

# Criteria for the Selection of Root Coverage Procedures. Part 2: Patient Factors, Defect Factors, Predictability of Coverage, Nature of Post-Operative Attachment

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The variety of root coverage procedures, the variability of recession anatomy, including the adjoining tissues, high expectations of aesthetically demanding patients and the elective nature of the surgical procedure pose great challenges with regard to therapeutically establishing the indication as well as risk assessment of the planned intervention. The aim of this review is to reveal and evaluate crucial factors that enable the clinician to select the most suitable procedure.

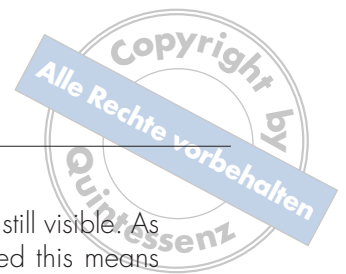
**Key words:** aesthetics, coronally advanced flap, enamel matrix derivative, envelope technique, guided tissue regeneration, lateral sliding flap, root coverage, smoking, subepithelial connective tissue graft

## INTRODUCTION

Extensive data are available for the various methods of root coverage in the form of controlled randomised trials and case studies (Roccuzzo et al, 2002). However, these studies are largely confined to the extent of coverage that can be achieved with the particular method. This fails to take account of all the criteria that influence method selection. This might explain the heterogeneity of the results both between the different forms of treatment and within the same treatment groups. All in all, method selection must take into consideration the following factors or groups of factors:

- Patient factors
  - aesthetics
  - smoking
  - compliance
- Defect factors
  - length of the recession
  - width of the recession
  - width and thickness of the keratinised gingiva apical to the recession
- Predictability of coverage
  - average coverage
  - percentage proportion of complete coverage
- Nature of the post-operative attachment
  - regeneration
  - repair.

This list does not follow any order of priority. Instead, the above factors carry different weights, depending on the clinical findings.



## PATIENT FACTORS

In cases requiring root coverage it is particularly important to recognise patients' concerns and thus their 'expectation profile' in relation to treatment, then correctly assess the risks of surgical treatment in view of that expectation profile. This also has forensic relevance because all these procedures involve an elective operation. This means an intervention to which there are alternatives – including the alternative of non-treatment – and the timing of which can be decided by the patient without any risk of a substantial deterioration. This article describes significant factors in this context.

### Aesthetics

Dissatisfaction with oral aesthetics may cause the patient to have root coverage carried out. Objectively, teeth 15–25 may be affected. An essential consideration is the course of the smile line, which can be divided into four different grades (low, medium, high, very high) (Jensen et al, 1999). The interdental gingiva and the gingival margin are only visible when the smile line is high or very high. In a study by Jensen et al (1999) involving subjects of Caucasian origin, a high or very high smile line was found in 33% of women aged 35 years and under and in 25% of men aged 35 years and under. This figure was 25% for men and women from all age groups (Fig 1). This study dealt with a numerically highly relevant group of patients. As well as these patients, there were also those who, irrespective of visibility and hence highly subjectively, felt that recessions impaired their appearance.

Criteria that determine the aesthetic outcome are:

- extent of the coverage
- colour of the gingiva in the former recession area compared with the adjoining local gingiva
- form of the gingiva, particularly the thickness of the tissue compared with the adjacent local gingiva
- texture, in other words the surface quality of the gingiva over the former recession
- garland-shaped path of the marginal gingiva.

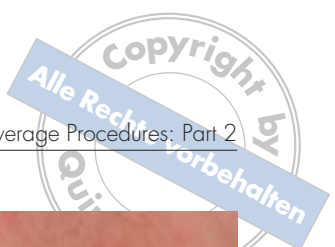
Complete coverage of the recession is the most important aesthetic criterion. Partial coverage, for example 80%, which may be judged entirely successful by the clinician, will not satisfy patients who often have high aesthetic expectations, because the

most coronal part of the recession is still visible. As far as method selection is concerned this means that, as far as possible, techniques should be chosen that promise a high probability of complete coverage.

The criteria 'colour', 'form' and 'surface texture' are most likely to be achieved with single-layer methods (coronal advancement or lateral sliding flaps) because only local tissue is used for coverage. The same may also be assumed for the guided tissue regeneration (GTR) technique in which the membrane is covered by the coronally advanced flap, hence local tissue is again used. However, optimal aesthetics are impaired by the uncertainty of complete coverage with both these groups of techniques.

Complete coverage is most likely to be guaranteed by the connective tissue graft (CTG) technique and hence the most important aesthetic criterion is met. However, not infrequently the colour, form and surface texture will differ from that of the adjacent gingiva because the tissue was harvested and grafted from elsewhere (hard palate). These differences can be influenced but not always completely eliminated by covering the graft with a localised split flap. The colour often appears slightly lighter than the surrounding gingiva (Fig 2). The form is often more raised and bulging in comparison with the local gingiva. The surface texture can be uneven if the grafted tissue is too thick (>1.5 mm) (Fig 3). If the CTG is not completely covered by the flap, the border between flap edge and CTG may be visible as a retracted horizontal line (Vergara and Caffesse, 2004). The fact that these side-effects are not fundamental defects of the CTG technique was demonstrated by Zucchelli et al (2003) with a modified CTG technique, in which the graft thickness was  $\geq 1$  mm and the later gingival margin was not formed by the graft but by the keratinised border of the covering split flap. Assuming optimal surgical technique, the CTG method may therefore be regarded as the method of choice, from the aesthetic point of view, for medium-sized and long recessions (Fig 4).

The garland-like path of the marginal gingiva depends on the surface of the root or that of the coronally adjacent enamel areas. If these form a convex bulge outwards, the marginal gingiva will follow a garland-like path. However, if there are abrasions in the enamel area close to the gingiva, for example, the convex path of the surface is



**Fig 1a** Medium to high smile line in a 35-year-old patient with Miller class I recessions on all the anteriors. The necessary re-crowning makes coverage of the recessions absolutely essential.

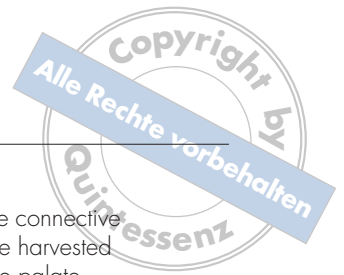


**Fig 1b** The intraoral view shows a keratinised gingiva that is still wide enough but not very thick. For this reason, coverage with a CTG and a coronally advanced flap was planned. Laboratory-made interim crowns were inserted beforehand.



**Fig 1c** The teeth were prepared for interim crowns in order to establish roughly the eventual crown length. This was followed by preparation of a split flap from tooth 14 to 24.





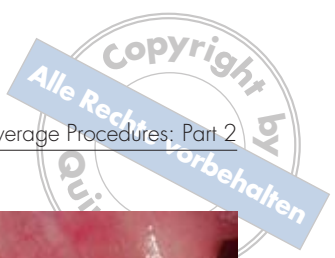
**Fig 1d** Adapting the connective tissue grafts that were harvested from both sides of the palate.



**Fig 1e** Almost complete (seven-eighths) coverage of the CTG by the coronally advanced split flaps. Treatment of teeth 12 to 22 with interim crowns prepared in the laboratory pre-operatively.



**Fig 1f** Eight months post-operatively, restoration with all-ceramic, adhesively bonded crowns. The gingival zenith of the canines and the central incisors is virtually at the same height, that of the lateral incisors slightly below that. The gingiva shows good aesthetics in terms of colour, form, surface texture and garland-type course.



**Fig 2a** Miller class I wide and middle-sized recession with a residual band of approximately 1 mm keratinised gingiva. In order to achieve widening of the gingiva as well as coverage, it was planned to perform a CTG by the extended envelope technique described by Bruno (1994).



**Fig 2b** The coronally advanced split flap covers around seven-eighths of the graft without tension.



**Fig 2c** Seven weeks after the surgical procedure, the recession is completely covered, but the tissue is still bulging and uneven. The edge between the split flap and the interdental gingiva left is still clearly visible as a horizontal line drawn inwards.





**Fig 2d** Seven years post-operatively the coverage has remained stable. The form has adapted to the local gingiva. However, the surface does not display the stippling of the adjacent, local gingiva; in particular, the colour is lighter than that of the adjacent gingiva.



**Fig 3a** Short and wide Miller class I recession at tooth 21. The treatment involved a CTG and the extended envelope technique described by Bruno (1994).



**Fig 3b** Three years after the surgical operation, the recession is completely covered. The gingiva is clearly widened, but raised and lighter than the surrounding local gingiva. The gingiva over the recession also displays an irregular surface texture with lacuna-type depressions.

**Fig 4a** Wide and medium-sized recession at bridge abutment 21 with a residual band of approximately 1.5 mm of keratinised gingiva. The necessary renewal of the bridge makes root coverage necessary prior to prosthetic work. Coverage was provided using a CTG.



**Fig 4b** One year after prosthetic treatment, the result is aesthetically satisfactory. The gingiva over the former recession cannot be distinguished from the local gingiva in terms of colour, form and surface texture. The zenith of the marginal gingiva lies in the distal third of the crown, as on the non-crowned contralateral incisor. The result could have been further improved by horizontal soft tissue augmentation in the region of bridge unit 22.



interrupted and the course of the marginal gingiva is correspondingly irregular. In such cases, the abrasions have to be built up by the adhesive technique so that a convex surface results which spontaneously fits the path of the marginal gingiva (Fig 5).

### Smoking

It is sufficiently well known that smoking should be regarded as a risk factor for surgical treatment (Rivera-Hidalgo, 2003). However, the reports in the literature are conflicting with regard to the results of root coverage. Comparing the flap operation (mucoperiosteal flap) alone with the flap operation using bio-absorbable membranes, Amarante et al (2000) found no difference

between smokers ( $\geq 20$  cigarettes a day) and non-smokers. A study by Harris (1992) using CTGs also found no difference in average root coverage between smokers and non-smokers (smokers: 98.5% vs. non-smokers: 97.6%). By contrast, Zucchelli et al (1998) found a significantly negative influence on the coverage outcome of both the GTR and the CTG techniques in subjects who smoked more than ten cigarettes a day. Using the CTG technique, Martins et al (2004) also established a significantly negative effect on the average coverage achieved in smokers ( $\geq 20$  cigarettes/day for at least five years) after four months (smokers: 58.84% vs. non-smokers: 74.73%). This coincides with results reported by Trombelli and Scabbia (1997),



**Fig 5a** Wide and medium-sized Miller class I recession with additional root caries and wedge defect extending into the enamel. Owing to the reduced keratinised gingiva apical to the recession, a CTG by the extended envelope technique of Bruno (1994) was planned.



**Fig 5b** Two years post-operatively the recession in the former root area is approximately 90% covered. The keratinised gingiva was widened by about 400%. Owing to the wedge defect still present, the garland-type path of the marginal gingiva is disrupted.



**Fig 5c** After build-up of the wedge defect with composite filling, a regular path of the marginal gingiva can be achieved.



**Fig 5d** The lip view with a high smile line is aesthetically acceptable.



who found significant differences in average root coverage by the GTR technique in favour of non-smokers (non-smokers: 78% vs. smokers: 57%). However, the same research group (Scabbia and Trombelli, 1998) did not find any significant difference between smokers ( $\geq 10$  cigarettes/day) and non-smokers in terms of long-term stability (six months to four years post-operatively).

Although the results tend to be worse for smokers than non-smokers, it cannot be deduced from existing studies that root coverage is contraindicated for smokers. These studies also do not suggest that any specific method is more affected by the factor of 'smoking' than any other. Therefore, smoking cannot be seen as a deciding criterion when selecting the method.

### Compliance

In the context of root coverage, compliance relates less to plaque control and more to patients switching to an atraumatic cleaning technique. This is assumed to be a decisive factor in the long-term stability of any root coverage treatment, although this hypothesis has not yet been substantiated by relevant studies (Wennström and Zucchelli, 1996). Indirectly this connection emerges from the observation that Miller class I and II recessions are found commonly in subjects with a high level of oral hygiene, who brush several times a day and use hard toothbrushes (Löe et al, 1992; Khocht et al, 1993; Serino et al, 1994; Vehkalahti, 1998). As

the switch to an atraumatic cleaning technique is not always entirely successful, preference should be given to methods by which an adequately wide and thick keratinised gingiva can be achieved, which is more resistant to traumatic influences (Fig 6).

### DEFECT FACTORS

The following defect factors are relevant to method selection for Miller class I/II recessions:

1. length of the recession,
2. width of the recession,
3. width and thickness of the keratinised gingiva.

Other defect factors, such as probing depth and bleeding on probing, may be ignored because in all studies they have not been found to be of any pathological value and there are no appreciable changes between the pre-operative and final findings.

#### Length of recession

Depending on the length of the recession (distance: cemento-enamel junction to gingival margin), recessions can be classified as short/flat ( $< 3$  mm), medium (3–5 mm) and long/deep ( $> 5$  mm). Based on the requirement that the recession must be covered by the flap up to the cemento-enamel junction with both single-layer and two-layer techniques, the coronally advanced flap (mucoperiosteal flap) or



**Fig 6a** Recurrent cleaning lesion in region 23 and 24 (arrow) with multiple Miller class I recessions in this area and very narrow keratinised gingiva.

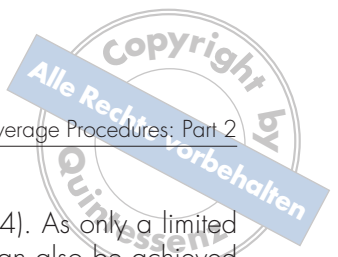


**Fig 6b** The treatment was performed with a CTG and the envelope technique as described by Bruno (1994). The recessions 21 to 24 were completely covered. At the same time, the keratinised gingiva was markedly widened and thickened. No further cleaning lesions appeared during an observation period of five years.

semilunar technique is suitable for flat recessions with a wide enough keratinised gingiva. If the keratinised gingiva is too narrow or absent while the recession is flat, the coronally advanced flap (split flap) or the envelope technique is indicated, each with a CTG. For medium-sized recessions, greater coronal advancement of the flap must be carried out. This can be achieved, in the same way as with short recessions, by means of a coronally advanced flap (mucoperiosteal flap) if a periosteal slit is made at the base of the flap. However, a wide enough keratinised gingiva apical to the recession is required. If the keratinised gingiva is narrow or absent, only the two-layer technique can be used in such cases in the form of the extended envelope technique

(Bruno, 1994) or the coronally advanced flap, each with a CTG (Langer and Langer, 1985). Long recessions cannot be covered by a coronal advancement alone, which means that lateral sliding flaps either in one layer or, more often, in two layers (i.e. with a CTG) are the method of choice (Grupe and Warren, 1956; Nelson, 1987; Harris, 1992; Zucchelli et al, 2004).

Membrane methods (GTR) can be employed for short and medium recessions because the membranes can be completely covered by the coronally advanced flap (mucoperiosteal flap). Membrane techniques are contraindicated for long recessions because complete membrane coverage by the coronally advanced flap is not usually successful.



### Width of recession

The width of the recession is defined as the distance between mesial and distal gingival margin level with the cemento-enamel junction. This defect factor only becomes important when selecting the method if the width is  $\geq 4$  mm and is combined with a long recession. In such a situation, the use of single-layer methods, such as a lateral sliding flap, is made difficult for two reasons (Grube and Warren, 1956; Zucchelli et al, 2004): first, the bone at the harvesting site is greatly exposed because of the larger flap width required; secondly, the flap often cannot cover the whole width of the recession without tension. Membrane techniques (GTR) are also contraindicated because the recession cannot be bridged by regeneration tissue throughout its width. Trombelli et al (1995), using expanded polytetrafluoroethylene membranes (Gore-Tex®), show that the extent of coverage and the attachment gain decrease as the width of the recession increases. For long, and at the same time wide ( $\geq 4$  mm), singular recessions, a double papilla flap with CTG is therefore the method of choice (Harris, 1992) (Fig 7). The lateral sliding flap described by Nelson (1987) is indicated for multiple recessions of this kind.

### Width and thickness of keratinised gingiva

These two criteria affect the gingiva apical to the recession but also the gingiva surrounding the teeth adjacent to the recession. The width and thickness apical to the recession has greater relevance because a coronally advanced flap is most commonly used with both the CTG and GTR techniques. In nearly all the studies on root coverage, only the width is considered out of the two criteria 'width' and 'thickness'. This is justifiable in that the thickness of the keratinised gingiva correlates with the width (Olsson et al, 1993; Eger et al, 1996). An average width of 3–5 mm and a thickness of between 0.8 and 1.5 mm is given for healthy subjects (Eger et al, 1996).

Where the keratinised gingiva is sufficiently wide ( $\geq 3$  mm), the coronally advanced flap (mucoperiosteal flap) is the method of choice for short and medium recessions. If the gingiva apical to the recession is too narrow, a coronally advanced mucoperiosteal flap, in other words the single-layer method, is contraindicated because this is associated with only a slight gain and often even a loss of keratinised gingiva (Amarante et al, 2000; Trombelli et al, 1996; Wennström and Zucchelli, 1996; Modica et al, 2000; Carvalho da Silva et

al, 2004; Cueva et al, 2004). As only a limited gain in keratinised gingiva can also be achieved with the GTR technique (Roccuzzo and Buser, 1996; Scabbia and Trombelli, 1998; Tatakis and Trombelli, 2000; Al-Hamdan et al, 2003; Trabulsi et al, 2004), the indication for this method is similarly limited if the gingiva apical to the recession is narrow. In these cases, the CTG technique is the method of choice. It always brings about considerable widening of the keratinised gingiva.

In the meta-analysis by Al-Hamdan et al (2003), widening of 116% was achieved with the CTG method, but only 61% with the GTR technique. Similar differences were revealed by the studies assessed in the review study by Roccuzzo et al (2002) (Table 1).

The thickness of the gingiva has only been measured separately in a few studies on root coverage (Müller et al, 1998; Baldi et al, 1999; Carvalho da Silva et al, 2004). According to these studies, a significant increase in gingival thickness could be achieved by the CTG technique, whereas there was no difference between pre- and post-operative thickness of the gingiva with the flap operation alone (mucoperiosteal flap). Furthermore, a direct relationship was found between flap thickness and the extent of root coverage. A thickness of  $>0.8$  mm always led to complete coverage, while only partial root coverage could be achieved with a flap thickness  $<0.8$  mm (Baldi et al, 1999).

A summary of the classification of defect factors and single- or two-layer methods is given in Table 2.

## PREDICTABILITY OF COVERAGE

The extent of average root coverage and the frequency of complete coverage that can be achieved with a particular method play a key role in method selection.

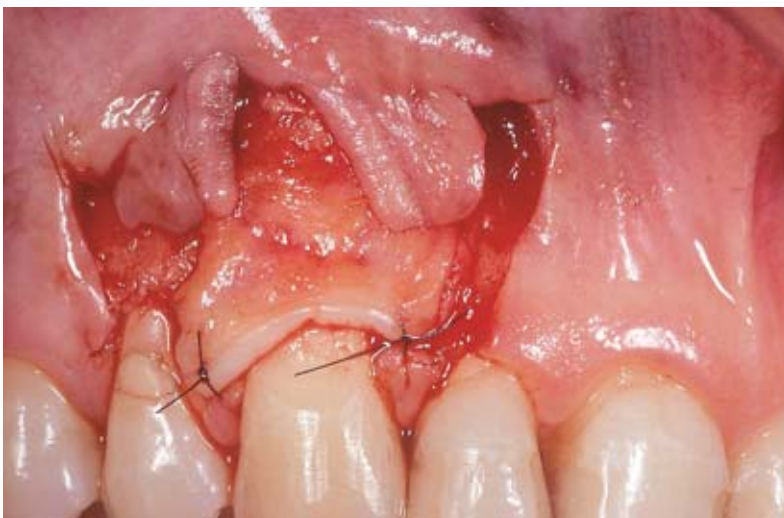
In a systematic review, Roccuzzo et al (2002) presented the results for the GTR technique, the CTG technique and coronally advanced flaps, which are summarised in Table 3. According to these results, the highest average and complete coverage rates are achieved with the CTG technique. Statistically, coverage was significantly greater with CTG than with the GTR technique. GTR did not differ statistically significantly from coronally advanced flaps. There was also no statistically significant difference between the use of bio-absorbable and



**Fig 7a** Wide and long Miller class I recession at tooth 13. The keratinised gingiva is reduced except for a residual band of 0.5 mm. Distally a labial frenum radiates into the marginal gingiva. There is an abrasion extending far into the enamel. In view of the width in combination with the length, a CTG with a double papilla flap was planned.



**Fig 7b** After a horizontal incision path level with the cemento-enamel junction, and two vertical relieving incisions at the adjacent teeth and a wedge-shaped excision in the fornix of the recession, two split flaps were prepared distally and mesially.



**Fig 7c** The CTG with epithelial bridge covers the recession as far as the cemento-enamel junction and lies lateral to the periosteum at a width of approximately 3 mm. It is fixed with two interdental sutures in the region of the epithelial cuff.



**Fig 7d** The two split flaps were advanced to the midline of the recession and stitched. The harvesting sites mesially and distally could be completely covered because of the elasticity of the flaps.

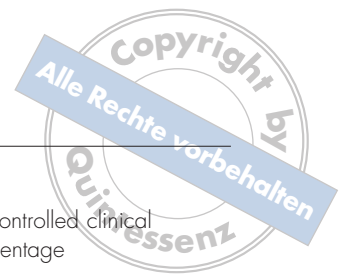


**Fig 7e** Three months post-operatively the recession is 100% covered. The keratinised gingiva is roughly three times wider than pre-operatively. The probing depth is 1 mm and there is no bleeding on probing. The course of the marginal gingiva is irregular because of the enamel abrasion present.



**Fig 7f** Seven years after the surgical intervention, the coverage result has remained stable. The width of the keratinised gingiva has further increased. The path of the marginal gingiva was improved by compensating for the enamel abrasion with a composite filling and thus restoring a convex surface.





**Table 1** Keratinised gingiva (KG) gain/loss during coverage of Miller class I and II recessions, based on 29 controlled clinical trials or case series with an observation period of at least six months (Roccuzzo et al, 2002). The average percentage gain/loss was calculated from the means of the test/control groups.

Method	Number of test/control groups	Number of recessions	Average gain/loss of KG (%)
Coronally advanced mucoperiosteal flap	5	66	-0.22
CTG with advanced split flap techniques	14	234	148.9
GTR, non-absorbable membranes	10	137	54.9
GTR, bio-absorbable membranes	14	186	55.3

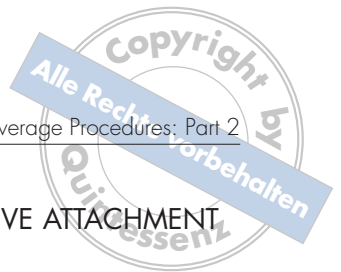
**Table 2** Indication for single- and two-layer covering methods for Miller class I and II recessions depending on the defect factors 'length and width of recession' and 'width of keratinised gingiva apical to the recession'.

Defect factors	Adequately wide KG		Narrow/absent KG	
	narrow (<4 mm)	wide (>4 mm)	narrow (<4 mm)	wide (>4 mm)
Short (<3 mm)	coronal AF or semilunar flap		coronal AF + CTG or envelope technique + CTG	
Medium (3–5 mm)	coronal AF		coronal AF + CTG or extended envelope technique + CTG	
Long (>5 mm)	unilateral lateral AF	double lateral AF + CTG	unilateral lateral AF + CTG	double lateral AF + CTG

AF, advancement flap; KG, keratinised gingiva

**Table 3** Average and complete coverage of Miller class I/II recessions for the GTR method, the CTG method and the coronally advanced flap, based on 28 controlled clinical trials or case series with an observation period of at least six months (from Roccuzzo et al (2002)).

Method	Number of recessions	Average coverage (%)	Percentage with complete coverage
Coronally advanced mucoperiosteal flap	66	72.3 (n = 5)	35.4 (n = 5)
CTG with advanced split flap techniques	209	83.7 (n = 14)	47.75 (n = 11)
GTR, non-absorbable membranes	129	73.94 (n = 9)	26.3 (n = 8)
GTR, bio-absorbable membranes	186	68.31 (n = 14)	33.65 (n = 11)



non-absorbable membranes. There was considerable heterogeneity of results both between the individual methods and within the same method, although only Miller class I/II recessions were included. This may be explained by variability in the quality of surgical technique or by factors such as 'smoking', 'recession length and width' or 'width of the keratinised gingiva at the start of treatment'. These results were confirmed by a meta-analysis (Al-Hamdan et al, 2003), incorporating 18 studies with a total of 272 recessions. Comparison of the CTG and GTR methods revealed significant differences in favour of the CTG technique for average root coverage (CTG: 81% vs. GTR: 74%) and for the percentage with complete coverage (CTG: 55% vs. GTR: 41%).

Whether the additional use of EMD (enamel matrix derivatives) improves the coverage result cannot definitively be answered at present, although the majority of studies do not show any positive influence. In two controlled trials, no significant difference in the coverage result was demonstrated between the flap operation alone and the additional use of EMD (Modica et al, 2000; Hägewald et al, 2002). Comparison of the flap operation with a CTG or with EMD revealed no significant differences between the two groups in terms of coverage outcome (McGuire and Nunn, 2003). However, in the trial by Nemcovsky et al (2004) with the same study design, significantly less coverage was achieved in the EMD group (77.4%) than in the CTG group (84.1%). Berlucchi et al (2002) compared flap surgery + EMD with the CTG technique + EMD and found no difference between the two groups in terms of the coverage results. In relation to the GTR technique, no difference in coverage was again found between application of the membrane (collagen membrane) alone and the additional application of EMD (Trabulsi et al, 2004). As far as method selection is concerned, these comparisons reveal that statistically significant coverage of recessions can be achieved with all the methods, but the CTG technique promises the best results in terms of coverage and gain in keratinised gingiva. If it is proved by further studies that the combination of flap surgery and EMD leads to coverage results equally as good as the CTG technique, the simpler surgical technique and lower stress to the patient would be arguments in favour of selecting EMD plus flap surgery – provided that the keratinised gingiva is pre-operatively wide enough and thick enough.

## NATURE OF POST-OPERATIVE ATTACHMENT

The new attachment after successful coverage can only be demonstrated histologically. In this respect, all the reports on this subject are individual case studies in which, after coverage was completed, the treated tooth had to be removed for various reasons.

Various types of attachment were reported for the different methods. Three types of new attachment have been reported for the CTG technique, namely regeneration, long junctional epithelium and connective tissue attachment (Weng et al, 1998; Harris, 1999a, 1999b; Bruno and Bowers, 2000; Goldstein et al, 2001; Majzoub et al, 2001; McGuire and Cochran, 2003). Meanwhile, the GTR method mainly resulted in regeneration with new cement, periodontal ligament and bone over the covered root surface (Gottlow et al, 1990; Cortellini et al, 1993; Waterman, 1997; Parma-Benfenati and Tinti, 1998; Vincenzi et al, 1998; Weng et al, 1998). Only Harris (2001) found a long junctional epithelium on four teeth after GTR treatment.

When EMD were used alone or in addition to coronally advanced flaps or CTG, this mainly resulted in regeneration, according to reports to date (Rasperini et al, 2000; McGuire and Cochran, 2003; Fritz et al, 2004; Sallum et al, 2004; Sculean and Schwarz, 2004). However, Carnio et al (2002) found a connective tissue attachment on a total of four teeth (in other words a course of connective tissue fibres parallel to the root surface) when using CTG with EMD (as with CTG alone).

Conditioning of the root surface, for example with citric acid, tetracycline-HCl or EDTA (Prefgel®), is a matter of debate in the literature. Not only regeneration (Common et al, 1983; Gottlow et al, 1986), but also a predominantly long epithelial attachment (Fritz et al, 2004), has been observed. Since regeneration comes closest to the physiological structure of the periodontium, it may be assumed that better, together with more stable, coverage results can be achieved with methods that are more likely to bring about regeneration. However, this hypothesis has not been proved by existing studies either for the results initially achieved or for the long-term results, when comparing the GTR and the CTG techniques, but also comparing the coronally advanced flap with and with-



out EMD (Pino Prato et al, 1996; Jepsen et al, 2000; Modica et al, 2000; Bouchard et al, 2001; Hägewald et al, 2002; Harris, 2002; Rocuzzo et al, 2002). Thus the nature of the attachment achieved is ruled out as a deciding criterion for method selection, at least for the time being.

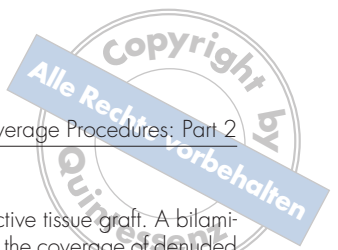
## KEY POINTS

1. Statistically significant coverage of recessions is possible with all the described methods, except the double papilla flap without CTG.
2. The following factors are important to method selection: length and width of the recession, width of the keratinised gingiva, predictability of the degree of coverage, aesthetics in respect of colour, form and surface texture.
3. Smoking must be regarded as a risk factor but has no relevance to the choice of method. The same applies to the nature of the attachment after completed coverage.
4. Where the keratinised gingiva apical to the recession is wide enough ( $\geq 3$  mm), single-layer techniques are the method of choice, particularly because they are less invasive procedures (no graft harvesting required).
5. The CTG technique is superior to the single-layer methods (mucoperiosteal flap) and the GTR method in terms of average and complete coverage rates and widening of the keratinised gingiva.
6. There is no statistically significant difference in coverage results between the single-layer methods (mucoperiosteal flap) and GTR.
7. Bio-absorbable and non-absorbable membranes do not display any statistically significant difference in terms of coverage results.
8. The aesthetic result in terms of colour, form and surface texture can be achieved more reliably with single-layer methods (mucoperiosteal flap) and GTR than with the CTG technique.
9. Root conditioning with citric acid or tetracycline-HCl does not improve the clinical outcome.
10. The use of EMD is a methodological simplification but, according to the majority of the trials currently known, it does not bring about any improvement in the coverage result.

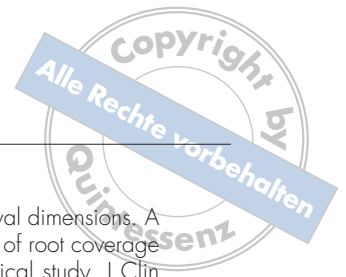
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