairside
Additional measures
• conditioning of the root surface (citric acid, tetracycline-HCl, EDTA)
• biological mediators (e.g. enamel matrix derivatives, platelet-rich plasma)

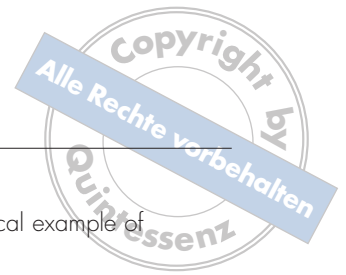
* = of historical interest only

this achieves greater flap mobility (Fig 8). As the size of the harvesting site has to be limited, the number of recessions that can be covered by two-layer techniques is restricted. The surgical technique is demanding and the strain on the patient is greater than with a single-layer method because of graft harvesting from a second operation site (hard palate).

Guided Tissue Regeneration

This method involves interposing a membrane (bio-absorbable, non-absorbable) between the mucoperiosteal flap and the root surface, fixing it with sutures or nails and completely covering it with the flap.

Accordingly the characteristics of GTR correlate with better wound stability in comparison with the single-layer technique. The space which needs to be maintained between the root surface and the membrane for guided tissue regeneration can only be guaranteed with a titanium-reinforced membrane (Gore-Tex®). The bio-absorbable membranes commercially available at present do not guarantee that this space is maintained. Nevertheless, partial or complete coverage results, associated with regeneration, have been reported with this type of membrane (Vincenzi et al, 1998). The membrane is always covered with a coronally advanced flap. The technique is a difficult operation to perform, like the connective tissue graft.



Figs 3a to 3f Clinical example of a semilunar flap.

Fig 3a Pre-operative view with Miller class I/II, short and wide recessions at the central incisors. The teeth are fitted with old all-ceramic crowns which are to be replaced. Before root coverage, the teeth are fitted with laboratory-made interim crowns.



Fig 3b Incision parallel to the course of the marginal gingiva at a distance of approx. 6 mm within the keratinised gingiva. The flap must not be too narrow as that would jeopardise the lateral vascular supply. After a second marginal incision, sharp/blunt separation of the mucoperiosteal flap takes place.



Fig 3c Apical advancement of the flap up to the margin of the interim crowns. Suturing in this position by interdental stitches and tied-off sutures. The operation field is covered with a tooth-coloured dressing (Barricaid®) until the first check-up after 9–10 days.



Fig 3d Ten days after the surgical procedure, a well-perfused operation area with active granulation in the harvesting area can be seen. No further treatment is required after removal of the stitches.

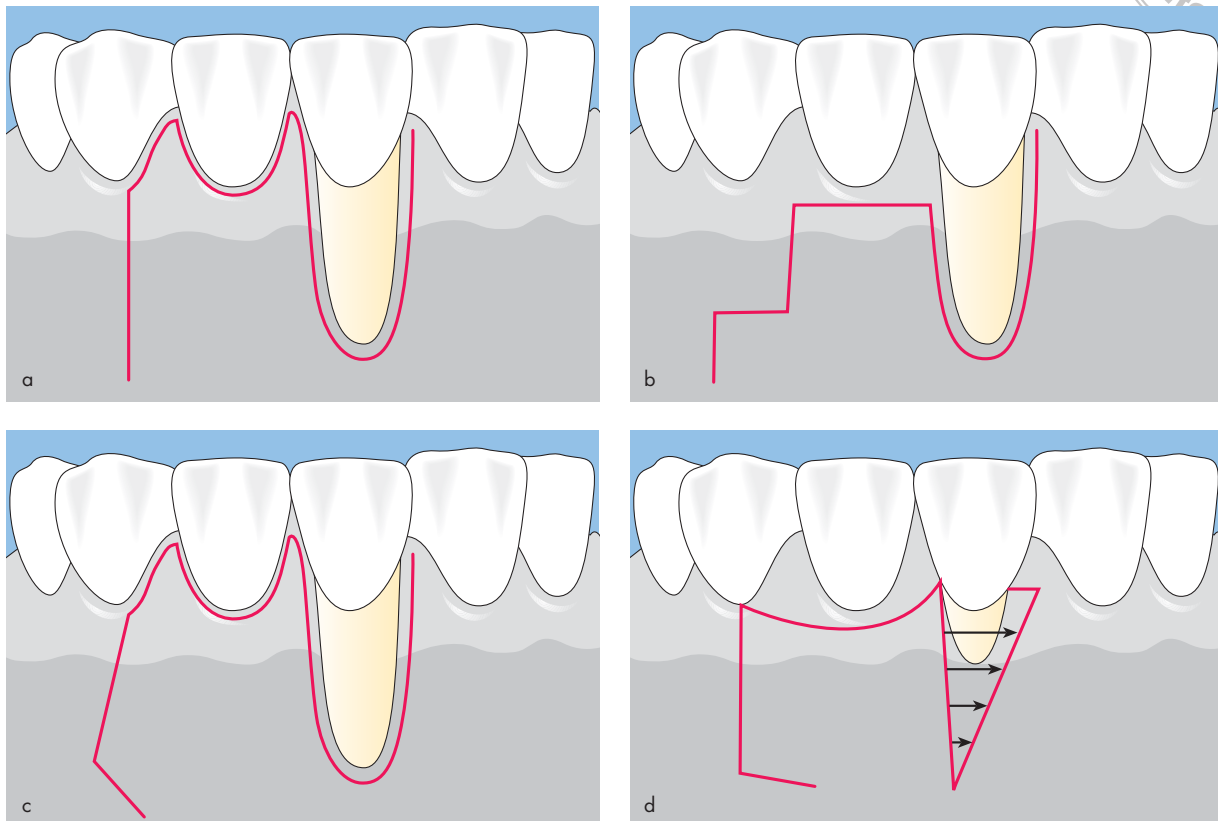


Fig 3e After final restoration with galvano crowns, a harmonious course of the marginal gingiva can be seen in the whole area of the upper anteriors.



Fig 3f After five years, there is a slight local recurrence, so that the metallic edge of the galvano crown on tooth 11 is just visible. Overall, the aesthetic result is still acceptable.





Figs 4a to 4d Diagram of the original and the modified incision method for lateral sliding flaps.

a Original incision according to Grupe and Warren (1956).

b Modified incision path to protect the marginal gingiva, as described by Grupe (1966).

c Incision path with relieving incision (cut-back), as described by Corn (1964).

d Modified incision path to protect the marginal gingiva, as described by Zuccheli et al (2004).

When a non-absorbable membrane is used, this has to be removed in a second operation after about six weeks. This is why absorbable membranes, which do not require removal and hence are less stressful for patients, have become increasingly accepted. Several adjacent recession defects can be treated at the same time by the GTR technique.

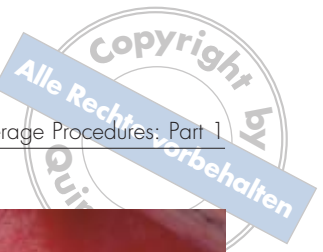
Additional Measures

Attempts are constantly being made, particularly with single-layer techniques, to improve the results by the additional use of a wide variety of substances.

Most commonly to date, efforts have been made to enhance the outcome by conditioning the root surface. The citric acid or tetracycline-HCl used for this purpose lead to decalcification of the root sur-

face and hence to exposure of the collagen fibrils, to bacterial decontamination and elimination of smear layers. The aim is to slow down epithelial growth and promote connective tissue attachment. It has not yet been proved, however, that these measures do improve the clinical outcome (Wennström, 1996; Trombelli, 1999; Bouchard et al, 2001).

Enamel matrix derivatives (EMD) are used because they are proven to promote regeneration by contributing to the formation of acellular cementum, promoting the proliferation of periodontal ligament fibroblasts and inhibiting deep epithelial growth. Furthermore, they are supposed to have osteopromotive and antibacterial properties (Sculean and Schwarz, 2004). In the treatment of recessions, there has not yet been any clear evidence that EMGs have a positive effect when combined with



Figs 5a to 5f Example of the two-layer technique with a connective tissue graft and a coronally advanced flap according to Langer and Langer (1985).



Fig 5a Pre-operative view of a short and wide Miller class II recession. The band of keratinised gingiva is greatly reduced with a residual width of around 1 mm.

Fig 5b After horizontal and vertical incision, the split flap is mobilized beyond the mucogingival border.



Fig 5c The connective tissue graft with epithelial bridge is fixed with interdental sutures level with the cemento-enamel junction.





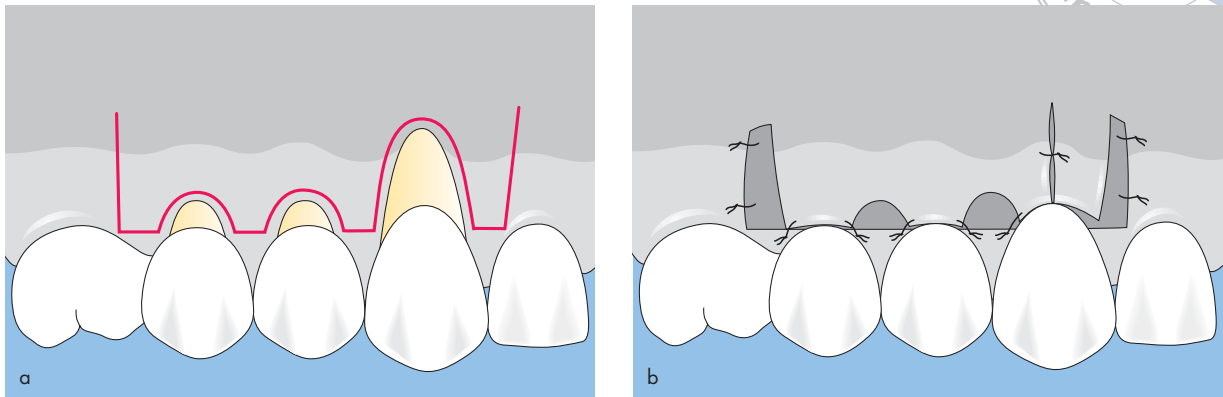
Fig 5d Roughly seven-eighths of the graft are covered by the split flap, so that optimal nutrition is guaranteed.



Fig 5e One week postoperatively, a well-perfused operation field can be seen. The surface layers of the ridge of epithelium are noticeable as a white coating that can be wiped off.



Fig 5f Three months postoperatively the recession is completely covered. The aesthetics are satisfactory because the colour and surface texture of the gingiva over the recession do not differ from that of the local, adjacent gingiva.



Figs 6a and 6b Lateral sliding flap as described by Nelson (1987).

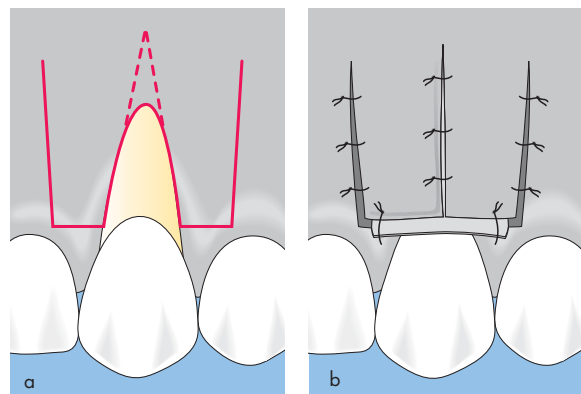
a Incision path.

b Lateral displacement of the flap to cover the underlying connective tissue graft. The distal and mesial harvesting areas cannot be entirely covered.

Figs 7a and 7b Double papilla flap as described by Harris (1992).

a Incision path. In the fornix of the recession, a wedge-shaped excision is required in order to prevent the wound edges from curling up.

b The flaps moved to the middle of the recession cover the connective tissue graft. The harvesting sites can be partly covered because of the elasticity of the flaps.



other methods (e.g. mucoperiosteal flaps, CTG) (Modica et al, 2000; Berlucci et al, 2002; Hägewald et al, 2002; McGuire and Nunn, 2003; Nemcovsky et al, 2004; Trabulsi et al, 2004).

Platelet-rich plasma (PRP) contains a large number of chemical substances and biological mediators which have a beneficial effect on wound healing. In particular, various growth factors, such as transforming growth factor β (TGF- β), insulin-like growth factor (IGF) and platelet-derived growth factor (PDGF) support angiogenesis and speed up osteoblast and fibroblast proliferation (Weibruch et al, 2003; Wolf et al, 2003; Diedrich, 2004). In a randomised clinical trial, Cheung and Griffin (2004) examined the question of whether PRP has

an influence on the outcome of root coverage (Miller class I and II). In the test group the recessions were covered with a collagen sponge impregnated with PRP (Collacote, Integra LifeSciences Co., Plainsboro, NJ, USA) and a mucoperiosteal flap, while the control group was treated by the typical CTG method. After eight months, there was no statistically significant difference between the two groups either in terms of average coverage (PRP group, 80%; CTG group, 95%) or in the percentage with complete coverage (PRP group, 60%; CTG group, 65.5%). Similarly, no statistically significant differences were found in respect of attachment gain and the pre/postoperative width of the keratinised gingiva. The aesthetic results were better in the PRP group than in the CTG group.



Figs 8a to 8f Example of the two-layer technique with a connective tissue graft and the extended envelope technique described by Bruno (1994).

Fig 8a Pre-operative view of a medium, wide Miller class II recession at tooth 13. Because of the keratinised gingiva apical to the recession, which is about 4 mm wide, the single-layer technique with a coronally advanced mucoperiosteal flap would also have been possible as differential treatment.



Fig 8b Before root coverage, teeth 14-16 are fitted with laboratory-made interim crowns.



Fig 8c Horizontal incision path extended, at the same time dispensing with vertical relieving incisions.

Fig 8d Adapting the connective tissue graft, which covers the recession up to the cemento-enamel junction.



Fig 8e As a result of the extended horizontal incision, the split flap can be advanced so far coronally that the graft is completely covered and thus nutrition of the site can be fully assured.



Fig 8f Three years after the surgical procedure, the recession is completely covered. The aesthetic result is satisfactory. Teeth 14-16 are fitted with a VMK bridge.





REFERENCES

- Baldi C, Pini-Prato G, Pagliaro U, Nieri M, Saletta D, Muzzi L, Cortellini P. Coronally advanced flap procedure for root coverage. Is flap thickness a relevant predictor to achieve root coverage? A 19-case series. *J Periodontol* 1999;70:1077–1084.
- Berlucchi I, Francetti L, Del Fabbro M, Testori T, Weinstein RL. Enamel matrix proteins (Emdogain) in combination with coronally advanced flap or subepithelial connective tissue graft in the treatment of shallow gingival recessions. *Int J Periodontics Restorative Dent* 2002;22:583–593.
- Bouchard P, Malet J, Borghetti A. Decision-making in aesthetics: root coverage revisited. *Periodontology* 2000 2001;27:97–120.
- Bruno JF. Connective tissue graft technique assuring wide root coverage. *Int J Periodontics Restorative Dent* 1994;14:126–137.
- Cheung WS, Griffin TJ. A comparative study of root coverage with connective tissue and platelet concentrate grafts: 8-month results. *J Periodontol* 2004;75:1678–1687.
- Cohen DW, Ross SE. The double papilla repositioned flap in periodontal therapy. *J Periodontol* 1968;39:65–70.
- Corn H. Edentulous area pedicle grafts in mucogingival surgery. *Periodontics* 1964;2:229–242.
- Diedrich P: Parodontale Wundheilung und Regeneration. In: Erpenstein H, Diedrich P (Eds.): *Atlas der Parodontalchirurgie*, Elsevier, Urban & Fischer, München 2004.
- Erpenstein H, Halben JH. Freies Bindegewebsstransplantat zur Rezessionsdeckung. In: Erpenstein H, Diedrich P (Eds.): *Atlas der Parodontalchirurgie*, Elsevier, Urban & Fischer, München 2004.
- Grupe H. Modified technique for the sliding flap operation. *J Periodontol* 1966;37:491.
- Grupe HE, Warren RF. Repair of gingival defects by a sliding flap operation. *J Periodontol* 1956;27:92–99.
- Hägewald S, Spahr A, Rompolo E, Haller B, Heijl L, Bernimoulin J-P. Comparative study of Emdogain® and coronally advanced flap technique in the treatment of human gingival recessions. A prospective controlled clinical study. *J Clin Periodontol* 2002;29:35–41.
- Haney JM, Nilveus RE, McMillan PJ, Wikesjö UME. Periodontal repair in dogs: Expanded polytetrafluorethylen barrier membranes support wound stabilization and enhance bone regeneration. *J Periodontol* 1993; 64:883–890.
- Harris RJ. The connective tissue and partial thickness double pedicle graft: a predictable method of obtaining root coverage. *J Periodontol* 1992;63:477–486.
- Harris RJ. The connective tissue with partial thickness double pedicle graft: The results of 100 consecutively treated defects. *J Periodontol* 1994;65:448–461.
- Heinz B, Jepsen K, Arjomand M, Jepsen S. Enamel matrix derivate in the treatment of periodontal recession defects. *J Periodontol* 1999;70:235–236.
- Langer B, Langer L. Subepithelial connective tissue graft technique for root coverage. *J Periodontol* 1985;56:715–720.
- McGuire M, Nunn M. Evaluation of human recession defects treated with coronally advanced flaps and either enamel matrix derivate or connective tissue. Part 1: Comparison of clinical parameters. *J Periodontol* 2003;74:1110–1125.
- Miller PD. A classification of marginal tissue recession. *Int J Periodontics Restorative Dent* 1985;5:8–14.
- Modica F, Del Pizzo M, Rocuzzo M, Romagnoli R. Coronally advanced flap for the treatment of buccal gingival recessions with and without enamel matrix derivate. *J Periodontol* 2000;71:1693–1698.
- Nelson SW. The subpedicle connective tissue graft. A bilaminar reconstructive procedure for the coverage of denuded root surfaces. *J Periodontol* 1987;58:95–102.
- Nemcovsky CE, Artzi Z, Tal H, Kozlovsky A, Moses O. A multicenter comparative study of two root coverage procedures: Coronally advanced flap with addition of enamel matrix proteins and subpedicle connective tissue graft. *J Periodontol* 2004;75:600–607.
- Pini Prato G, Clauser C, Cortellini P, Tinti C, Vincenti G, Pagliaro U. Guided tissue regeneration versus mucogingival surgery in the treatment of human buccal recessions. A 4-year follow-up study. *J Periodontol* 1996;67:1216–1223.
- Raetzke PB. Covering localized areas of root exposure employing the “envelope” technique. *J Periodontol* 1985; 56:397–402.
- Sculean A, Schwarz F. Einsatz von Schmelz-Matrix-Proteinen in der regenerativen Parodontaltherapie: Welche Anwendungen sind evidenzbasiert? *Z Zahnärztl Implantol* 2004;20:36–42.
- Tinti C, Vincenti G. The treatment of gingival recession with “guided tissue regeneration” procedures by means of Gore-Tex membranes. *Quintessenz Int* 1990;6:465–468.
- Trabulsi M, Oh TJ, Eber R, Weber D, Wang HL. Effect of enamel matrix derivate on collagen guided tissue regeneration-based root coverage procedure. *J Periodontol* 2004;75:1446–1457.
- Trombelli L. Periodontal regeneration in gingival recession defects. *Periodontology* 2000 1999;19:138–150.
- Vincenzi G, De Chiesa A, Trisi P. GTR using a resorbable membrane in gingival recession type defects: A histologic case report in humans. *Int J Periodontics Restorative Dent* 1998;18:25–33.
- Weibrich G, Kleis W, Wagner W. Platelet-rich Plasma (Thrombozytenkonzentrate) in der präprothetischen Chirurgie und Implantologie – eine aktuelle Literaturübersicht. *Z Zahnärztl Implantol* 2003;19:168–174.
- Wennström JL. Mucogingival therapy. *Ann Periodontol* 1996;1:671–701.
- Wikesjö UME, Nilveus R. Periodontal repair in dogs: Effect of wound stabilization on healing. *J Periodontol* 1990;61:719–724.
- Wolf HF, Rateitschak KH, Rateitschak EM: *Farbatlanten der Zahnmedizin*. Band 1: Parodontologie, Thieme, Stuttgart 2003, S. 351.
- Zucchelli G, Cesari C, Amore C, Montebugnoli L, De Sanctis M. Laterally moved, coronally advanced flap: a modified surgical approach for isolated recession-type defects. *J Periodontol* 2004;75:1734–1741.

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