Case Series

Ten-Year Results After Connective Tissue Grafts and Guided Tissue Regeneration for Root Coverage

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Background: This study clinically evaluates the 10-year results of connective tissue graft (CTG) and guided tissue regeneration (GTR) therapies using bioabsorbable barriers for root coverage (i.e., the reduction of recession depth).

Methods: In 15 patients, 38 Miller Class I and II recessions were treated. Recession defects received a CTG or GTR by random assignment. At baseline (immediately prior to surgery) and 6 and 120 ± 12 months after surgery, clinical parameters were obtained.

Results: Nine patients, who contributed 24 recession defects, were available for re-examination at 120 ± 12 months. Six and 120 ± 12 months after receiving a CTG, statistically significant ($P < 0.05$) root coverage was observed compared to baseline root coverage (6 months: 3.07 ± 1.74 mm; 120 ± 12 months: 2.07 ± 1.89 mm). The GTR therapy resulted in statistically significant root coverage compared to baseline root coverage only after 6 months (2.28 ± 1.77 mm; $P < 0.05$). Both groups experienced a statistically significant loss of coverage from 6 to 120 ± 12 months (CTG: –1.0 ± 0.78 mm; GTR: –2.03 ± 2.24 mm). At 120 ± 12 months after CTG surgery, the stability of root coverage was statistically significantly better than 120 ± 12 months after GTR surgery ($P = 0.002$). The CTG caused more post-surgical discomfort ($P < 0.05$), but it resulted in a better treatment outcome ($P < 0.05$) than GTR as perceived by patients.

Conclusion: The long-term stability of root coverage (i.e., the reduction of recession depth) and esthetic results perceived by patients were significantly better 10 years after CTG surgery, statistically, than after GTR surgery using bioabsorbable barriers. *J Periodontol 2010;81:827-836.*

KEY WORDS

Esthetics, dental; gingival recession; guided tissue regeneration, periodontal; randomized controlled clinical trial; treatment outcome.

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Although circularly denuded root surfaces (facial/oral and interproximal recessions) as a result of periodontitis do not respond completely or predictively to surgical coverage attempts,[1] there are several techniques that are successfully used to treat facial recessions:[2] e.g., coronally advanced and lateral positioned flaps, free gingival and connective tissue grafts (CTG), and guided tissue regeneration (GTR).[3,4] Further, there exists a wide variation of different modifications of these techniques. The CTG methods encompass the envelope technique,[5] the coronally advanced flap,[6] and the double-papilla pedicle technique.[7] GTR may be performed using non-resorbable[8-10] or bioabsorbable[9-11] barrier membranes or, more recently, using enamel matrix derivative.[9,12,13] Single studies[14,15] comparing CTG and GTR procedures found small advantages in root coverage for CTGs. However, these differences failed to reach statistical significance. In meta-analyses, a CTG was found to be statistically significantly superior to GTR with regard to root coverage.[3,4,9] Further, structured reviews[3,4] did not find statistically significant differences between the clinical results of coronally advanced flaps alone or in combination with barrier membranes or between the outcomes of non-resorbable or bioabsorbable barriers.

doi: 10.1902/jop.2010.090632

However, in contrast to the GTR technique, the CTG method requires a second surgical site to harvest connective tissue and, thereby, creates additional morbidity and effort. The patient and surgeon have to decide whether the superiority of a CTG justifies the additional morbidity and cost. Further, the observation periods of most studies on root coverage[3] range from 6 to 12 months with a few studies reporting results 24,[16] 48,[17] or 60 months[18] after surgery. To our knowledge, there exists only one long-term (≥5 years of follow-up) study[19] that reported results from 6 to 22 years after a root-coverage procedure using CTGs. Another study[20] reported results from 10 to 27 years after gingival augmentation surgery with the aim of increasing keratinized tissue using marginal and submarginal free gingival grafts. Six years after a coronally advanced flap procedure with and without membranes, a loss of root coverage of 0.5 and 1.0 mm was reported.[20] The relapse in the non-membrane group was statistically significant, but the relapse in the membrane group was not statistically significant. However, because of the small size of the re-examination sample (n = 11), the study failed to find a significant difference between groups.[21] The concern of how long root coverage lasts after receiving a CTG compared to GTR in the long term remains unanswered.[22,23] We hypothesized that root coverage after GTR may be stable as least as long as after receiving a CTG. Furthermore, structured reviews[3,4,22,23] published in the previous 8 years recommended the evaluation of patient-centered outcomes based on esthetics.

Thus, the objective of the present randomized, controlled clinical trial was to assess and compare clinical results 10 years after CTG therapy according to the envelope technique and GTR therapy using a bioabsorbable barrier. Additionally, patient-centered outcomes were recorded and compared.

MATERIALS AND METHODS

Patients

Originally, 15 patients (10 females and five males) who were undergoing periodontal treatment at the Department of Periodontology, Center of Dental, Oral, and Maxillofacial Medicine (Carolinum), Johann Wolfgang Goethe-University Frankfurt am Main, Germany, and had a total of 38 Miller Class I and II buccal recession lesions[1] were treated with either a CTG according to the envelope technique[5] or GTR using bioabsorbable polylactide acetyltributyl citrate barriers.[§10,24] The population was evaluated 3 months after surgery.[25] The patients ranged in age from 18 to 60 years at the time of surgery and had to: be ≥18 years of age; have a diagnosis of maxillary or mandibular buccal Miller Class I or II recessions,[1] i.e., the soft tissue had to fill the interdental space completely, with no attachment loss, and with distances between the cemento-enamel junction (CEJ) and the alveolar crest ≤2 mm at the interproximal sites;[26] have recession depths (RDs) ≥3 mm; perform effective individual oral hygiene (approximal plaque index [API] ≤25%[27]); and provide written informed consent.

Surgery was performed from May 1, 1997 to November 12, 1998. One hundred twenty ± 12 months after surgery, all patients who originally participated in the clinical trial were recalled. After enrollment of the patients, the study protocol, risks, benefits, and procedures were explained, and written informed consent was obtained. The study was approved by the Institutional Review Board for Human Studies, Medical Faculty, Johann Wolfgang Goethe-University Frankfurt am Main (approval #185/08).

Periodontal Surgery

Recessions were randomly assigned by lot to the CTG or GTR group. The surgeries that were performed in this study were previously described in detail.[5,25] Briefly, in both groups, the effect of local anesthesia was evaluated by bone sounding around the teeth that were to undergo surgery. If ≥2-mm distance from the CEJ to alveolar crest was measured, the defect was excluded from the study. In the CTG group, a 0.5-mm broad collar of the sulcus epithelium at the recession was excised. The denuded root surface was scaled and planed thoroughly. A pouch (envelope) was prepared using a #15 blade, and the gingiva and mucosa were separated from the periosteum to provide nutrition for the CTG from the underlying periosteum and covering soft tissue. After the pouch was prepared, the CTG was harvested at the premolar and molar regions of the palate. Two incisions, 2 mm apart from each other, were made parallel to the gingival margin and the palatal bone. The length of these incisions was twice the width of the recession to be treated. Thereafter, the margin of the palatal epithelium was removed from the CTG, and it was placed within the pouch covering the denuded root surface totally (Fig. 1). The CTG was fixed with tissue adhesive,[‖] and the surgical site was covered with periodontal dressing.[¶] The harvesting site at the palate was sutured and occasionally dressed.

In the GTR group, a sulcular incision was made at the recession site. Mesially and distally diverging releasing incisions were made to create a trapezoid flap. The tissue was elevated as a full-thickness flap in the coronal portion and as a split flap in the apical portion. The epithelium of the papillae mesial and distal to the recession defect was removed. Bioabsorbable polylactide acetyltributyl citrate barriers[#] were fitted

§ GUIDOR Matrix Barrier, GUIDOR, Huddinge, Sweden.
‖ Histoacryl, B. Braun Melsungen, Melsungen, Germany.
¶ COE-PAK, GC America, Alsip, IL.
# Guidor Matrix Barrier, Guidor.

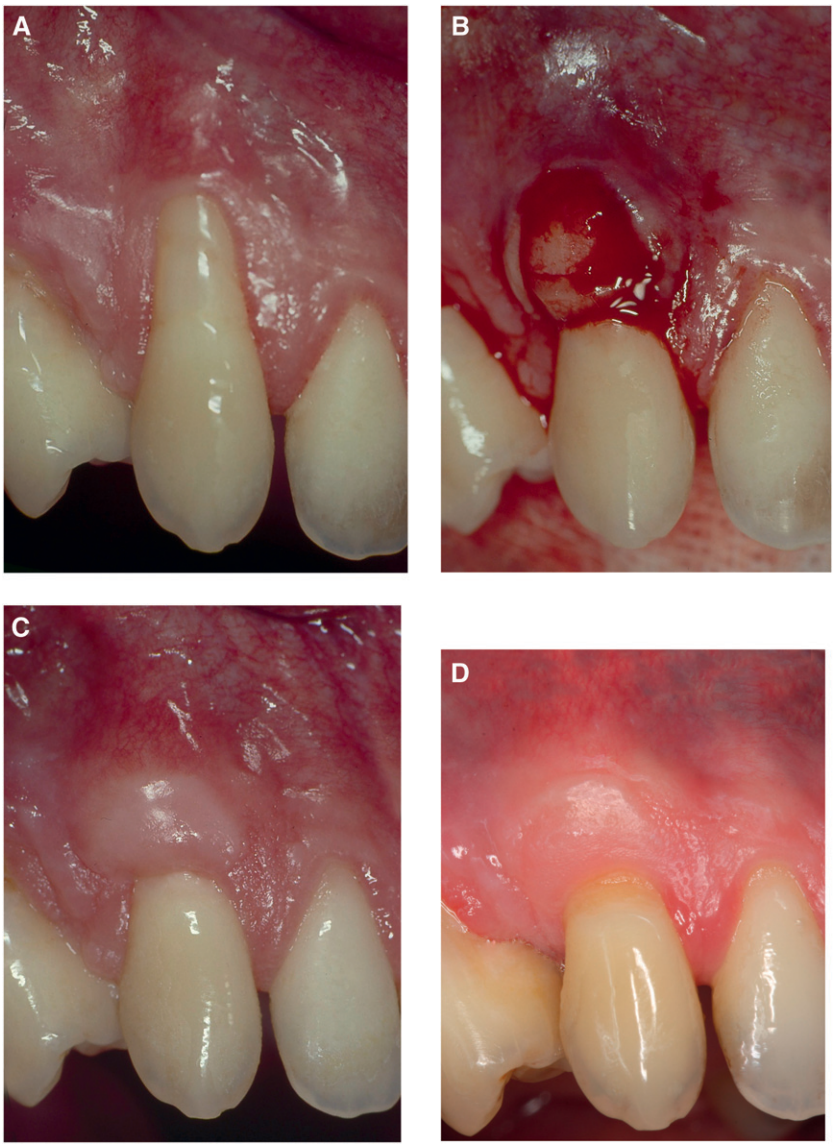

Figure 1.
A through D) *Root coverage with CTG at the right maxillary canine of patient 8. A) Recession defect at buccal aspect of tooth #6 at baseline. B) Intrasurgical view after CTG. C) Complete root coverage and increased GW 6 months after surgery. D) Stability of root coverage and GW 1 20 months after surgery.*

to cover the recession and to apically overlap the alveolar bone. The barrier was fixed with a sling around the neck of the tooth using the incorporated suture. Finally, the trapezoid flap was repositioned coronally to totally cover the barrier, but without tension, and then sutured** (Fig. 2).

Patients were instructed to refrain from mechanical plaque control at the surgical sites for 6 weeks after surgery at the GTR sites and for 1 week at the CTG sites. Patients in both groups rinsed with a 0.2% chlorhexidine gluconate solution†† for 2 minutes three times daily. At the GTR sites, a 1% chlorhexidine gel was applied three times daily for 6 weeks. Patients were placed on a maintenance schedule including oral hygiene instructions and professional tooth cleaning 3, 6, 12, and 24 months after surgery.[25] Afterwards, most patients stopped receiving supportive periodontal treatment (SPT) at the department of periodontology and saw their general dentist for preventative dental check-ups. A patient who complied with at least one SPT visit per year at the department of periodontology was classified as having regular SPT.[28-31]

Clinical Examinations

The clinical examinations were previously described in detail.[25] Briefly, at the buccal site of each recession defect tooth, the following parameters were measured to the nearest 1 mm using a calibrated, straight, rigid, periodontal probe‡‡ at baseline and at the 6-month re-examination:

Probing depths (PDs): as reference points for PD measurements, the bottom of the pocket and the gingival margin was used.

Vertical probing clinical attachment levels (CAL-V): as a reference for the CAL-V measurements, the CEJ was used; if the CEJ could not be identified, e.g., due to a restoration, the margin of this restoration served as reference.

RD: measured from the CEJ to the gingival margin.

Recession width (RW): the periodontal probe was oriented horizontally and located at the most apical convexity of the CEJ; then, the horizontal distance between the mesial and distal gingival margin was assessed.

Gingival width (GW): measured after staining with 3% iodine solution from the gingival margin to the mucogingival border.

Bleeding on probing (BOP): bleeding was recorded 30 seconds after probing.[25]

Surgeries and baseline and 6-month re-examinations were performed by the same individuals (PRK and EN). In 2005, the Department of Periodontology replaced the calibrated, straight, rigid periodontal probe§§ with a simple manual rigid probe‖‖ as the

** Monocryl, 6-0, P-1, Ethicon, Norderstedt, Germany.
†† Corsodyl, Fink, Herrenberg, Germany.
‡‡ PCP 12, Hu-Friedy, Chicago, IL.
§§ PCP 12, Hu-Friedy.
‖‖ PCP-UNC 15, Hu-Friedy.

standard probe. Thus, 120 ± 12 months after therapy, the clinical parameters (PD, CAL-V, BOP, RD, RW, and GW) were assessed by a single examiner (KN) using the simple manual rigid probe. This examiner was masked to the type of therapy and was calibrated prior to the re-examination.[32]

At 120 ± 12 months after therapy, patients who were re-examined were asked about their current and past smoking habits. Patients who reported being smokers were classified as current smokers. Patients who had quit smoking were classified as former smokers.

Patient-Centered Outcomes

At the time of the 120 ± 12-month clinical re-examinations, all patients were asked for their opinion on the CTG and GTR therapies. Because of the fact that the assessments showed variation within patients, the following patient-centered outcomes were analyzed per defect: 1) post-surgical discomfort (yes/no), 2) duration of discomfort (days/weeks/months/years) at donor site (CTG only) and recession site, 3) improvement of reason for surgery (yes/no), and 4) satisfaction with the result (grade A [very good] through F [insufficient]).[19]

Data Analyses

Calibration measurements with the calibrated, straight, rigid periodontal probe¶¶ and the simple manual rigid probe## were compared using the paired *t* test. As measures of agreement for the calibration of the re-examiner (KN), we calculated the SD of single measurements[33] and the frequency of differences between both measurements.

RD was considered the main outcome variable to compare the long-term clinical outcomes of CTG and GTR procedures. All other clinical parameters and their long-term changes were considered secondary outcome variables.

The patient was defined as the statistical unit. However, most patients contributed >1 recession defect or >1 pair of defects to the study. Thus, for each patient and treatment assignment, means were calculated from the clinical parameters measured at the recession sites at baseline and after 6 and 120 ± 12 months. All parameters were tested for normal distribution using the Kolmogorov-Smirnov/Lilliefors test. Because of the small sample size, statistical comparisons were only calculated for the main outcome variable (i.e., RD) and the patient-centered outcomes. The means at baseline and 6 and 120 ± 12 months after therapy were compared by using the Mann-Whitney U test between CTG and GTR therapies. Comparisons between baseline and 6 and 120 ± 12 months within each group were performed using the Wilcoxon signed-rank test. CTG and GTR therapies were compared regarding patient-centered outcomes using the χ^2 or Fisher exact tests.

The percentage of relative root coverage was calculated for each recession defect (RD reduction/baseline RD × 100). Further, the percentage of the frequency of recessions with total root coverage was calculated (number of recession defects with total coverage/total number of defects × 100). Statistical analyses were performed using a computer program.***

RESULTS

Patients

Fifteen patients with 38 recession defects were originally enrolled into the study. Six patients did not participate in the 120 ± 12 months re-examinations for the following reasons: one patient died, two patients could not be contacted (address unknown and name was changed due to marriage), and three patients refused to participate in the re-examination without giving a reason.

Nine patients (mean age: 32.2 ± 9.0 years at baseline) who contributed 24 recessions were available for re-examinations at 120 ± 12 months: five females; seven never-smokers, one former smoker, and one current smoker (Table 1). None of the patients complied with regular SPT visits. The therapy (CTG or GTR) assignment according to jaw and tooth type is given in Table 1.

Power analyses for comparisons of the split-mouth group (seven patients and ten pairs of defects) and parallel group (nine patients and 10 CTG/14 GTR defects) for the main outcome variable "stability of RD" from 6 to 120 ± 12 months after surgery revealed a 6% and 13% test power for the split-mouth and parallel groups, respectively.

Clinical Parameters

Calibration measurements failed to show any statistically significant differences for recession measurements using the two different periodontal probes. Discrepancies were <1.0 mm for all measurements between the repeated assessments for RW and GW and <1.0 mm for all but one measurement for RD. The respective calibration dates for CAL-V and PD were recently published.[32]

The mean and standard deviation of RD at baseline and 6 and 120 ± 12 months after surgery, changes of RD 6 and 120 ± 12 months after surgery, and differences of RD between CTG and GTR groups are given in Table 2. At baseline, there were no statistically significant differences between the CTG and GTR groups (Table 3). Six and 120 months after surgery, statistically significant root coverage (i.e., RD reduction

¶¶ PCP 12, Hu-Friedy.
PCP-UNC 15, Hu-Friedy
*** Systat for Windows, version 10.0, Systat, Evanston, IL.

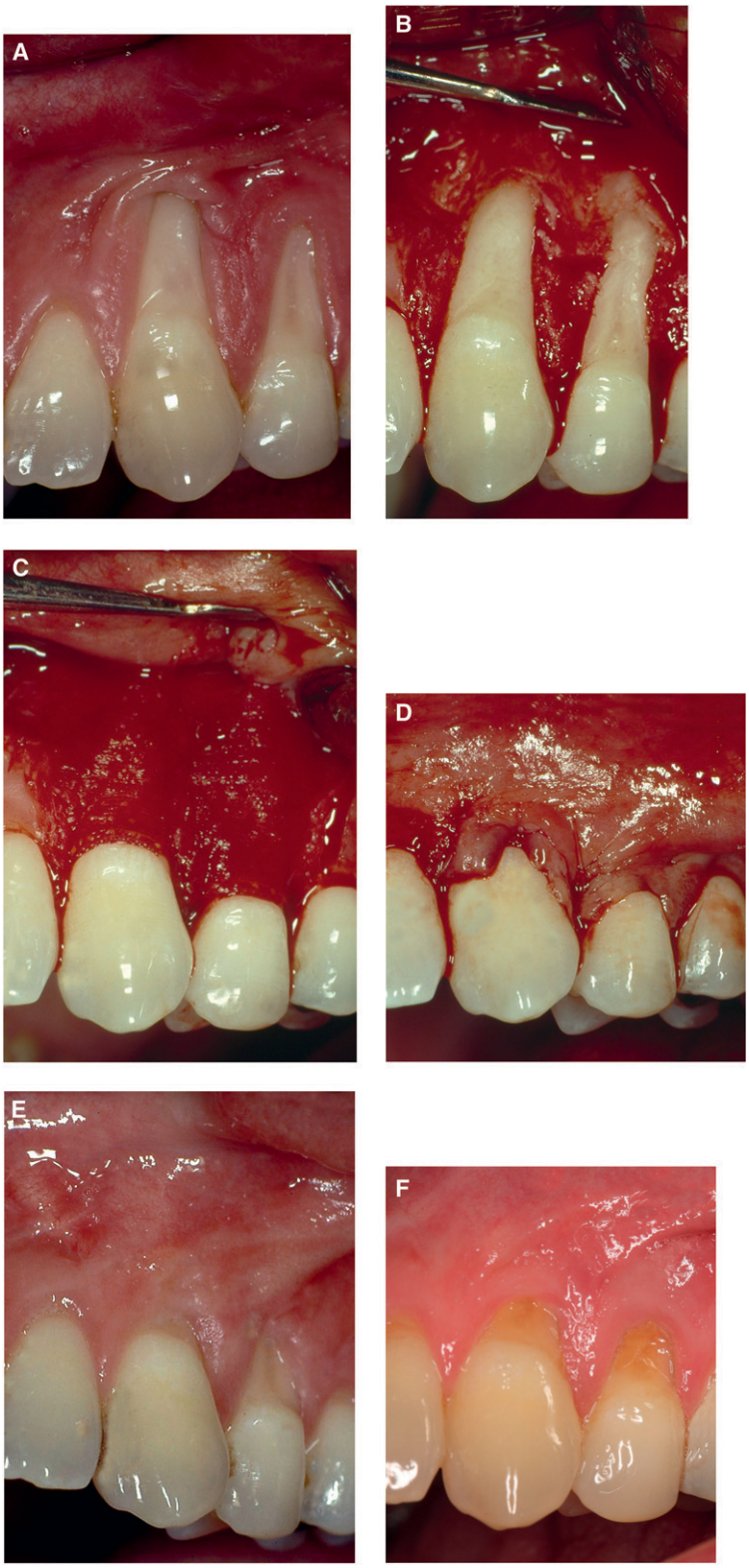

Figure 2.
A through F) *Root coverage with GTR at left maxillary canine and first premolar of patient 7. A) Recession defects at buccal aspect of teeth #11 and #12 at baseline. B) After flap elevation. C) Bioabsorbable polylactide acetyltributyl citrate barriers. D) Coronally advanced flap. E) Six months after surgery. F) Recurrence of buccal recessions 120 months after surgery.*

compared to baseline) was assessed for both groups (P <0.05; Table 2). From 6 to 120 months, a statistically significant average loss of root coverage (i.e., RD increase) was observed in both groups (Table 2). Ten years after surgery, most of the root coverage originally gained in the GTR group was lost. Root coverage (i.e., RD reduction compared to baseline) 120 ± 12 months after CTG surgery was statistically better than after GTR surgery (P=0.002) (Table 2).

The mean and standard deviation of PD and CAL-V and the number of sites with BOP at baseline and 6 and 120 ± 12 months after surgery, as well as the changes in these variables 6 and 120 ± 12 months after surgery, are given in Table 3. Six and 120 months and from 6 to 120 months after surgery, CTG and GTR groups failed to show relevant changes in PD and BOP (Table 3). Six months after surgery, CAL-V gains were assessed for CTG and GTR groups (Table 3). From 6 to 120 months, a relevant CAL-V loss was observed in both groups (Table 3).

Six months after surgery, the relative root coverage was 72.7% ± 23.4% with two of seven sites (28.6%) exhibiting total coverage in the CTG group and 47.4% ± 36.1% with one of nine sites (11.1%) exhibiting total coverage in the GTR group. The respective values 120 ± 12 months after surgery were 43.7% ± 41.7% with complete coverage at one of seven sites (14.3%) in the CTG group and 1.9% ± 36.4% at zero of seven sites in the GTR group. Ten years after receiving a CTG, the RD was increased in only one of seven patients (14.3%) compared to the baseline value. In the GTR group, five of nine patients (55.5%) exhibited a mean RD increase compared to baseline.

A significant RW reduction was observed 6 and 120 ± 12 months after CTG surgery but not after GTR surgery. A small but increased RW was observed from 6 to 120 ± 12 months after surgery in both groups (Table 4). A relevant gain of GW was observed 6 and 120 ± 12 months after the CTG surgery and 120 ± 12 months after the GTR surgery. A small GW gain was observed from 6 to 120 ± 12 months after surgery in both groups. The RW and GW gains were better 6 and 120 ± 12 months after CTG surgery than after GTR surgery (Table 4).

Patient-Centered Parameters

All patients judged the situation with the respective teeth as improved. In the CTG group, patients reported post-surgical discomfort in nine of 10 defects (90%). In six defects,

Table 1.

Patient Characteristics

Patients and Dropouts	Age (years) at Time of Surgery	Gender	Tooth # CTG	Tooth # GTR	Smoking
Patient #					
1	45	Female	22	27	Never
2	44	Female	11	4, 5, 6	Former
3	34	Female	11	6	Never
4	38	Male	–	6	Current
5	31	Male	6, 22	11, 27	Never
6	18	Female	–	22	Never
7	29	Male	5, 6	11, 12	Never
8	33	Male	6	11	Never
9	29	Female	6, 22	11, 27	Never
Dropout #					
10	35	Female	27, 28	22	Not documented
11	50	Female	11, 12	5, 6	Not documented
12	38	Male	–	6	Not documented
13	60	Female	27	22	Not documented
14	33	Female	11	6	Not documented
15	56	Female	11	6	Not documented

– = not applicable.

Table 2.

RD Assessment (mm; mean ± SD)

Examinations/Patients Within-Group Comparisons	CTG (n = 7)	GTR (n = 9)	Between-Group Comparisons (*P*)
Baseline	4.07 ± 1.54	4.94 ± 2.04	0.421
6 months	1.00 ± 1.00	2.67 ± 1.70	0.054
Change versus baseline	–3.07 ± 1.74	–2.28 ± 1.77	0.592
P	0.017	0.012	–
120 months	2.00 ± 1.05	4.69 ± 1.41	0.002
Change versus baseline	–2.07 ± 1.89	–0.25 ± 2.52	0.138
P	0.042	0.859	–
Change at 6 months versus at 120 months	1.00 ± 0.78	2.03 ± 2.24	0.557
P	0.042	0.018	–

– = not applicable.

discomfort lasted for days, and in three defects, discomfort lasted for weeks. In the GTR group, post-surgical discomfort was reported for four of 14 defects (29%), which lasted only for days in all cases. Discomfort was more frequent ($P = 0.005$) and lasted longer ($P = 0.011$) in the CTG group than the GTR group. However, improvement of baseline complaints ($P = 0.013$) and self-assessment of treatment outcomes ($P = 0.034$) was better for the CTG group than the GTR group. Although 60% of all CTG defects were judged to show good improvement 120 ± 12 months after surgery, this was only the case in one of 14 GTR sites (Table 5).

DISCUSSION

Some structured reviews[3,4,9] revealed a superior root coverage in Miller Class I and II recession defects with the CTG compared to GTR. Other structured reviews[22,23] reported a superior reduction of RW with the CTG compared to GTR. According to the reviews,[22,23] a CTG provides a better reduction of RW than GTR with bioabsorbable barrier membranes provides, but a CTG does not provide a better reduction of RW than a GTR with non-resorbable barriers provides. Roccuzzo et al.[3] reported a weighted mean root coverage and attachment gains of 3.7 and 4.0 mm, respectively, for GTR therapy with non-resorbable barriers (five studies); 2.86 and 2.84 mm, respectively, for GTR therapy with bioabsorbable barriers (eight studies); and 3.1 and 3.01 mm, respectively, for CTG therapy (eight studies) after 6 to 48 months in controlled clinical trials. The absolute root coverage and attachment gain of 3.07 and 3.3 mm, respectively, 6 months after CTG therapy and of 2.28 and 2.3 mm, respectively, after GTR therapy with a bioabsorbable membrane observed in the present study confirmed these results. However, it should be noted that the reported means in most of the controlled clinical trials discussed by Roccuzzo et al.[3] combined a coronally advanced flap with a CTG, whereas in the present study, CTGs were used according to the envelope technique.[5]

From 6 to 120 months, a statistically significant average loss of root coverage (i.e., RD increase) was observed in both groups: 10 years after CTG therapy in the GTR group, nearly 40% of root coverage that was

Table 3.

PD and CAL-V (mean ± SD) and BOP

Examinations/Changes	PD (mm)		CAL-V (mm)		BOP (n sites)	
	CTG (n = 7)	GTR (n = 9)	CTG (n = 7)	GTR (n = 9)	CTG (n = 7)	GTR (n = 9)
Baseline	1.6 ± 0.4	1.6 ± 0.7	5.7 ± 1.5	6.6 ± 2.4	0	0
6 months	1.4 ± 0.5	1.6 ± 1.1	2.4 ± 1.3	4.2 ± 2.4	0	0
Change versus baseline	−0.2 ± 0.5	0.0 ± 1.2	3.3 ± 1.5	2.3 ± 2.0	0	0
120 months	1.6 ± 0.5	1.6 ± 0.8	3.6 ± 1.4	6.3 ± 1.9	0	2
Change versus baseline	0.0 ± 0.5	0.0 ± 0.6	2.1 ± 1.9	0.3 ± 2.6	0	2
Change at 6 months versus at 120 months	0.2 ± 0.6	0.0 ± 1.3	−1.1 ± 1.3	−2.1 ± 3.0	0	2

Table 4.

RW and GW (mm; mean ± SD)

Examinations/Changes	RW		GW	
	CTG (n = 7)	GTR (n = 9)	CTG (n = 7)	GTR (n = 9)
Baseline	5.64 ± 1.40	5.26 ± 1.23	2.89 ± 2.18	1.72 ± 1.84
6 Months	2.64 ± 2.53	4.01 ± 2.37	5.89 ± 2.78	1.60 ± 2.14
Change versus baseline	−3.00 ± 1.93	−1.25 ± 1.84	3.00 ± 1.50	−0.12 ± 0.56
120 months	2.96 ± 1.42	4.23 ± 0.99	6.32 ± 1.43	2.98 ± 1.21
Change versus baseline	−2.68 ± 1.25	−1.03 ± 1.36	3.43 ± 2.84	1.26 ± 1.59
Change at 6 months versus at 120 months	0.32 ± 1.83	0.22 ± 2.11	0.43 ± 3.00	1.38 ± 1.90

originally gained and most of the root coverage originally gained in the GTR group was lost. This is in contrast to results reported 10 to 27 years after gingival augmentation surgery that aimed to increase keratinized tissue using marginal and submarginal free gingival grafts. The authors[20] report additional root coverage (0.5 mm for marginal free gingival grafts and 0.8 mm for submarginal free gingival grafts) from 1 year after surgery to the re-examination (10 to 27 years after surgery). This is noteworthy because gingival augmentation, not root coverage, was the aim of the surgery (i.e., an increase of gingiva in width and thickness). This additional root coverage is explained by creeping attachment.[20] All patients of the present study quit SPT at some point between 2 and 10 years after surgery. The instability of the root coverage may be due to ineffective oral hygiene that caused gingivitis or due to the relapse of patients to using traumatic horizontal brushing routines. Agudio et al.[20] kept all patients every 4 months for SPT. Thus, Agudio et al.[20] were able to maintain effective individual oral hygiene with an atraumatic, apico-coronal brushing technique that provided conditions that were optimal for stability or even for creeping attachment. CTG therapy resulted in a greater gain of keratinized tissue than GTR therapy in this study.[20] A greater gain of keratinized tissue after CTG therapy was revealed by structured reviews also.[22,23] Recently, it was shown that sites with only a small amount of keratinized tissue are less stable than augmented sites.[20] The fact that root coverage after GTR therapy is less stable than after CTG therapy may be due to less keratinized tissue at GTR sites compared to CTG sites. Differences in flap thickness may be another reason for different outcomes after GTR and CTG therapies. Whereas CTG therapy provided a >90% root coverage irrespective of the baseline flap thickness, GTR therapy resulted in statistically significantly worse root coverage in cases of thin baseline flaps.[14] A linear correlation between the flap thickness and root coverage was demonstrated when using a coronally advanced flap without barrier membrane (GTR) or a CTG.[34,35] A structured review[36] that meta-analyzed all studies that reported baseline flap thickness came to the conclusion that an association between flap thickness and the amount of root coverage existed for GTR and CTG procedures but not for the coronally advanced flap

Table 5.

Improvement of Baseline Situation and Self-Assessment of Outcome

Improvement of Defects	CTG (n = 10)	GTR (n = 14)
No	0	2
Moderate	0	6
Satisfactory	3	5
Good	6	1
Total resolution of baseline complaint	1	0
P		0.013
Self-Assessment of Outcome (school grades)	**CTG (n = 10)**	**GTR (n = 14)**
E	0	1
D	0	7
C	2	4
B	7	2
A	1	0
P		0.034

School grades from A (best) to E (worst) are used in Table 5.
n = number of defects.

procedure alone. The surgeries re-examined in the present study were performed between May 1997 and November 1998. Thus, when planning the study, the knowledge presented in the structured review[36] was not available and could not be considered. It may be that the outcomes after GTR surgery are worse than those after CTG surgery, which may be due to thin buccal gingiva at baseline in most cases.

A different post-surgical protocol was used after GTR surgery than after CTG surgery. The GTR group rinsed with chlorhexidine for 6 weeks, whereas the CTG group rinsed with chlorhexidine for only 1 week. In addition, patients in the GTR group were instructed to apply 1% chlorhexidine gel three times daily at the surgical sites. Chlorhexidine inhibits cell migration in cell cultures and bacterial growth in patients.[37] Thus, the 1% chlorhexidine may have inhibited cell migration in the GTR group and led to less root coverage. However, bacterial colonization of the barrier jeopardizes GTR outcomes. Further, the subgingival application of 1% chlorhexidine after scaling and root planing in full-mouth disinfection was shown to result in better attachment gain than full-mouth scaling alone.[37]

The present study compared two different flap designs with the same objective of covering denuded root surfaces. Recession defects were randomly assigned to receive a CTG according to the envelope technique and/or GTR using a coronally positioned flap. Is it possible to fairly compare the outcomes of these different flap designs? This study is not the first to notice that CTG surgery performs better than GTR surgery with bioabsorbable barriers. However, to our knowledge, the present study is the first to show that this observation is also true in the long term. Structured reviews[3,4] compared studies on the use of CTG and GTR therapies and included envelope-technique studies. A previous study[38] compared different flap designs (a semilunar coronary positioned flap and subepithelial CTG) with the same objective. Thus, we believe the comparison made in our study (two different flap designs with the same objective) is fair enough.

There is an obvious dilemma in the effort to achieve high intra- and interexaminer reproducibility and to obtain long-term results. The reproducibility of the original examiners 9.5 years after the short-term reexaminations (at 6 months) were completed may not be the same. Thus, a comparison, e.g., by replicated measurements, of the original examiners (PRK and EN) to the examiner (KN) of the 120 ± 12-month reexaminations was unlikely to resolve this problem. Additionally, measurement error may have been introduced because splints were not used to mark the precise sites of probing. However, even if splints for probing had been applied in the original study,[25] it may have been difficult to preserve them for ~10 years and to fit them to the teeth when their positions may have changed during the 10 years. These issues apply to all long-term observations.[32]

Interestingly, structured reviews[3,4,22,23] published in the previous 8 years unanimously recommended the evaluation of patient-centered outcomes based on esthetics. When asked, most patients (five of nine patients [55%] in the present study and 16 of 20 patients [80%] according to Rossberg et al.[19]) cite esthetics as a reason for root coverage. However, up until now, root-coverage procedures were evaluated according to the ability to improve clinical parameters that could be measured accurately by examiners but only seldom gave an idea as to how patients judged improvements in the esthetics of their gums. With procedures aiming to improve patient esthetics, patient-centered parameters should be the primary outcome variables. A MEDLINE search using the items "root coverage" AND "patient-centered outcomes" failed to provide any results. To the best of our knowledge, Rossberg et al.[19] were

the first to report patient-centered outcomes in a study on long-term results after CTG surgery.

The present study found that the mean relative root coverage reduced from 72.7% to 43.7% in the CTG group and from 43.7% to 1.9% in the GTR group, respectively. Nevertheless, all patients judged the esthetics of their respective teeth as improved. Discomfort was more frequent ($P = 0.005$) and lasted longer ($P = 0.011$) in the CTG group compared to the GTR group. However, there was more improvement of most clinical parameters after CTG surgery than after GTR surgery, and the improvement of baseline complaints ($P = 0.013$) and self-assessments of treatment outcomes ($P = 0.034$) were better in the CTG group compared to the GTR group. A higher morbidity after CTG surgery seems to be accepted for better clinical results,[3,4,22,23] better long-term stability, and better improvement of esthetics than after GTR surgery. Acellular dermal matrix (ADM) may be a solution for this dilemma. The use of ADM may overcome the requirement to harvest the CTG from the palate, which is the prominent source of post-surgical discomfort in root-coverage procedures.[38] However, evidence for the additional benefit of ADM when used with coronally advanced flaps is still controversial.[9]

The barrier membrane used in this clinical trial was recently reintroduced to the market. Thus, the results of this study may be particularly valuable for the clinician to decide what method should be used for root coverage. Further, to the best of our knowledge, this is the first controlled clinical trial to provide long-term results (10 years) for the comparison of CGT and GTR surgeries for root coverage.

The sample size (seven of nine patients and 10 of 14 recession defects) of this study was too small to show the equivalence of both surgical techniques with a sufficient test power after 120 ± 12 months. For the observed differences regarding root coverage between CTG and GTR therapies, a type I error $\alpha < 0.05$, and the observed SD of the difference between tests and controls, a test power of 6% and 13% for split-mouth and parallel groups, respectively, was calculated. However, 10 years after surgery, most (96%) of the root coverage originally gained in the GTR group was lost. CTG therapy was statistically significantly superior to GTR therapy regarding the root coverage and GW 120 ± 12 months after surgery ($P = 0.002$).

CONCLUSIONS

Within the limitations of the present study, the following conclusions were drawn:

1) Miller Class I and II gingival recession defects treated by a CTG or GTR using bioabsorbable membranes exhibit a partial to complete loss of root coverage at 10 years after surgery in patients who did not comply with SPT recalls.

2) Defects treated by CTG therapy showed a better long-term stability of root coverage compared to defects treated by GTR therapy with bioabsorbable membranes.

3) The patient-perceived esthetic results, as assessed long-term, were significantly higher in defects treated with CTGs.

ACKNOWLEDGMENTS

The authors thank Leigh Stevens, Microsoft language consultant, London, United Kingdom, for her valuable and competent support in the preparation of the manuscript. The study was funded by the authors and their institutions. The authors report no conflicts of interest related to this study.

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Submitted November 12, 2009; accepted for publication January 30, 2010.