Influence of Periodontal Parameters on Root Coverage: A Longitudinal Study

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Abstract

Objective: This study aimed to evaluate the effect of initial periodontal clinical parameters on the final outcome of the treatment of periodontal recessions by means of a coronally positioned flap (CPF).

Materials and methods: The CPF technique was used in a total of 39 Miller Class I/II gingival recessions of the upper canines and/or premolars. The clinical periodontal parameters evaluated were: probing depth, gingival recession height, gingival recession width, keratinized mucosa, attached keratinized mucosa, flap thickness and free gingival margin thickness. The degree of root coverage was evaluated 6 months and 1 year after the surgery. The data were analyzed by Student's *t*-test, Mann-Whitney and Pearson's correlation tests, as well as linear regression.

Results: A significant reduction in gingival recession height, gingival recession width, keratinized mucosa, and attached keratinized mucosa were observed. A significant negative correlation was found between gingival recession and root coverage percentage at 1 year, and a significant negative correlation between gingival margin thickness and coverage percentage at 1 year. The gingival recession and flap thickness significantly predicted the amount of root coverage.

Conclusions: The initial dimensions of gingival recession and the mucosa thickness were correlated to the percentage of root coverage. The gingival recession width was the major predictor of root coverage.

Key words: Coronally positioned flap, gingival thickness, gingival recession, keratinized mucosa, root coverage

Introduction

Gingival recession (GR) is defined as an apical displacement of the soft tissue with respect to the cemento-enamel junction (Wennström, 1996). This clinical condition is a common finding in patients with a high standard of oral hygiene, as well as in periodontally untreated populations with poor oral hygiene (Serino *et al.*, 1994). Many factors have been proposed to influence the ethiopathogenesis of gingival recession, including plaque-induced inflammation, toothbrush trauma, teeth alignment, orthodontic treatment and restorative procedures. Also, several predisposing factors and conditions commonly associated with gingival recession are mentioned in the literature: thermal/chemical injury, thin gingiva, frenum position problem, soft tissue deformities and narrow band of keratinized tissue (Merijohn, 2016).

The migration of the marginal tissue to an apical position may result in esthetically unfavorable effects, as well as in increased susceptibility to root caries and dentine hypersensitivity (Bouchard *et al.*, 2001). The main goal in surgical treatment of gingival recession is to cover the exposed root surfaces, to improve esthetics and to reduce hypersensitivity. Additional benefits that result from this treatment may include an increase in gingival width and thickness. Different treatment approaches such as the use

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of free gingival grafts (Nabers, 1966), laterally positioned flaps (Grupe and Warren, 1956), coronally advanced flaps (Harvey, 1970), subepithelial connective tissue grafts (Langer and Langer, 1985), guided tissue regeneration (Pini Prato, 1992) and acellular dermal matrix allografts (Tal *et al.,* 2002) have been developed to achieve the above goals.

The selection of one surgical technique should consider several factors, some of which are related to the defect (i.e., size of the recession defect, presence or absence of keratinized tissue adjacent to the defect, width and height of the interdental soft tissue, depth of the vestibule, presence of frenuli) while others are related to the patient (Zucchelli *et al.,* 2000).

Usually, one of the primary reasons to obtain root coverage has been attributed to establishing an adequate width of keratinized tissue. A previous study reported that root coverage with a coronally positioned flap alone was strongly associated with flap thickness (Baldi *et al.,* 1999). Coronally positioned flap alone produced excellent defect coverage when sites had, among other characteristics, "adequate" tissue thickness (Allen *et al.,* 1989). In addition, the integrity of the proximal bone is also essential to determine the predictability of outcomes in terms of root coverage, irrespective of the surgical technique used (Allen *et al.,* 1989).

Although there are several studies investigating root coverage procedures, to this date the influence of periodontal clinical parameters in the degree of root coverage is still not clear. In this regard, there are few clinical trials evaluating the periodontal parameters on root coverage and these studies use different methods that did not allow definitive conclusions (Baldi *et al.,* 1999; Huang *et al.,* 2005; Hwang and Wang, 2006). Furthermore, clinicians must consider data from the literature in order to select the most predictable surgical approach among those feasible in a given clinical situation. Therefore, the aim of this study was to evaluate the effect of initial periodontal clinical parameters on the final outcome of the treatment of periodontal recessions by coronally positioned flap procedure. The investigated parameters were probing depth, gingival recession dimensions, keratinized mucosa and tissue thickness.

Materials and methods

Sample size

Sample size was calculated based on the standard deviation of the width of gingival recessions obtained from a previous study (Douglas de Oliveira *et al.,* 2013) with the difference to be detected after treatment set at 1 mm. To compensate for subject dropout, 10% was added. The minimum sample size required was 39 gingival recessions (GR) considering a 95% confidence and a power of 85%.

Selection of individuals and surgical sites

This study was conducted in accordance with the Helsinki Declaration, 1975, revised in 2013, and was independently reviewed and approved by the Institutional Review Board of the Pontifical Catholic University of Minas Gerais (PUC Minas), Brazil, under protocol 0044.0.213.000-07. A signed informed consent was obtained from all individuals prior to their participation and all subjects' rights were protected at all times.

The following inclusion criteria were adopted: periodontal health; presence of Miller Class I or II GR (Miller, 1985) in canines and/or maxillary premolars; complaint of esthetics or hypersensitivity. The following patients were excluded: smokers or those who had been ex-smokers for fewer than 10 years; under the age of 18 or older than 50 years; those under orthodontic treatment, or who had concluded orthodontic treatment within the last six months; presence of occlusal trauma; presence of dental prostheses; restored teeth; noncarious cervical lesions; those with problems of a systemic nature that contraindicated or altered the proposed surgical periodontal therapy. Therefore, 14 individuals (1 male and 13 females), aged between 28 and 47 years (mean age 35.79), with 39 GR were selected.

All individuals were instructed about the etiology of their recessions, and were submitted to surgical treatment of one or more GR, in order to resolve problems of hypersensitivity or for esthetic reasons. Prior to surgery, oral hygiene instructions were provided, and scaling using hand and powered instruments as well as coronal polishing was performed 3 times per week until the minimum plaque score was achieved. The criterion for surgery was optimal plaque index (Löe, 1967) with a full-mouth plaque score of 15% or less. Stillman's technique, using a soft-bristle toothbrush, gentle brushing and fluoridated toothpaste was recommended.

Clinical parameters

Clinical assessments were performed by a trained and calibrated periodontist (TRV). The calibration was done by the test-retest method with an interval of 7 days in five teeth with gingival recessions. Intra-examiner repeatability was conducted before the trial began and the intra-class correlation coefficient was 0.99. Using the central-vestibular midline (CV) of the dental crown as the point of reference, the parameters described below were evaluated before (baseline), as well as 6 months and 1 year after surgery.

1. Probing depth (PD): measured from the gingival margin to the bottom of the gingival sulcus, at the CV site, with a periodontal probe (Williams probe, Hu-Friedy, Rio de Janeiro, Brazil).
2. GR height (GRH): the distance between the most apical point of the cemento-enamel junction and gingival margin was determined with a periodontal pachymeter (Mitutoyo Sul Americana, Santo Amaro, Brazil) (Yared *et al.,* 2006).

3. GR width (GRW): the distance between the mesial gingival margin and distal gingival margin of the tooth (across the buccal surface at the cemento-enamel junction level) was determined with a periodontal pachymeter.
4. Clinical attachment level (CAL): the sum of GRH and PD.
5. Keratinized mucosa (KM): compound solution of iodine (Schiller) was applied and the periodontal pachymeter, taking as reference the distance from the most apical point of the GRH up to the mucogingival line, was used.
6. Attached keratinized mucosa (AKM): recorded by means of periodontal pachymeter, taking as reference the most apical point of the GRH up to the mucogingival ling, and subtracting the PD.
7. Free gingival mucosa thickness (GMT): measured on the CV surface using the periodontal pachymeter.
8. Flap thickness (FT): measured on the CV surface during the surgical procedure of the partial thickness flap using the periodontal pachymeter.

The percentage of defect coverage was calculated as [(preoperative GRD–postoperative GRD)/preoperative GRD] x 100, except for FT, which was measured only during the surgery.

Surgical procedure

Again, a single trained and experienced periodontist (TRV) performed all surgeries using a previously described technique that involves a coronally positioned flap (Wennström *et al.,* 1996). Briefly, extra-oral antisepsis was performed with topical iodopovidine and intraoral antisepsis with 0.12% chlorhexidine rinse for 1 minute. Lidocaine (2.0%) with 1:100,000 epinephrine was used for local anesthesia. The surgical bed was opened by means of an intrasulcular incision and two slightly oblique vertical relaxing incisions in the mesial and distal papillae of the tooth with GR, resulting in a trapezoidal flap, and delineating the future papilla. A full thickness flap was raised from the gingival margin up to 1.0 mm after the bone crest. A partial thickness flap was dissected in the apical direction to the mucogingival line from 1.0 mm of exposed bone tissue. To allow coronal advancement of the flap, all muscle insertions and fibers in the flap were eliminated. Coronal mobilization of the flap was considered adequate when the gingival margin of the flap was able to passively reach a coronal level to the cemento-enamel junction of the target tooth. The external surface of the papilla was de-epithelialized, the root scaling procedures were performed with curettes numbers 3-4 and 5-6, and root planing was done with diamond-coated burs. The flap was adapted on the root surface 1.0 mm coronally to the cemento-enamel junction and immobilized with a suspended suture associated with isolated stiches in the relaxing incisions. The periodontal flap was sutured free of tensions. No surgical cement was used. Primary closure of the surgical wound was obtained with the use of nylon 5.0 thread.

Post-operative care

All patients received instructions regarding postoperative care. The patients were instructed to take 500 mg sodium dipyrone every 4 hours for 3 days and 100 mg nimesulide every 12 hours for 5 days (if they experienced pain). They were asked to not brush their teeth in the surgical areas until suture removal, and to rinse with 0.12% chlorhexidine digluconate solution for 1 minute twice a day for 15 days. Sutures were removed after 14 days. During this visit, patients were also reinstructed with regard to atraumatic brushing techniques and were enrolled in maintenance care.

Statistical analysis

The Shapiro-Wilk test was used to confirm normal distribution of the data. Mean values and standard deviations were calculated for all clinical variables. The significance of differences in periodontal measures before and after treatment was evaluated by the Friedman and analysis of variance (ANOVA) tests. The Wilcoxon and paired Student's *t*-test were used as post-hoc tests, and Bonferroni correction was used for the post-hoc analysis. The Wilcoxon test was performed to compare the results of the root coverage degree at 6 months and 1 year. The Mann-Whitney test was used in order to analyze differences between the procedure results in canines and premolars. Correlations between the variables were evaluated using the Spearman correlation test. A simple linear regression was conducted in order to verify the independent variables that best predicts the percentage of root coverage at 1 year postoperatively with the independent variables that obtained a p value lower than 0.20 in the correlation test. Differences were considered statistically significant at $p < 0.05$. Statistical analysis was performed using statistical software (Software Package for Social Science. IBM Corp., Armonk, NY, USA).

Results

Fourteen participants aged 28 to 47 years-old (1 male and 13 female; mean age, 35.79) had 39 GR. Sixteen GR were located in first premolars (41%), 13 in canines (33%), and 10 in second premolars (26%). Healing was successfully accomplished in all GR and all participants were evaluated throughout the established period.

The mean values of the clinical parameters at baseline, 6 months and 1 year after treatment are shown in the *Table 1*. Significant statistical differences were observed for GRH, GRW, KM, AKM, GMT and CAL but not for PD (*Table 1*). At the 1 year follow-up, complete root coverage (100%) was achieved in 10.3% (n = 4) GR, and the mean percentage of root coverage was 82.83% (SD: 12.02).

At the 1-year follow-up, correlations between percentage root coverage and the following parameters were encountered: GRH ($r = -0.67$, $p < 0.001$); GRW ($r = -0.76$, $p < 0.001$); GMT ($r = 0.67$, $p < 0.001$); FT ($r = 0.69$, $p < 0.001$). There was no correlation between the 1-year root coverage percentage and all other periodontal parameters at baseline (*Table 2*).

The decreases in GRH and GRW were statistically associated, respectively, with 8.18% and 14.14% improvement in mean root coverage, and the FT with 46%. The variables PD, KM and AKM were not statistically correlated to the percentage of root coverage (*Table 3*). There were no statistically significant differences between canines and premolars in any periodontal parameters at any of the evaluation times (*Table 4*).

Table 1. Clinical parameters (mm) at baseline, 6 months and 1 year postoperatively.

	Baseline (T_0)		6 months (T_1)		1 year (T_2)		*p*	Post-hoc test
	Mean (SD)	Median (Q1; Q3)	Mean (SD)	Median (Q1; Q3)	Mean (SD)	Median (Q1;Q3)		
GRH	2.58 (0.73)	2.56 (2.19; 2.89)	0.36 (0.35)	0.19 (0.05; 0.64)	0.48 (0.38)	0.32 (0.14; 0.82)	<0.001*	T_0 x T_1: < 0.001 T_0 x T_2: < 0.001 T_1 x T_2: < 0.001
GRW	3.55 (0.61)	3.52 (3.16; 3.98)	0.74 (0.57)	0.57 (0.19;1.34)	0.88 (0.62)	0.69 (0.31; 1.53)	<0.001*	T_0 x T_1: < 0.001 T_0 x T_2: < 0.001 T_1 x T_2: < 0.001
PD	1.05 (0.22)	1.00 (1.00; 1.00)	1.12 (0.33)	1.00 (1.00; 1.00)	1.15 (0.48)	1.00 (1.00; 1.00)	0.204*	-
KM	3.99 (0.82)	4.07 (3.28; 4.52)	3.75 (0.83)	3.79 (3.09; 4.36)	3.73 (0.83)	3.77 (3.05; 4.34)	<0.001**	T_0 x T_1: < 0.001 T_0 x T_2: < 0.001 T_1 x T_2: < 0.001
AKM	2.94 (0.84)	2.84 (2.25; 3.52)	2.73 (0.83)	2.72 (2.05; 3.36)	2.70 (0.83)	2.69 (2.03; 3.34)	<0.001**	T_0 x T_1: < 0.001 T_0 x T_2: < 0.001 T_1 x T_2: < 0.001
GMT	0.46 (0.16)	0.48 (0.30; 0.62)	0.59 (0.16)	0.60 (0.30; 0.62)	0.63 (0.16)	0.64 (0.46; 0.78)	<0.001*	T_0 x T_1: < 0.001 T_0 x T_2: < 0.001 T_1 x T_2: < 0.001
% Root coverage	-	-	87.62 (11.05)	93.31 (79.32; 96.80)	82.83 (12.02)	88.21 (74.26; 92.31)	<0.001***	-
FT	0.50 (0.15)	0.52 (0.34; 0.64)	-	-	-	-	-	-

*Friedman test (Wilcoxon post-hoc test); **ANOVA (paired *t* post-hoc test); ***Wilcoxon test. GRH, gingival recession height; GRW, gingival recession width; PD, probing depth; KM, keratinized mucosa; AKM, attached keratinized mucosa; GMT, free gingival mucosa thickness; FT, flap thickness.

Table 2. Correlations between root coverage percentage 1 year postoperatively and periodontal parameters at baseline.

	PD		GRH		GRW		KM		AKM		GMT		FT	
	r_s	*p*	r_s	*p*	r_s	*p*	r_s	*p*	r_s	*p*	r_s	*p*	r_s	*p*
root coverage percentage 1y	0.238	0.145	-0.670	<0.001	-0.768	<0.001	0.292	0.071	0.212	0.194	0.671	<0.001	0.691	<0.001

r_s, Spearman correlation; PD, probing depth; GRH, gingival recession height; GRW, gingival recession width; KM, keratinized mucosa; AKM, attached keratinized mucosa; GMT, free gingival mucosa thickness; FT, flap thickness.

Table 3. Simple linear regression for root coverage percentage 1 year postoperatively.

Variables (T_0)	β	95% Confidence interval		R^2	*p*
		Lower	Upper		
PD	10.39	-7.19	27.98	0.01	0.239
GRH	-8.18	-12.91	-3.45	0.22	0.001
GRW	-14.14	-18.59	-9.68	0.51	< 0.001
KM	2.66	-2.11	7.44	0.01	0.266
AKM	1.82	-2.90	6.55	0.01	0.439
GMT	49.23	31.41	67.03	0.44	< 0.001
FT	53.58	34.98	72.18	0.46	< 0.001

PD, probing depth; GRH, gingival recession height; GRW, gingival recession width; KM, keratinized mucosa; AKM, attached keratinized mucosa; GMT, free gingival mucosa thickness; FT, flap thickness.

Table 4. Clinical parameters (mm) according to teeth group and evaluation time.

Variables	Baseline (T_0)				*p*	6 months (T_1)				*p*	1 year (T_2)				*p*
	Canine		Premolar			Canine		Premolar			Canine		Premolar		
	Mean	SD	Mean	SD		Mean	SD	Mean	SD		Mean	SD	Mean	SD	
PD	1.00	0.00	1.08	0.27	0.311	1.15	0.38	1.12	0.33	0.738	1.23	0.60	1.12	0.43	0.462
GRH	2.87	0.81	2.43	0.66	0.071	0.47	0.43	0.31	0.30	0.200	0.60	0.46	0.43	0.34	0.195
GRW	3.78	0.82	3.44	0.46	0.063	0.88	0.67	0.68	0.52	0.304	1.03	0.72	0.81	0.57	0.245
KM	3.93	0.99	4.03	0.74	0.612	3.71	1.00	3.78	0.76	0.571	3.69	1.00	3.76	0.76	0.571
AKM	2.93	0.99	2.95	0.77	0.812	2.71	1.00	2.75	0.77	0.677	2.69	1.00	2.72	0.77	0.677
GMT	0.45	0.18	0.47	0.16	0.800	0.57	0.17	0.60	0.16	0.665	0.61	0.17	0.64	0.16	0.612
FT	0.48	0.16	0.51	0.15	0.698	-				-	-				-

PD, probing depth; GRH, gingival recession height; GRW, gingival recession width; KM, keratinized mucosa; AKM, attached keratinized mucosa; GMT, free gingival mucosa thickness; FT, flap thickness.

Discussion

Gingival recession can cause dentin hypersensitivity, root caries, abrasion and inconvenience to patients due to esthetic, psychological and functional problems (Chrysanthakopoulos, 2014). Although there are several periodontal plastic surgery procedures for GR treatment, the relation of periodontal parameters to the surgical treatment outcomes for this condition is not clear in the literature. The results from the present study indicate that the dimensions of specific clinical parameters can influence the percentage of root coverage.

Significant improvements in the periodontal status for GRH, GRW, KM, AKM and GMT at 6 months and 1 year were observed. The root coverage reflects the safety, stability and success of the surgical procedure at 1 year, and these results are in accordance with previous studies (Cairo *et al.,* 2014; Graziani *et al.,* 2014; Tonetti *et al.,* 2014).

The significant reduction in GR dimensions encountered at 6 months and 1 year postoperatively may be explained by the ability of the coronal replacement of the flap in covering the exposed root (Wennström *et al.,* 1996). The present results are also in accordance with systematic reviews that described high predictability for root coverage and clinical attachment gain when using coronally positioned flaps for the treatment of Miller Class I/II gingival recession (Hofmänner *et al.,* 2012; Cairo *et al.,* 2014; Graziani *et al.,* 2014; Tonetti *et al.,* 2014).

Similarly, other clinical trials also reported that an increase in GRH was negatively correlated with a reduction in percentage of root coverage (Pini Prato *et al.,* 1996; Clauser *et al.,* 2003; Douglas de Oliveira *et al.,* 2013). Although there was a statistically significant increase in the GR width and height from 6 months to 1 year (approximately 0.12 mm), this difference was not of clinical or esthetical importance and, therefore, did not compromise the root coverage success achieved 1 year postoperatively. The wider recessions are more difficult to cover because of the distance of the vascular resources from the center of the denuded root, and the requirement of nutrients to preserve the flap from necrosis (Pini Prato *et al.,* 2005; Haghighati *et al.,* 2009).

The present results are similar to previous studies that found that larger initial GMT led to a higher percentage of root coverage (Allen *et al.,* 1989; Baldi *et al.,* 1999; Huang *et al.,* 2005; Hwang and Wang, 2006). However, it is important to mention that in some cases it would not be the gingival thickness that favors the success of root coverage, but other factors, such as interruption of the trauma caused by brushing (Wennström *et al.,* 1996).

Thicker gingival tissue maintains vascularization, favors tissue adaptation and promotes wound healing during and after surgery (Zuhr *et al.,* 2014). Thicker gingival tissue is resistant to trauma and, consequently, to recession. It makes tissue manipulation feasible, promotes better attachment (Hwang and Wang, 2006), improves esthetics (Bherwani *et al.,* 2014), presents less clinical inflammation and offers a better prognosis for surgical procedures. In contrast, the 'minimum' GMT has not yet been established (Allen *et al.,* 1989; Baldi *et al.,* 1999; Huang *et al.,* 2005). The majority of studies measure gingival thickness coronally to the mucogingival junction at different levels; however, it is not clear if the position is relevant (Hwang and Wang, 2006). In the present study, the measurement of GMT was performed on the CV surface, with the use of a periodontal pachymeter, whereas some studies used an Iwanson compass. Others defined gingival thickness by the visibility of the periodontal probe during probing (a rather subjective method), and there are also reports of the use of an endodontic spacer for this purpose (Allen *et al.,* 1989; Wennström *et al.,* 1996; Baldi *et al.,* 1999; Huang *et al.,* 2005; Hwang and Wang, 2006; Douglas de Oliveira *et al.,* 2013).

In the present study, a negative correlation was found between FT and final GRH, as well as between FT and final GRW. An indirect relationship was found between initial GMT and initial GR ($p < 0.05$). These results suggest the influence of gingival thickness on the etiology of periodontal recessions. Another study (Huang *et al.*, 2005) reported that a significant contraction of the FT may result in a smaller amount of root coverage, thus determining the great importance of carefully manipulating the periodontal flap.

No statistically significant difference was observed in PD at any time and with the root coverage percentage one year postoperatively. This could be explained because the participants did not have any periodontal disease. The parameters KM and AKM showed a little reduction that was statistically significant, but did not correlate with the root coverage percentage 1 year postoperatively. These results are in agreement with some studies that demonstrated the KM and AKM did not correlate with root coverage (Blanc *et al.*, 1991; Harris and Harris, 1994), although the amount of KM and AKM has important play in the surgery technique selection. However, this result does not corroborate other studies that report the augmentation of KM and AKM, which may be caused by keratinization of the covering epithelium or by the genetic memory of the mucogingival line (Camargo *et al.*, 2001; Douglas de Oliveira *et al.*, 2013; Cairo *et al.*, 2014).

In the daily treatment of patients in the clinic, the surgical technique used in single recession defects is the CPF, which achieves excellent results such as shorter time, lower morbidity and minimal invasiveness compared to other surgical procedures. Furthermore, with the CPF, the real influence of each periodontal parameter could be evaluated in terms of outcome. The clinical relevance consists of the fact that the CPF can be indicated in cases of shallow gingival recessions with good prognosis.

The surgical technique used herein (CPF) allows the gingival flap to maintain vascularization, facilitates tissue adaptation and promotes wound healing during and after surgery (Hwang and Wang, 2006). The literature reports that the use of grafts and/or biomaterials can predictably increase gingival dimensions (Cairo *et al.*, 2004; Hofmänner *et al.*, 2012). Thus, the final outcome can be faced as an effect of the initial periodontal parameters themselves, since only the flap was manipulated and replaced.

The short-term results obtained from this research were already published and discussed in a previous study. The reader is encouraged to see Vieira *et al.* (2016) for more details about 3 months findings.

The present study may have limitations as there was no control or placebo group because all patients were referred to periodontal surgery, and measurement bias may have occurred because the periodontist was not masked or double-masked.

Conclusions

The initial clinical periodontal parameters were correlated to the percentage of root coverage. The gingival recession was the major predictor of the amount of root coverage. However, clinicians should carefully evaluate the other parameters, as they can also influence the predictability of the surgical root coverage.

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