J Clin Periodontol 2011; 38: 715–720 doi: 10.1111/j.1600-051X.2011.01744.x

Journal of Clinical Periodontology

Fourteen-year outcomes of coronally advanced flap for root coverage: follow-up from a randomized trial

Giovanpaolo Pini Prato[1], Roberto Rotundo[1], Debora Franceschi[1], Francesco Cairo[1], Pierpaolo Cortellini[2] and Michele Nieri[1]

[1]Department of Periodontology, University of Florence, Florence, Italy; [2]European Research Group on Periodontology (ERGOPERIO), Berne, Switzerland

Pini Prato G, Rotundo R, Franceschi D, Cairo F, Cortellini P, Nieri, M. Fourteen-year outcomes of coronally advanced flap for root coverage: follow-up from a randomized trial. J Clin Periodontol 2011; 38: 715–720. doi: 10.1111/j.1600-051X.2011.01744.x.

Abstract

Trial Design: This long-term 14-year-randomized split-mouth study aimed at evaluating (1) the outcomes of two different methods of root surface modifications (root surface polishing *versus* root planing) used in combination with a coronally advanced flap (CAF) and (2) the long-term results of CAF performed for the treatment of single gingival recessions.

Methods: Ten patients with similar bilateral recessions $\geqslant 2$ mm were selected for a split-mouth randomized design study. Exposed root surfaces were assigned to receive polishing (test sites) or root planing (control sites). A multilevel model was used to analyse data at 3 months, 1, 5 and 14 years.

Results: One patient dropped out after 1 year. At 14 years, recession depth (Rec) was 0.9 (1.2) mm for the test sites and 0.9 (0.9) mm for the control sites. The interaction between treatment and keratinized tissue was significant ($p = 0.0035$). Rec increased slightly over time ($p = 0.0006$) in both the groups.

Conclusions: This study shows that during a long-term follow-up, gingival recession recurred in 39% of the treated sites following the CAF procedure.

Key words: coronally advanced flap; gingival recession; long term; randomized-controlled trial; statistical interaction

Accepted for publication 9 May 2011

Coronally advanced flap (CAF) is one of the most reliable techniques for the treatment of single gingival recessions and different surgical flap designs have been proposed over time, increasing the possibility of achieving complete root coverage (Cairo et al. 2008; Chambrone et al. 2010).

A prerequisite for root coverage is the treatment/modification of the exposed root surface using different mechanical and/or chemical approaches. Root planing is still being used to remove the microbial biofilm, minimizing cementum toxicity (Bertrand & Dunlap 1988), to smooth irregularities and grooves on the exposed root surface (Wennström 1996) and to remove root caries lesions (Fourel 1982; Miller 1983). Vigorous planing has also been suggested to reduce the convexity of the root and the mesio-distal distance between periodontal spaces (Holbrook & Ochsenbein 1983), thus improving the possibility of obtaining a greater reduction of the recession. However, Saletta et al. (2005) have demonstrated that while strong root planning (40 strokes) does not modify root curvature, it does minimally reduce (3%) the mesio-distal dimensions of the root surface and slightly flattens (6%) the root surface. It should also be considered that most of Miller Class I and II gingival recessions are associated with toothbrushing trauma in patients with high levels of oral hygiene, clinically healthy gingiva and clean root surfaces. The role of mechanical instrumentation of the exposed root seems questionable in these patients (Wennström 1996) and a more conservative approach could be considered. A previous randomized-controlled clinical study (RCT) (Pini Prato et al. 1999) compared two mechanical treatments of shallow (< 3 mm) gingival recessions associated with CAF: root planing with curettes *versus* polishing

Conflict of interest and source of funding statement

The authors declare that there are no conflicts of interest in this study.
No external funding, apart from the support of the authors' institutions, was available for this study.

with a rubber cup and a prophylaxis paste. At the 3-month re-evaluation, the difference in terms of recession reduction between the test and control sites was not statistically different and residual dental hypersensitivity was present in two sites treated with root planing. More recently, an RCT (Zucchelli et al. 2009b) was conducted to compare the efficacy of hand and ultrasonic instrumentation of the root associated with the CAF approach. The results showed that both treatments were equally effective in terms of root coverage and clinical attachment level (CAL) gain 6 months after surgery.

In the past, chemical conditioning of the exposed cementum (citric acid, tetracycline HCL, etc.) was suggested to improve the clinical and histological outcomes of the treatment of gingival recessions. Chemical agents were used to remove the smear layer produced by root instrumentation (Liu & Solt 1980), to expose the collagen fibrils of the dental matrix, facilitating the formation of a new connective attachment (Selvig et al. 1981; Polson & Proye 1982), and to eliminate cytopathic material on the exposed root that could inhibit fibroblast growth (Olson et al. 1985). However, systematic reviews (Roccuzzo et al. 2002; Oates et al. 2003) have shown that sites treated with root planing alone or with combined chemical/mechanical treatment do not show significant differences in terms of root coverage.

Although a large number of clinical trials have been published on the treatment of localized gingival recessions, few data are available on the long-term results of these procedures. Leknes et al. (2005), in a long-term RCT, report that CAF is a reliable technique for the treatment of recessions in terms of root coverage, probing depth (PD) and CAL gain. In particular, the results are stable at a short follow-up (6–12 months) but long-term (6 years) stability seems to be critically dependent on the recall visits and re-instruction in the use of non-traumatic brushing practices.

Using the same population of a previous study (Pini Prato et al. 1999), this long-term 14-year-randomized split-mouth study aimed at evaluating (1) the outcomes of two different methods of root surface modifications (root planing *versus* root surface polishing) used in combination with CAF and (2) the long-term results of CAF performed for the treatment of single gingival recessions.

Methods

Study population

The study population comprised the group published in a previous short-term split-mouth randomized clinical trial conducted to investigate the potential benefit of root instrumentation or root polishing in the treatment of single gingival recessions with the CAF procedure 3 months after surgery (Pini Prato et al. 1999). Ten patients were selected among individuals referred to the Department of Periodontology of University of Siena Dental School. An a priori sample size calculation was not performed.

Information on this study is summarized below.

The entry criteria used were: (1) non-compromised systemic health and no contraindications for periodontal surgery; (2) presence of maxillary bilateral buccal recessions $\geqslant 2$ mm classified as Miller's Class I or II; (3) difference in the depth of the gingival recession between right and left site $\leqslant 1$ mm and difference in CAL $\leqslant 2$ mm; (4) identifiable cement–enamel junction (CEJ); (5) tooth vitality and absence of grooves, irregularities, caries or restorations in the area to be treated; (6) no periodontal surgical treatment during the previous 24 months on the involved sites; and (7) full-mouth plaque score $<20\%$ and full-mouth bleeding score $<20\%$; and (8) absence of plaque and bleeding on probing at the selected sites.

The 10 patients enrolled in this study received oral hygiene instructions to eliminate habits related to the aetiology of the recessions.

Clinical measurements

The following measurements were taken by one investigator (G. P. P.) using a PCP UNC 15 periodontal probe at baseline:

recession depth (Rec) on the mid-buccal site;
PD on the mid-buccal site;
CAL calculated as PD+Rec;
keratinized tissue (KT) width: distance between the gingival margin (GM) and the mucogingival junction (MGJ);
Anatomical crown length (IM–CEJ): distance between the incisal margin (IM) and the CEJ;
Dentin hypersensitivity (DH): present or absent.

Randomization

A split-mouth design was used. The sites were randomly assigned to two treatment groups (test and control) by tossing a coin (P. C.) immediately before surgery. In the test group, exposed root surfaces were treated by polishing before flap elevation, using a rubber cup and a prophylaxis paste for 60 s under local anaesthesia. Polishing was also performed in the intrasulcular area. Immediately after polishing, the root surface was washed with a water spray for 60 s. In the control group, exposed root surfaces were treated by means of root planing, using curettes under local anaesthesia. Root planing was also performed in the intrasulcular area. Immediately after instrumentation, the treated root surfaces were washed for 60 s with a water spray.

Surgical procedures

Both groups underwent the CAF procedure performed by the same operator (G. P. P.). In nine patients, homologous contra-lateral teeth were treated while a canine and a contra-lateral lateral incisor were treated in patient number 4. A trapezoidal flap was designed using one intrasulcular and two oblique releasing incisions. The full-split-thickness pedicle flap was then elevated. Care was taken to reduce flap tension and facilitate the passive coronal displacement of the GM. The papillae adjacent to the gingival recession were carefully de-epithelialized and the flap was then coronally displaced and sutured.

Post-surgical protocol

Patients were instructed to avoid any mechanical trauma and toothbrushing for 3 weeks in the surgical area. Chlorhexidine rinses were prescribed twice daily for 1 min. Sutures were removed 7 days after surgery and prophylaxis was performed. About 3 weeks after surgery, all patients were instructed to resume mechanical tooth cleaning. The patients were recalled 3 months after surgery and periodontal measurements were repeated.

Follow-up 3 months–14 years

The 10 patients of the previous article were enrolled in the present study and were followed for a long period of time.

Table 1. Descriptive statistics

	Baseline (10 patients)		1 year (10 patients)		5 years (9 patients)		14 years (9 patients)	
	polishing	root planing	polishing	root planing	polishing	root planing	polishing	root planing
Rec (mm)	3.1 (1.1)	2.9 (1.0)	0.6 (0.7)	0.5 (0.6)	0.9 (1.1)	0.7 (0.8)	0.9 (1.2)	0.9 (0.9)
KT (mm)	3.1 (1.3)	2.7 (1.2)	2.4 (1.3)	2.6 (0.8)	2.3 (1.7)	2.4 (1.0)	2.4 (1.8)	2.3 (1.3)
PD (mm)	1.3 (0.5)	1.3 (0.5)	0.7 (0.4)	1.0 (0.4)	0.8 (0.5)	1.0 (0.4)	1.0 (0.6)	1.0 (0.5)
CRC	–	–	4 (40%)	4 (40%)	5 (56%)	4 (44%)	5 (56%)	3 (33%)
Hypersensitivity	5 (50%)	4 (40%)	0 (0%)	0 (0%)	3 (33%)	2 (22%)	3 (33%)	3 (33%)

Mean (standard deviation) for quantitative variables and frequency (percentage) for qualitative variables.
Test, polishing; control, root planning; Rec, recession depth; KT, keratinized tissue; PD, probing depth.

During the 14-year observation period, patients were recalled for 1-, 5- and 14-year follow-up visits and they complied with the programme of supporting periodontal care. They were also recalled every 6 months for professional re-instruction and prophylaxis.

The same baseline and 3-month periodontal measurements (Rec, PD, CAL, IM–GM, IM–MGJ and GM–MGJ) were repeated by the same investigator (G. P. P.), who was not blinded to the treatment and who always used the same periodontal probes.

Statistical analysis

Quantitative data were summarized as means (standard deviation) and qualitative data were summarized as frequency (percentage).

Differences in Rec between the two treatment groups were analysed using a multilevel model at three levels: patient, site and occasion. Occasion refers to the measurements performed at 3 months, 1, 5 and 14 years. Explicative variables were treatment (polishing *versus* root planing), baseline Rec, baseline KT width and time (3 months, 1, 5 and 14 years). Interactions treatment × time, treatment × Rec and treatment × KT were tested. Non-significant interactions were excluded from the model. Time was used as a continuous variable. The software was MLwiN version 2.02© Multilevel Models Project Institute of Education, University of Bristol, Bristol. The algorithm used to fit the model was the Iterative Generalized Least Square.

Differences in hypersensitivity (DH) and CRC at 14 years between the treatment groups were analysed using the McNemar test.

Results

Out of 10 patients, one patient dropped out 1 year later because she moved to another country. In the test group (polishing), Rec was 0.6 (0.7) mm at 1 year (in 1997), 0.9 (1.1) mm at 5 years (in 2001) and 0.9 (1.2) mm at 14 years (in 2010). In the control group (root planing), Rec was 0.5 (0.6) mm at 1 year, 0.7 (0.8) mm at 5 years and 0.9 (0.9) mm at 14 years.

CRC was quite stable over time in both sides. Eight sites, five in the test and three in the control group, showed complete root coverage at 14 years. On the other hand, one site (root planing) showing CRC at 3 months developed a new recession at 14 years while one site (polishing) and one site (root planing) that showed a recession at 3 months developed a CRC at 14 years.

The amount of KT decreased slightly over time in both sides.

Dental hypersensitivity disappeared in both sides 1 year after treatment, while it recurred in three sites of each group at the 14-year follow-up (Table 1).

No side effects occurred during the follow-up period.

Table 2. Multilevel model for recession depth

$$Rec_{ijk} = b_{0ijk} + b_1 Treatment_{jk} + b_2 baseline\_recession_{jk} + b_3 baseline\_KT_{jk} + b_4 Treatment \times baseline\_KT_{jk} + b_5 Time_{ijk} + v_k + u_j + e_j$$

Term	Estimate	Standard error	*p*-Value
Intercept	−0.608	0.443	
Treatment (Test = 1)$_{jk}$	0.766	0.272	0.0049
Baseline recession$_{jk}$	0.463	0.093	<0.0001
Baseline KT$_{jk}$	−0.077	0.093	0.4077
Treatment × baseline KT$_{jk}$	−0.251	0.086	0.0035
Time$_{ijk}$	0.024	0.007	0.0006
$\sigma^2_{\text{Patient}}$	0.072	0.044	
σ^2_{Site}	0.016	0.022	
$\sigma^2_{\text{Occasion}}$	0.118	0.022	

Treatment is a binary variable with value 1 if test and 0 if control side. Time is a continuous variable in years. Recession and KT are measured in mm.
σ^2, variance; *i*, *j*, *k*, occasion, site, patient; KT, keratinized tissue.

Inferential statistics

The multilevel model for Rec is shown in Table 2. The interaction between treatment and KT is significant ($p = 0.0035$). In fact, in cases of 3 mm of baseline KT, the two treated groups showed no difference in terms of Rec during the follow-up observations. Nevertheless, comparing the two treatments, the greater the baseline amount of KT, the lower the final Rec in the test group (polishing), while in the control sites (root planing), the lower the baseline amount of KT, the lower the final Rec (Fig. 1).

Taking into consideration 3 mm of baseline KT as the point of indifference between the two treatments, Figs 2 and 3 show the trend of gingival Rec variation within the two groups over time, for sites with KT < 3 mm and sites with KT ⩾ 3 mm.

Rec increased slightly over time ($p = 0.0006$) in both the test and the control sites. Seven sites (four in the polishing group and three in the root planing group) showed an increased Rec from 3 months to 14 years.

At 14 years, there was no difference in dental hypersensitivity or CRC between the two groups ($p = 1$ and $p = 0.8308$, respectively).

One treated case is reported in Figs 4–8.

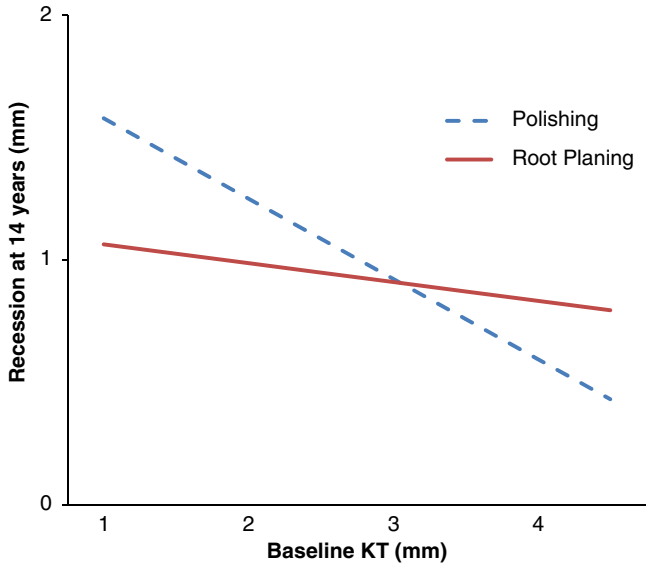

Fig. 1. Interaction between treatment and baseline keratinized tissue, considering a baseline recession depth of 3 mm.

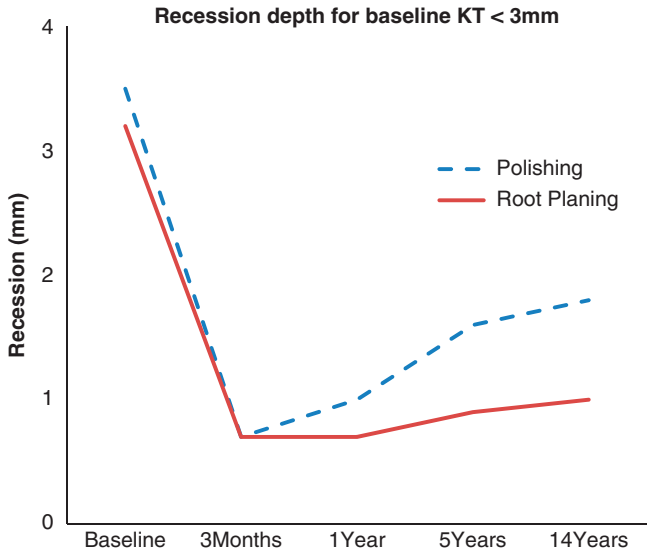

Fig. 2. Trend of gingival recession depth in sites with keratinized tissue (KT) < 3 mm during the 14-year follow-up.

Discussion

Using the same patients of the previous study (Pini Prato et al. 1999), the present 14-year long-term randomized clinical study aimed at evaluating: (1) the outcomes of two different methods of root surface treatments (root planing *versus* root surface polishing) used in combination with CAF and (2) the long-term results of CAF performed for the treatment of single gingival recessions.

Outcomes of root surface treatment: root planing *versus* root surface polishing

Only a few studies discuss different approaches for treating exposed root surfaces associated with gingival recession for root coverage procedures. Oles et al. (1988) compared the efficacy of scaling/polishing, root planing and sodium hypochlorite root conditioning associated with a laterally positioned flap. Three months later, the results of that study did not show any statistical difference in the clinical outcomes among the three treated groups.

More recently, another randomized-controlled split-mouth clinical study (Zucchelli et al. 2009b) was conducted to compare the efficacy of hand and ultrasonic instrumentation in combination with CAF in 11 patients with bilateral Miller Class I and II single recessions. The control root surfaces were planed with curettes while the test group roots were instrumented with ultrasonic piezoelectric devices. Hand and ultrasonic root instrumentation proved equally effective in terms of root coverage and CAL gain at 6 months post-surgery.

In the present study, a multilevel statistical model was set up considering baseline Rec, baseline KT width, treatment and occasions as explicative variables; Rec was the outcome variable. Interaction effects were considered in the model. Interaction is defined as ''a process in which the combined effects of two or more variables are greater than the sum of their individual effects'' (Lang & Secic 2006). In this study, treatment ''per se'' (polishing *versus* root planing) did not show differences in terms of the final Rec; on the other hand, the treatment combined with the baseline amount of KT showed a significant effect. In fact, the two approaches showed different trends: polishing (test group) resulted in a greater recession reduction in the presence of a greater KT width, while root planing (control group) showed a greater recession reduction in sites with a smaller amount of KT. However, these observed clinical outcomes following the two root surface therapies appear to be difficult to explain and therefore further studies are needed.

A post hoc power calculation was reported in the previous short-term study publication (Pini-Prato et al. 1999). The power to detect a difference in change of 0.5 mm at a significant level of $\alpha = 0.05$ was 67%. In this long-term study, a significant difference in interaction terms was found. Therefore, the study has sufficient power to detect this difference. Also, it is possible that the interaction result is due to chance and in this case a statistical type I error is made.

Long-term results of the CAF procedure

The present study was also useful in evaluating the long-term outcomes of the CAF technique for the treatment of

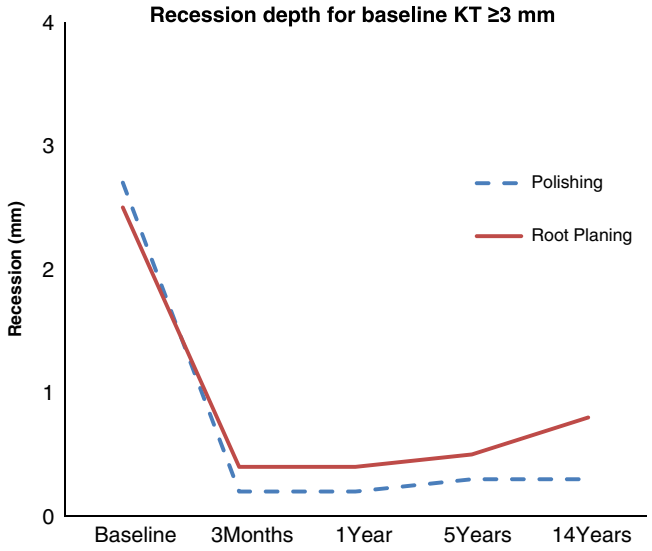

Fig. 3. Trend of gingival recession depth in sites with keratinized tissue (KT) ⩾ 3 mm during the 14-year follow-up.

Fig. 4. Bilateral recessions on maxillary canines.

Fig. 5. The exposed roots were randomly treated by a rubber cup and a prophylaxis paste (left side-test group) and by a sharp curette (right side-control group).

Fig. 6. Coronally advanced flaps were performed on both the test and the control sites in the same surgical session.

Fig. 7. Results 1 year after surgery. Complete root coverage was obtained in both the test and the control sites.

Fig. 8. Results 14 years after surgery. Recession of gingival margin occurred in both sites.

gingival recession defects. Few data are available in the periodontal literature. Leknes et al. (2005) reported a severe recurrence of gingival recession in a 6-year long-term study in sites treated either with CAF alone or with CAF and a bio-resorbable barrier. At 6 years, out of 11 bilateral single recessions, only two sites treated with barriers and one site treated with CAF were still completely covered.

A 3-year case-series study (De Sanctis & Zucchelli 2007) reported an increased amount of KT associated with 97% average root coverage following a modified CAF procedure performed on single-recession defects.

In a 5-year long-term evaluation of a case series treated with the envelope type of CAF approach on multiple recessions, Zucchelli & De Sanctis (2005) reported a slight shift of the GM as compared with 1-year data. In fact, complete root coverage was observed in 88% of the cases at 1 year, while it decreased to 85% at 5 years.

Another 5-year long-term comparative study (Pini Prato et al. 2010) on multiple recessions treated with CAF alone or with CAF+connective tissue graft (CTG) showed a similar trend towards a consistent shift of the GM in the CAF-treated sites, while the CAF+CTG-treated sites showed a tendency towards a coronal shift of the GM.

The present long-term study performed on single gingival recessions revealed an apical shift of the GM in about 39% of the treated sites, showing a progressive worsening of the gingival recessions during the 14-year follow-up period. The estimated apical shift was 0.024 mm per year, on average. This result was statistically significant even if it might not appear relevant from a clinical standpoint. However, a small increase in gingival recession may cause the recurrence of dental hypersensitivity. The observed relapse of the soft tissue defects could be due to a resumption of traumatic toothbrushing habits in patients with high levels of oral hygiene even if they were included in a stringent maintenance protocol with recalls every 4–6 months. At each recall visit, the oral hygiene procedures were checked and the patients were re-motivated and re-instructed, if needed. As a consequence of the apical shift of the GM, the dental hypersensitivity that had disappeared in all the treated sites after 1 year reappeared after 14 years in six sites (three patients) that did not show complete root coverage.

Regarding the KT width, the results of this study showed that it tends to decrease over time. These outcomes differ from those reported in other studies where an increased amount of KT occurred after 1 and 5 years (Zucchelli et al. 2005, 2009a, b).

This randomized trial does have some methodological limitations, such as the lack of sample-size calculation and blind-

ness. However, it should be considered that this study was conducted back in 1995–1996; CONSORT statements to improve the quality of randomized-controlled trials were not available at that time.

In conclusion, root planing and polishing treatments of the exposed root surface used in combination with CAF showed similar outcomes in terms of recession reduction after 14 years. However, considering the baseline amount of KT, polishing seems to be more indicated than root planing in cases of KT widths >3 mm, while root planing appears to be more appropriate in cases of baseline KT widths of <3 mm. In addition, at 14 years, an apical shift of the GM (recession relapse) was found in 39% of the sites treated with the CAF procedure.

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Address:
Giovanpaolo Pini Prato
viale Matteotti
11 50121 Florence
Italy
E-mail: gpinipr@tin.it

Clinical Relevance

Rationale for the study: To verify the long-term outcomes of root planing *versus* root surface polishing used in combination with the CAF procedure for the treatment of single gingival recessions.

Principal findings: Gingival Rec tend to increase following CAF during a 14-year follow-up period. Interaction was found between treatment and baseline KT.

Practical implications: The amount of baseline KT could influence the choice of treatment. An apical shift of the GM occurs in the long-term follow-up period.