Effect of Periodontal Parameters on Root Coverage

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Abstract

Objective: The aim of this study was to evaluate the influence of periodontal clinical parameters on the treatment of gingival recession by means of a coronally positioned flap (CPF).

Materials and methods: In this clinical study, the coronally positioned flap technique was used in a sample of 14 individuals with Miller's Class I or II gingival recession of the canines and/or maxillary premolars, totaling 39 recessions. The clinical periodontal parameters evaluated were: probing depth (PD), gingival recession height (GRH), gingival recession width (GRW), clinical attachment level (CAL), keratinized mucosa (KM), attached keratinized mucosa (AKM), gingival thickness (GT) and free gingival margin thickness (GMT). The degree of root coverage was evaluated 3 months after the surgical procedures were performed. The data were analyzed using Student's-*t*, Mann-Whitney and Pearson's correlation tests, as well as the Cohen's *d*.

Results: After root coverage, there was no significant change in PD. Significant reductions in GRH and GRW were observed. In addition, a significant reduction in KM and AKM, and an increase in GMT were also observed. A significant negative correlation was found between initial GMT and gingival recession at 3 months, and a significant negative correlation between GT and periodontal recession at 3 months. There was large effect size for GRH, GRW, CAL, KM, AKM and GMT parameters.

Conclusions: The initial gingival recession height, keratinized mucosa and free gingival margin thickness were the parameters that had the most influence on root coverage by the coronal sliding flap technique.

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

Introduction

Gingival recession (GR) is characterized by a loss of attachment, exposing the root surface, with the gingival margin located apically to the amelocemental junction (American Academy of Periodontology, 2001). Its etiology is of a multifactorial nature, being associated with pathological, anatomical and physiological factors that lead to the loss of protective and supporting tissues of the teeth (Levine *et al*., 2014). This periodontal condition may be localized or generalized and affects patients with both high and low standards of oral hygiene; it is more prevalent in patients with a high standard (Paolantonio, 2002).

Gingival recession has a prevalence of 88% in individuals over the age of 65 years, and 50% in individuals aged between 18 and 64 years, in the world population (Paolantoni, 2002). Due to this high rate of prevalence, and the sequelae arising from this process (for example, dentin hypersensitivity, greater extent of bacterial biofilm accumulation, root caries lesions, gingival inflammation, difficulty with cleaning, progressive increase in clinical crown of teeth, and esthetic disharmony), there is an urgent need for treatment of this periodontal condition (Bherwani *et al*., 2014; Paolantoni, 2002).

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Selection of the surgical procedure for the treatment of GR may be determined by the configuration of the defect, predictability of the surgical technique, availability of donor tissue and patients' esthetic expectations (Douglas de Oliveira *et al*., 2013a). When choosing a procedure, not only esthetics and predictability must be considered (Harris and Harris, 1994), but also the re-establishment of function, shape, texture, color and contour of the tissues, as well as the potential to promote the formation of a new protective and supporting system for the teeth (Wang *et al*., 2001).

The root coverage techniques available at present have advantages, limitations and indications (Harris, 2002), with different results and patterns of repair (Wang *et al*., 2001). There are diverse mucogingival surgical techniques for the treatment of GR, such as the coronally positioned flap (Pini Prato *et al*., 1999), connective tissue grafting (Harris, 2002; Langer and Langer, 1985), allogeneic dermal grafts, absorbable and non-absorbable membranes, and growth factors, among the guided periodontal regeneration procedures (Wang *et al*., 2001; Tinti *et al*., 1992; Shieh *et al*., 1997).

In single recession defects, the most widely used flap technique is the coronally positioned flap (CPF). Moreover, the CPF may give satisfactory results as it has the advantages of being a short procedure that uses a single surgical area, thus reducing the morbidity of the patient, producing a better and more natural esthetic outcome (de Sanctis and Clementini, 2014).

The quest for effective treatment of GR historically demonstrates the appearance and perfection of innumerable surgical techniques (Bherwani *et al*., 2014; Harris and Harris, 1994; Harris, 2002; Pini Prato *et al*., 1999; Harlan, 1907; Sumner, 1969; Allen and Miller, 1989; Blanc *et al*., 1991; Wennstrom and Zucchelli, 1996; Borgheti *et al*., 2002; Huang *et al*., 2005; Hwang and Wang, 2006; Baldi *et al*., 1999). However, there is no consensus in the literature about the influence of the periodontal clinical parameters or degree of root coverage. The CPF was the technique elected due to a better observation of each periodontal parameter *per se,* without influence of grafts or biomaterials. The limitations and methodological differences among studies must be pointed out, which makes it difficult to analyze, compare and reach any general and definitive conclusion about the subject. The aim of this study was to evaluate the influence of clinical periodontal parameters on the surgical treatment of gingival recession.

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*., 2013b) with the difference to be detected after treatment set at 1 mm. To compensate for losses, 10% was added. The minimum sample size required was 39 recessions, considering a 95% confidence and 85% power.

Selection of individuals and surgical sites

This study was approved by the Research Ethics Committee of Pontifical Catholic University of Minas Gerais (PUC-Minas), protocol number 0044.0.213.000-07. This study was conducted in accordance with the Helsinki Declaration, 1975, revised in 2013. All patients signed a term of free and informed consent after thorough explanation of the nature, risks, and benefits of the clinical investigation.

The sample of the present study was obtained from individuals who were referred to the clinics of the PUC-Minas Dental School. Fourteen (14) individuals (1 male and 13 female), aged between 28 and 47 years (mean age 35.79), were selected, totaling 39 GR.

As inclusion criteria, the following was stipulated: presence of GR Miller Class I or II (Miller, 1985) in canines and/or maxillary premolars, and complaint of esthetics or hypersensitivity. The following patients were excluded: smokers or those who had been ex-smokers for less than 10 years; under the age of 18 or older than 50 years; presence of active periodontal disease (bleeding or suppuration on probing; and probing depth greater than 4.0 mm); those under orthodontic treatment, or who had concluded orthodontic treatment less than six months previously; presence of occlusal trauma; presence of dental prostheses; those with problems of a systemic nature that contraindicated or altered the proposed surgical periodontal therapy.

All the individuals were submitted to surgical treatment of one or more GR, in order to solve problems of hypersensitivity or for esthetic reasons, and patients were instructed about the etiology of their recessions. Prior to surgery, oral hygiene instructions were provided, and scaling using hand and powered instruments as well as coronal polishing were performed three times a week. The criterion for surgery was optimal plaque control with a full-mouth plaque score of 15% or less. All patients were instructed to use dental floss and atraumatic brushing. Stillman's technique, using a soft-bristle toothbrush, gentle brushing, and fluoridated toothpaste were recommended.

Clinical parameters

The investigator (TRV) in charge of clinical assessments was trained and calibrated for intraexaminer repeatability before the trial began. Calibration was done by the test-retest method with an interval of 7 days in five teeth with gingival recession. The intra-class correlation coefficient was 0.99.

The following clinical parameters were measured, all using the central-vestibular midline (CV) of the dental crown as the point of reference: 1) probing depth (PD):

measured from the gingival margin to the bottom of the gingival sulcus, at the CV site, with a periodontal probe (UNC-15 probe, Hu-Friedy, Rio de Janeiro, Brazil); 2) GR height (GRH): the distance between the most apical point of the cementoenamel junction and gingival margin, measured with a periodontal caliper; 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), measured with a periodontal caliper; 4) clinical attachment level (CAL): obtained with the aid of a periodontal probe (UNC-15 probe), by means of the sum of measurements of GRH and PD; 5) keratinized mucosa (KM): recorded by means of a periodontal caliper, taking as reference the distance from the most apical point of the GRH up to the mucogingival line. The Schiller solution was applied for better visualization; 6) attached keratinized mucosa (AKM): recorded by means of periodontal caliper, taking as reference the most apical point of the GRH up to the mucogingival line, and subtracting the PD; 7) free gingival mucosa thickness (GMT): measured on the CV surface using the periodontal caliper; 8) gingival thickness (GT): measured on the CV surface during the surgical procedure of the partial thickness flap, using the periodontal caliper. The percentage of gingival recession defect coverage was calculated as [(preoperative GRD–postoperative GRD)/preoperative GRD] x 100. All of these parameters were evaluated at baseline and 3 months after surgery, except that GT was measured only during the surgery.

Surgical procedure

A single operator (TRV) performed all surgeries using a previously described technique that involves a coronally positioned flap (Wennström and Zucchelli, 1996), as briefly described below (*Figure 1*).

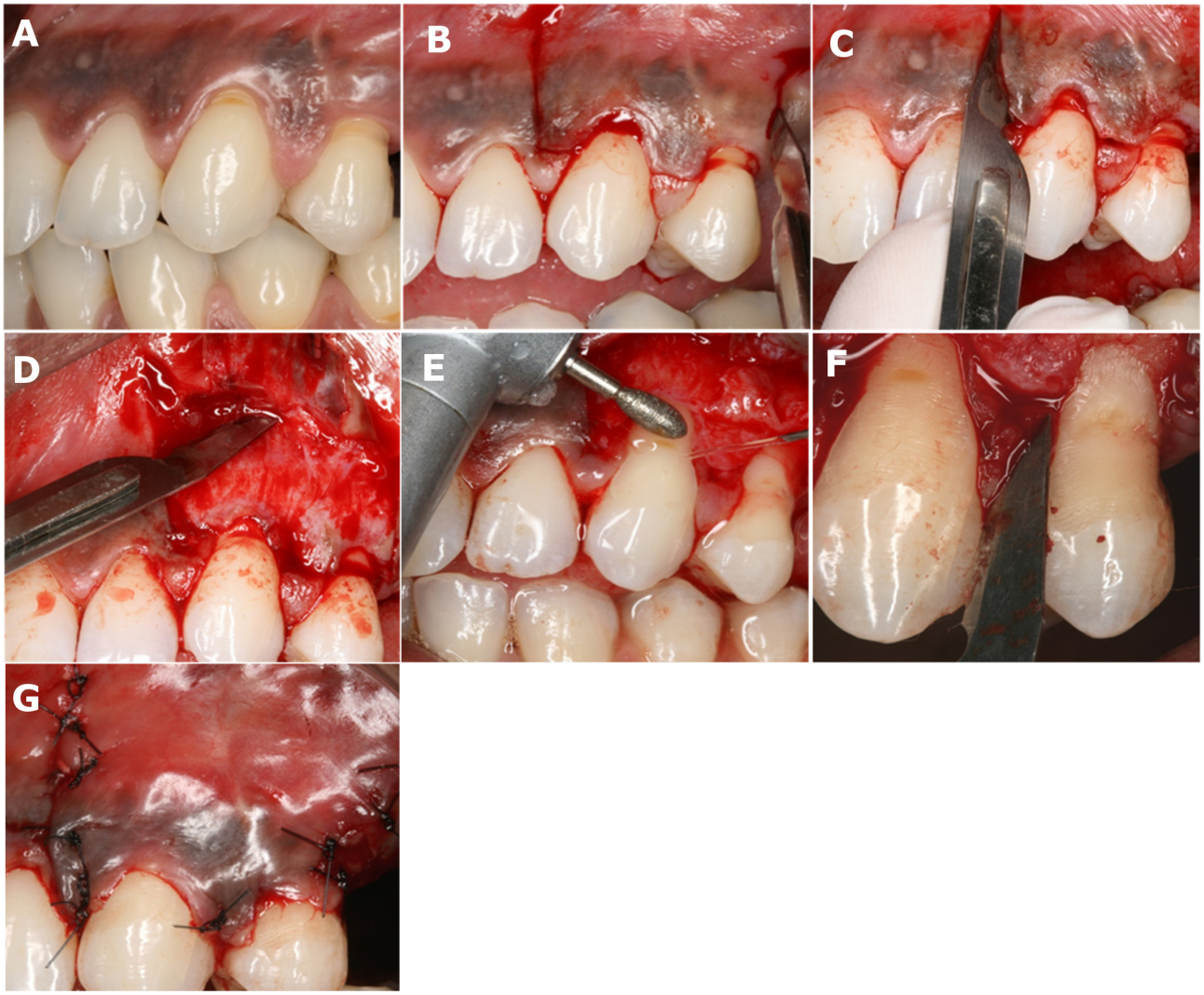

Figure 1. A) Maxillary left canine and first premolar with typical Miller Class I gingival recession; B) Incision resulting in a trapezoidal flap with papillae preservation; C) Full-thickness flap along the gingival margin; D) Partial-thickness flap extended to distal/mesial papillae and dissection of muscle insertions and fibers; E) Root surface planed with bur; F) De-epithelialization of the papilla; G) Flap kept in a coronal position by sling sutures around the tooth.

Before surgery, extraoral 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 a sulcular incision and two slightly oblique incisions, vertical relaxing incisions in the mesial and distal papillae of the tooth with GR, resulting in a trapezoidal flap, delineating the line of incision of the future papilla. A #15 blade was used. A full thickness flap was raised from the gingival margin up to 1.0 mm coronal to the bone crest. Apical to the bone exposure, a partial thickness flap was dissected in the apical direction to the mucogingival line using a #15 blade. To permit 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 level coronal to the cementoenamel junction of the target tooth. The external surface of the papilla was de-epithelialized, and the root scaling procedures were performed with curettes (Hu-Friedy) numbers 3-4 and 5-6, and root planing with diamond-coated burs. The flap was tried in the desired position, displaced and adapted on the root surface, positioned 1.0 mm coronally to the cementoenamel junction, and immobilized with a suspended suture associated with isolated stiches in the relaxing incisions. The periodontal flap was sutured free of tension. 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 (only if they experienced pain), along with 100 mg nimesulide every 12 hours for 5 days. They were asked not to 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 for maintenance care.

Statistical analysis

Statistical analysis was performed using statistical software (SPSS, version 22.0, IBM, Armonk, NY). Mean values and standard deviations were calculated for all clinical variables. The Shapiro-Wilk test was used to confirm normal distribution of the data. The significance of differences in periodontal measures before and after treatment was evaluated with Student's *t*-test. The relationship between the variables was evaluated using the Pearson correlation. Differences were considered statistically significant at $p < 0.05$.

To check the magnitude of the differences obtained between the baseline and 90 days post-treatment, the effect size was analyzed for each clinical parameter. Cohen's *d* was used to calculate the effect size for two dependent groups. The results were categorized as having a small ($0.20 \leq d$), medium ($0.21 \leq d \leq 0.50$), or large ($d \geq 0.51$) effect (Cohen, 1988).

Results

Fourteen individuals who contributed 39 gingival recessions were treated. The mean age was 35.79 (range 28 to 47 years), with one male and 13 females. The sites comprised 13 canines, 16 first premolars, and 10 second premolars. The values of the clinical parameters at baseline and after treatment are shown in *Table 1*. There was no significant reduction in PD ($p > 0.05$). There were statistically significant reductions in GRH, GRW, CAL, KM and GMT ($p < 0.05$) and a statistically significant increase ($p < 0.05$) in GT. There was a large effect size for GRH, GRW, CAL, KM and GMT, and a medium effect for PD and GT.

A statistically significant negative correlation was found between initial GMT and initial GRH ($r = -0.32$; $p = 0.049$), initial GRW ($r = -0.53$; $p < 0.001$), final GRH ($r = -0.52$; $p < 0.001$), and final GRW ($r = -0.73$; $p < 0.001$). There was a statistically significant negative correlation between GT and final GRH ($r = -0.54$, $p < 0.001$), and final GRW ($r = -0.75$; $p < 0.001$). There was also a significant negative correlation between initial KM and initial GRH ($r = -0.34$; $p = 0.034$). No significant correlations were observed among the other clinical parameters.

Table 1. Clinical parameters (mm) at baseline and 3 months postoperatively.

	Baseline	3 Months		
Parameters	**Mean (SD)**	**Mean (SD)**	***p***	**Cohen's *d***
PD	1.05 (0.22)	1.02 (0.16)	0.232	0.22
GRH	2.58 (0.73)	0.22 (0.28)	< 0.001	6.03
GRW	3.56 (0.62)	0.63 (0.55)	< 0.001	7.07
CAL	3.63 (0.73)	1.24 (0.39)	< 0.001	5.77
KM	3.99 (0.82)	3.67 (0.82)	< 0.001	0.55
AKM	2.95 (0.84)	2.64 (0.84)	< 0.001	0.52
GMT	0.47 (0.17)	0.50 (0.16)	< 0.001	0.25

PD, probing depth; GRH, gingival recession height; GRW, gingival recession width; CAL, clinical attachment level; KM, keratinized mucosa; AKM, attached keratinized mucosa; GMT, free gingival margin thickness

Table 2. Descriptive statistics of the parameters associated with percentage of root coverage.

	Percentage of Root Coverage					
	GRH ≤ 2.5	**GRH > 2.5**	**KM ≤ 3.0**	**KM > 3.0**	**GT ≤ 0.5**	**GT > 0.5**
n	19	20	5	34	20	19
Minimum	86.92	64.50	79.13	64.50	64.50	76.45
Maximum	100.00	100.00	94.94	100.00	100.00	100.00
Median	100.00	87.45	89.47	100.00	87.45	100.00

GRH, gingival recession height; KM, keratinized mucosa; GT, gingival thickness

The percentage of root coverage was 92.79%. There were four cases of complete root coverage (100%). The teeth with initial GRH ≤ 2.5 ± 0.7 mm, initial KM > 3.0 ± 0.8 mm and initial GT > 0.5 ± 0.2 mm attained complete root coverage (*Table 2*).

Discussion

Gingival recession may disturb patients due to esthetic, psychological and functional problems, *e.g.* dentin hypersensitivity, root caries and abrasion (Chrysanthakopoulos, 2014). Although there are many periodontal plastic surgery procedures for covering the exposed root surface, the effect of the periodontal status on the surgical treatment for this condition is not well defined in the literature. The results of this clinical study indicate that the dimensions of clinical parameters are implicated in the predictability of root coverage.

The success of GR treatment by means of CPF involves various criteria: surgical planning according to requirement; control of etiologic factors; adequate preparation of the receptor bed (Wennström and Zucchelli, 1996); root surface preparation (Pini Prato *et al.*, 1999) and flap positioned coronally to the amelocemental junction, without tension and with adequate biofilm control (Pini Prato *et al.*, 2000).

Based on this study, initial GRH ≤ 2.5 mm attained complete root coverage, while initial GRH > 2.5 mm did not. These results are similar to those found in the literature (Borgheti *et al.*, 2002; Pini Prato *et al.*, 1996; Clauser *et al.*, 2003; Douglas de Oliveira *et al.*, 2013b) which reported that an increase in GRH was associated with a reduction in complete root coverage and of the percentage of root coverage. However, there are several studies that reported divergent results, such as a greater reduction in periodontal recession in deeper defects (with greater GRH) (Wennström and Zucchelli, 1996; Trombelli, *et al.*, 1995; Zucchelli *et al.*, 1998; Zucchelli *et al.*, 2000).

Teeth with initial KM > 3.0 mm attained complete root coverage, while teeth with initial KM ≤ 3.0 mm did not. These results are in agreement with studies that determined a KM height of at least 3.0 mm as selection criterion for the donor site in the CPF technique (Allen and Miller, 1989; Huang *et al.*, 2005). However, others demonstrated that the initial height of the KM did not compromise root coverage (Blanc *et al.*, 1991; Harris and Harris, 1994).

Teeth with initial GMT > 0.5 mm attained complete root coverage, while teeth with initial GMT ≤ 0.5 mm did not. These results are similar to those found by some authors who found a positive correlation; that is, the larger the initial GMT, the higher the percentage of root coverage (Allen and Miller, 1989; Huang *et al.*, 2005; Baldi *et al.*, 1999; Hwang and Wang, 2006). However, 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 and Zucchelli, 1996).

Thicker gingival tissue maintains vascularization, favors tissue adaptation and promotes wound healing during and after surgery (Lindhe *et al.*, 2008; Zuhr *et al.*, 2014). Thicker gingival tissue is resistant to trauma, and, consequently, to recession. It makes tissue manipulation possible, promotes better attachment (Hwang and Wang, 2006), improves esthetics (Bherwani *et al.*, 2014), presents less clinical inflammation and offers a better prognosis of surgical procedures. Different measurements have been cited in the literature: 0.8 mm (Baldi *et al.*, 1999), 1.0 mm (Allen and Miller, 1989), 1.2 mm (Huang *et al.*, 2005), as the minimum gingival tissue thickness required for successful root coverage. However, the real minimum GT has not yet been established. The limited samples and methodological differences among studies make it difficult to analyze, compare and reach any general and definitive conclusion about the subject. The studies vary in the manner of measurement, localization of the gingival thickness evaluated and in the therapeutic method. The majority of studies measure gingival thickness coronally to the mucogingival junction, but at different levels, both in keratinized and in attached keratinized mucosa. It has not yet been consolidated whether position is a relevant factor. The difference in gingival thickness values may be related to the diverse measurement techniques. In the present study, the measurement of GT was performed on the CV surface with the use of a periodontal caliper in an extremely precise manner. 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 reports of the use of an endodontic spacer for this purpose (Wennströmu and Zucchelli, 1996; Huang *et al.*, 2005; Hwang and Wang, 2006; Baldi *et al.*, 1999; Allen and Miller, 1989; Douglas de Oliveira *et al.*, 2013a).

The initial GR was significantly reduced and its height inversely correlated with root coverage. These results are in agreement with those seen in the literature (Borghetti *et al*., 2005; Pini Prato *et al*., 1996; Clauser *et al*., 2003). In this context, the indices have emphasized the importance of the interproximal bone level and width of the recession in the predictability of coverage (Miller, 1985). The wider recessions are more difficult to cover, because the vascular resources are farther from the center of the denuded root than they are in narrow recessions (Sullivan and Atkins, 1968). Wider recession defects are considered a greater challenge than narrower ones and root curvature may have an impact on the outcome of root coverage, as the avascular area is larger in prominent roots (de Sanctis and Clementini, 2014). In addition, the CPF provided benefits in terms of root coverage of shallow Miller Class I and II recession defects (Nanavati *et al*., 2013). Based on this, in the present study the treated recessions were in accordance with the technique assumptions. The results of these studies confirm the importance of observing these criteria during surgical planning and for the success of treatment of periodontal recessions. Divergent results have demonstrated a positive correlation; that is, the greater the GR, the larger the final covering. However, it is important to point out that these discrepancies may be related to the different surgical techniques, biomaterials used in studies, professional experience and periodontal phenotype (Zucchelli *et al*., 2000).

In the present study, although no statistically significant change in PD occurred, a statistically significant improvement in CAL was observed at 3 months in comparison with baseline. This result, similar to that of other studies, may be based on the fact that the coronally positioned flap covered the root surface and consequently diminished the GRH. Thus, there is greater attachment of the protective periodontium, which causes the increase in CAL (Sullivan and Atkins, 1968; Paolantonio, 2002; Wang *et al*., 2001; Shieh *et al*., 1997).

There was a significant reduction of approximately 0.3 mm in both KM and AKM ($p < 0.05$) at 3 months. These results come close to those of others, in which a decrease of 0.2 mm ($p < 0.05$) was observed at 90 and 120 days, respectively (Trabulsi *et al*., 2004; Baldi *et al*., 1999). However, they differ from some results presented in the literature: increase of 0.2 mm ($p < 0.05$) after one year (Paolantonio, 2002); increase of 0.7 mm ($p < 0.05$) at 180 days (Wang *et al*., 2001) and increase of 0.9 mm ($p < 0.05$) at 180 days (Shieh *et al*., 1997). These differences may be related to the different post-surgical evaluation periods. Recent studies on the change in mucogingival line location after coronally advanced flaps have shown that this line tends to return to its original position (Pini Prato *et al*., 2005; Abolfazli *et al*., 2011). Therefore, one hopes that in longitudinal studies, an increase in KM may be observed after a CPF procedure.

The short re-evaluation time (3 months) in the present study did not allow this periodontal gain to be observed. However, there was a statistically significant increase of 0.03 mm in GMT at 3 months. A similar result was described by authors who found an increase in GMT at 180 days (Huang *et al*., 2005). These authors suggested a significant contraction of the gingival thickness may result in a smaller amount of root coverage, thus determining the great importance of manipulating the periodontal flap. In the present study a negative correlation was also found between GT and final GRH, as well as between GT and final GRW; that is, the greater the GT, the smaller the final GR. An indirect relationship was found between initial GMT and initial GR ($p < 0.05$). These data suggest the influence of gingival thickness on the etiology of periodontal recessions; that is, the smaller the GMT, the greater the presence and severity of GR.

The size effect is an additional measure to the traditional statistical test of the null hypothesis, aimed to determine the clinical importance of the effect, and not limited to significant or non-significant results (Cohen, 1988). Overall, the treatment showed a large effect of size (mainly in the GR dimensions), suggesting that the surgical root coverage achieves outcomes that can be noted by both patient and clinician. In other words, the effect of initial periodontal parameters on root coverage is not only statistically significant, but also clinically important; and the surgical root coverage is clinically effective in reducing gingival recession and improving the periodontal status. The clinician should pay attention to these parameters to better indicate a surgical procedure for those people who complain of gingival recession.

The literature presents great variability with regard to the therapies used; techniques for measuring the parameters; randomization; heterogeneity in the age ranges of the subjects; limitation in sample size; variety in the quantity of surgical sites; types of defects treated; and differences in post-operative follow-up periods, which makes it difficult to make comparisons of the data and conclusions with regard to the topic.

In the daily treatment of patients in the clinic, the surgical technique used in single recession defects is the CPF that achieved excellent results, including shorter time, lower morbidity and minimally invasive compared to other surgical procedures. Furthermore, in 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 present study may have potential limitations. First, there is no control or placebo group because all patients were referred to periodontal surgery. Second, measurement bias may have occurred because the study was not masked or double-masked.

Evaluation of the clinical periodontal parameters on the degree of root coverage, tissue remodeling and the maintenance of its stability requires further investigation by means of periodical records, with a standardization of the periodontal parameters, and follow-up of the longitudinal performance of the procedures.

Conclusion

In this study, initial gingival recession height ≤ 2.5 mm, initial keratinized mucosa > 3.0 mm, gingival thickness > 0.5 mm and free gingival margin thickness > 0.5 mm were the decisive parameters in the success of treatment of periodontal recessions, associated with complete root coverage. Therefore, the present study indicates that the initial GRH, initial KM, GT and initial GMT are significant factors associated with the success of root coverage by means of the CPF technique.

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