Surgical Crown Lengthening: A 12-Month Clinical Wound Healing Study

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Background: Surgical crown lengthening has been proposed as a means of facilitating restorative procedures and preventing periodontal injuries in teeth with structurally inadequate clinical crowns or exposing tooth structure in the presence of deep, subgingival pathologies which may hamper the access for proper restorative measures. The few clinical studies in the current literature on postsurgical soft tissue modifications after crown lengthening procedures report conflicting results. The present study was designed to assess the alterations of the marginal periodontal tissues as an immediate outcome of surgical crown lengthening and over a 12-month healing period.

Methods: The patient sample included 30 patients (84 teeth) who presented with various conditions hampering proper restorative measures in one or more teeth and, therefore, requiring surgical exposure of tooth substance. After initial supportive therapy, the patients were recalled for a baseline examination, and the following parameters were evaluated at interproximal and buccal/lingual sites of each experimental tooth: plaque index, gingival index, position of the gingival margin, probing depth, and attachment level. After baseline examination, the patients underwent apically positioned flap surgery with osseous and connective tissue attachment resection. During surgery, the amount of resection and the achieved lengthening of the clinical crown were evaluated. The patients were enrolled in a maintenance program including professional tooth cleaning every 2 to 4 weeks. The patients were reexamined 1, 3, 6, 9, and 12 months postoperatively.

Results: 1) Immediately after surgery, a significantly (P <0.001) increased clinical crown length of 3.7 ± 0.8 mm (mean) at interproximal and 4.1 ± 0.9 mm (mean) at buccal/lingual sites was achieved; 2) healing resulted in a statistically significant coronal displacement of the gingival margin of 3.2 ± 0.8 mm at interproximal (P <0.001) and 2.9 ± 0.6 mm at buccal/lingual (P <0.002) sites; and 3) as a consequence of this postsurgical soft tissue regrowth, the amount of the available tooth structure immediately after surgery decreased to 0.5 ± 0.6 mm at interproximal sites (P <0.0015) and to 1.2 ± 0.7 mm at buccal/lingual sites (P <0.001) at the 12-month examination.

Conclusions: The results of the present clinical investigation demonstrated that during a 1-year period of healing following surgical crown lengthening, the marginal periodontal tissue showed a tendency to grow in a coronal direction from the level defined at surgery. This pattern of coronal displacement of the gingival margin was more pronounced (P <0.001) in patients with "thick" tissue biotype and also appeared to be influenced by individual variations in the healing response (P <0.001) not related to age or gender. *J Periodontol 2001;72:841-848.*

KEY WORDS

Crowns; dental restorations, permanent; dental prosthesis design; gingiva/surgery.

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Successful restorative treatment of teeth usually requires preparation of well-defined restoration margins easily accessible for conservative measures and impression taking, correct fitting of prosthetic crowns, and adequate plaque control. There are clinical situations, however, when these requirements cannot be fulfilled.

In fact, the presence of a carious lesion, endodontic perforation, crown-root fracture, or preexisting margins of failing restorations in a deep subgingival location may hamper access for proper restorative measures. In addition, due to destructive caries, altered passive eruption, or pathologic wear, the supragingival available tooth structure may not be sufficient to permit adequate retention of the reconstruction. Furthermore, an increase in clinical crown length may be required to correct gingival margin asymmetries for esthetic reasons.

In such instances when attempts are made to obtain access or retention by extending preparations too deep subgingivally, a periodontal lesion characterized by gingival inflammation, loss of attachment, and alveolar bone resorption will result.[1-3]

In order to facilitate restorative procedures and to prevent periodontal injuries in teeth with structurally inadequate clinical crowns, the apically positioned flap technique with osseous resection has been recommended.[4-6]

Several authors have suggested surgically removing the periodontal support to an extent, leaving a distance from the level of the planned reconstruction margin to the level of the newly recontoured osseous crest of 3 mm,[4] 2.5 to 3.5 mm,[5] and 4 mm[6] in the exposed tooth.

These amounts of dental structure exposure were considered adequate to accommodate a new gingival unit formed by the regrowth of the supracrestal soft tissues, which will proliferate coronally during healing and yet leave sufficient supragingival tooth substance to complete the restorative procedures.

In these reports, however, sufficient information was not provided regarding the dimension of the postsurgical soft tissue modifications or the amount of time necessary to achieve the complete healing of the periodontal tissues and, therefore, the stability of the soft tissue levels.

The few clinical studies on periodontal tissue alterations which occur during healing after surgical crown lengthening reported conflicting results.[7,8] van der Velden observed, 3 years after surgery, a considerable amount of coronal regrowth of the interproximal gingival tissue from the level where the osseous crest was located after surgery.[7] On the contrary, Bragger et al. found, over a 6-month healing period after surgical crown lengthening, stable periodontal tissues, with minimal changes in the gingival margin levels from surgery to the end of the study.[8]

The reason for these different results may be related to several factors, including surgical skill and healing time. Moreover, other factors such as patient age and tissue biotype may influence the extent and duration of periodontal tissue alterations during the wound healing process.

The present clinical study was designed to assess alterations in the periodontal tissue levels as an immediate result of surgical crown lengthening and over a 1-year healing period.

MATERIALS AND METHODS

The clinical study included 30 patients, 19 to 62 years of age (mean age, 40.5), selected on the basis of various conditions hampering proper restorative measures on one or more teeth and requiring surgical exposure. Indications for surgical crown lengthening included: 1) gain of retention in teeth with insufficient amount of supragingival dental structure for prosthetic reconstruction; 2) accessibility to deep, subgingivally located lesions or preexisting faulty preparation margins for restorative treatment; and 3) correction of gingival tissue asymmetries present in the anterior segments of the dentition for esthetic reasons.

The treatment plan called for the tooth and at least 2 adjacent teeth (if present) to undergo surgical lengthening; the study population provided 84 teeth.

After an initial examination and treatment planning session, each patient received detailed instruction in proper self-performed plaque control measures[9] and underwent full-mouth scaling/root planing and removal of marginal irritants. After 1 to 2 months of plaque control supervision, the patients were recalled for a baseline examination. At the baseline examination, the following parameters were recorded for each experimental tooth at 4 sites (center mesial, center distal, midbuccal, and midlingual): 1) plaque index (PI);[10] 2) gingival index (GI);[11] 3) position of the gingival margin (GM), determined by assessing the distance between a fixed reference point (cementoenamel junction, preparation line, occlusal surface) and the gingival margin with a calibrated periodontal probe (diameter = 0.5 mm); 4) probing depth (PD), measured from the gingival margin using the periodontal probe and recorded to the nearest 1 mm; and 5) clinical attachment level (CAL), calculated as the sum of the PD and the position of the gingival margin.

In order to standardize the location of the probe during measurements, round notches or vertical grooves were prepared in the tooth/root as reference points. The patient's tissue biotype[12] was assessed and recorded as normal, thin, or thick. Following the baseline examination, patients underwent apically positioned flap surgery with osseous resection and recontouring.[4,6]

Surgical Procedure

Partial-thickness flaps were raised at the buccal and lingual aspects of the alveolar process of the experimental teeth. After secondary flap or supracrestal soft tissue removal, ostectomy and osteoplasty were performed by using hand chisels and rotating diamond burs. Following osseous recontouring, in order to remove any possible remnant of connective tissue attachment coronal to the alveolar crest, the exposed root surfaces were carefully planed with sharp curets or rotating flame-shaped finishing burs. The complete removal of remaining root cementum with inserting collagen fibers was performed to prevent reattachment of the surgically separated fibers in an undesired coronal position.[2,8,13-16]

The buccal and lingual flaps were subsequently adjusted, attempts were made to position them at or below the level of the alveolar crest, and they were stabilized with periosteal anchored sutures, which resulted in a complete exposure of the interdental alveolar bone crest.

To evaluate the changes in the osseous and periodontal tissue levels obtained at surgery, the following linear measurements were recorded during the surgical procedure on each experimental tooth: 1) the distance in an apico-coronal direction between the fixed reference point and the alveolar crest before ostectomy (AC before); 2) the distance in an apico-coronal direction between the fixed reference point and the alveolar crest after ostectomy (AC after); and 3) the distance in an apico-coronal direction between the fixed reference point and the margin of the sutured flap. These parameters were recorded at the same 4 sites used at the baseline examination.

Following the surgical procedure, a periodontal dressing‡ was applied. The periodontal dressing and sutures were removed 10 days after surgery and a plaque control regimen was reinstituted.

Maintenance

During the 12-month healing period, patients were maintained on a plaque control program which included professional tooth cleaning every second week for the initial 3 months and every fourth week for the remaining 9 months.

Reexamination

Patients were reexamined at 30, 90, 180, 270, and 360 days after surgery. Periodontal tissue modifications were studied by assessing the same parameters recorded at the baseline examination.

Statistical Analysis

The data were analyzed by means of analysis of variance (ANOVA), separately for interproximal and buccal/lingual measurements. Buccal and lingual measurements were combined in the absence of a statistically significant difference between the 2 individual values. Repeated measurements ANOVA was performed for probing depth and attachment level at baseline and at the end of the study, and the differences were analyzed for the effects of between-patient characteristics (age, gender, tissue biotype) by means of a backward stepwise ANOVA scheme, using type III sums of squares, separately for interproximal and buccal/lingual measurements. The analyses for the distance between the reference point and the gingival margin were similar but also included within-patient characteristics (amount of alveolar bone removed during surgery dichotomized as 0 to 0.5 and >0.5; and flap margin position categorized as <0, 0, >0).

The least significant difference test was applied when the appropriate F was significant to test for significant differences between groups. For all analyses, the level of significance was set at 0.05.

Table 1.

Baseline Examination at Interproximal and Buccal/Lingual Sites; Distances Between the Reference Point and Gingival Margin (GM), Between the Reference Point and Alveolar Crest Before (AC before) and After (AC after) Resection as Well as Between the Reference Point and Flap Margin (FM) After Suturing

	Interproximal		Buccal/Lingual	
GM	1.1 ± 1.6		1.6 ± 2.5	
AC before	3.9 ± 1.8	(P <0.001)	4.7 ± 2.3	(P <0.001)
AC after	4.8 ± 1.7		5.7 ± 2.4	
FM	6.9 ± 1.0		5.8 ± 2.2	
Difference AC after-GM	3.7 ± 0.8	(P <0.001)	4.1 ± 0.9	(P <0.001)

Mean values in mm ± standard deviation.

RESULTS

At the baseline examination, the mean distance between the reference point and the gingival margin measured at interproximal sites was 1.1 ± 1.6 mm, and the corresponding distance measured at buccal/lingual sites was 1.6 ± 2.5 mm (Table 1).

Surgical Phase

During surgery, after flap elevation and secondary flap or supracrestal soft tissue removal, the mean distance between the reference point and the level of the alveolar crest was 3.9 ± 1.8 mm at interproximal and 4.7 ± 2.3 mm at buccal/lingual sites.

‡ Coe-Pak, GC America Inc., Alsip, IL.

After osseous resection, the alveolar crest level was located at a distance from the reference point of 4.8 ± 1.7 mm at interproximal and 5.7 ± 2.4 mm at buccal/lingual sites.

The mean reduction of the crestal alveolar bone was 0.9 mm at interproximal sites and 1.0 mm at buccal/lingual sites. At 43 interproximal (52%) and 43 buccal/lingual sites (52%), the amount of crestal bone removal varied between 1 to 1.5 mm; at 31 interproximal (36%) and 27 buccal/lingual sites (32%), it amounted to 0.5 mm; and at 7 buccal/lingual sites (8%), it ranged between 2 to 2.5 mm. At 10 interproximal (12%) and 7 buccal/lingual sites (8%), no changes in the osseous crest level were observed (Table 2). The positions of the flap margin after suturing are reported in Table 1. The mean distances between the reference point and the flap margin measured at buccal/lingual sites (5.8 mm) were similar to the distance between the reference point and the alveolar crest obtained after resection at corresponding sites, demonstrating that the position of the flap margin was in coincidence with the osseous crest.

At interproximal sites, the distance measured between the reference point and the flap margin (6.9 mm) was greater than the distance between the reference point and the interproximal alveolar crest after resection (4.8 mm), reflecting a complete interdental osseous denudation.

At the completion of the surgical procedure, the mean distance between the reference point and the osseous crest/flap margin changed from the baseline values (reference point, gingival margin) of 1.1 ± 1.6 mm to 4.8 ± 1.7 mm at interproximal sites and from 1.6 ± 2.5 mm to 5.7 ± 2.4 mm at buccal/lingual sites. These changes were statistically significant ($P<0.001$). Thus, the surgical procedure resulted in an apical displacement of the marginal tissues and in a significant ($P<0.001$) increased mean clinical crown length of 3.7 ± 0.8 mm at interproximal and 4.1 ± 0.9 mm at buccal/lingual sites (Figs. 1 and 2).

Healing Phase

Plaque and gingival indices. The mean PI and GI scores calculated from measurements made at baseline, and at the 1-, 3-, 6-, 9- and 12-month examinations as well as a statistical analysis of the values are presented in Tables 3 and 4, respectively. At baseline, the mean PI values were 0.4 at interproximal and 0.3 at buccal/lingual sites; at the 12-month observation period, no statistically significant differences were present at any examination interval. Similarly, GI measurements remained substantially stable throughout the study.

Probing depth. The mean PD values recorded at the baseline examination varied between 2.7 ± 0.9 mm at interproximal and 1.4 ± 0.3 mm at buccal/lingual sites. At the 12-month final examination, the mean PD was 2.8 ± 0.7 mm at interproximal and 1.3 ± 0.4 mm at buccal/lingual sites. There was no statistically significant difference between the PD values obtained at

Table 2.

Number of Sites and Changes in Osseous Crest Level

	Interproximal		Buccal/Lingual	
Change (mm)	N (84)	%	N (84)	%
0	10	12%	7	8%
–0.5	31	36%	27	32%
–1	33	40%	26	31%
–1.5	10	12%	17	21%
–2	0	0%	5	6%
–2.5	0	0%	2	2%

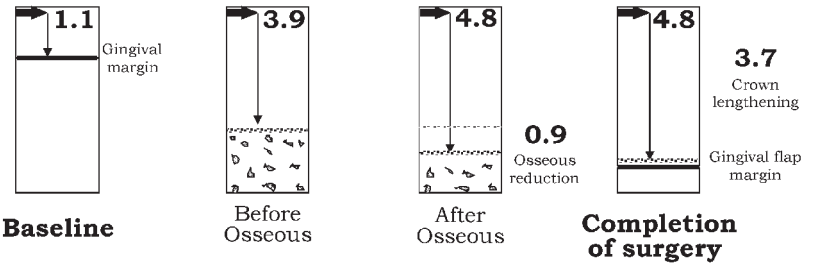

Figure 1.
Interproximal osseous reduction and crown lengthening during the surgical phase (mean values in mm) (➡: reference point).

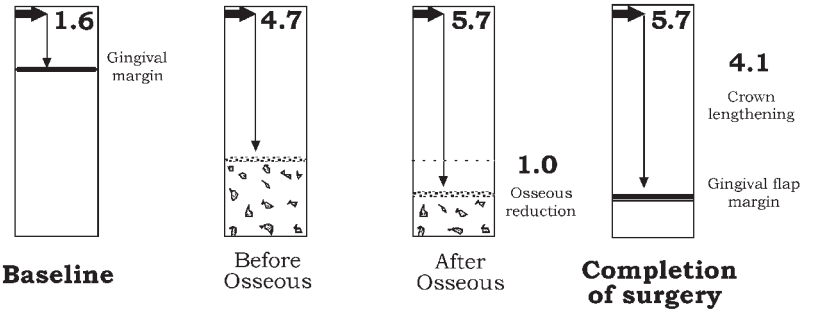

Figure 2.
Buccal/lingual osseous reduction and crown lengthening during the surgical phase (mean values in mm) (➡: reference point).

Table 3.

Plaque Index Scores at Baseline and at 1-, 3-, 6-, 9-, and 12-Month Examination (mean values ± SD)

Examination	Interproximal	Buccal/Lingual
Baseline	0.4 ± 0.3	0.3 ± 0.2
1 month	0.2 ± 0.3	0.3 ± 0.4
3 months	0.3 ± 0.5	0.2 ± 0.4
6 months	0.5 ± 0.4	0.3 ± 0.2
9 months	0.4 ± 0.3	0.2 ± 0.1
12 months	0.5 ± 0.2	0.3 ± 0.1

Table 4.

Gingival Index Scores at Baseline and at 1-, 3-, 6-, 9-, and 12-Month Examination (mean values ± SD)

Examination	Interproximal	Buccal/Lingual
Baseline	0.8 ± 0.4	0.5 ± 0.4
1 month	0.7 ± 0.6	0.5 ± 0.4
3 months	0.8 ± 0.7	0.4 ± 0.2
6 months	0.6 ± 0.4	0.3 ± 0.3
9 months	0.8 ± 0.6	0.4 ± 0.2
12 months	0.7 ± 0.3	0.4 ± 0.4

baseline and those recorded at the final examination (Table 5).

Clinical attachment level (CAL). CAL measurements recorded at baseline and at the final examination are presented in Table 6. Resective treatment resulted in a reduction at interproximal as well as buccal/lingual sites. At the interproximal sites, the mean CAL reduction amounted to 0.6 ± 0.7 mm, while at the buccal/lingual sites, the CAL shifted on average 1.1 ± 0.9 mm in the apical direction. This difference was statistically significant at both interproximal (P <0.0015) and buccal/lingual sites (P <0.001).

Position of the gingival margin. During the 12-month observation period, the location of the gingival margin underwent significant alterations from the immediate postsurgical level (Table 7). In fact, the mean distance between the reference point and the gingival margin which, at baseline, was 1.1 mm at interproximal sites and 1.6 mm at buccal/lingual sites and after surgery changed to (reference point/osseous crest) 4.8 mm and 5.7 mm, respectively, remarkably decreased during the course of healing. At the 12-month final examination, the gingival margin was located a distance of 1.6 mm at interproximal and 2.8 mm at buccal/lingual sites from the reference point.

Therefore, the mean crown length difference between baseline and final examination was 0.5 mm at interproximal (P<0.0015) and 1.2 mm at buccal/lingual (P<0.001) sites. This reduction from postsurgery to the final examination indicates that during healing, a displacement of the newly formed soft tissue margin in a coronal direction from the postsurgical level had occurred (Figs. 3 and 4).

In fact, the values calculated from measurements obtained after 12 months of healing showed that the position of the gingival margin was 3.2 ± 0.8 mm at interproximal and 2.9 ± 0.6 mm at buccal/lingual sites

Table 5.

Probing Depth Scores at Baseline and at 1-, 3-, 6-, 9-, and 12-Month Examination (mean values in mm ± SD)

Examination	Interproximal	Buccal/Lingual
Baseline	2.7 ± 0.9	1.4 ± 0.3
1 month	1.6 ± 0.6	0.9 ± 0.4
3 months	2.1 ± 0.7	1.1 ± 0.3
6 months	2.4 ± 1.0	1.2 ± 0.5
9 months	2.6 ± 0.9	1.2 ± 0.8
12 months	2.8 ± 0.7	1.3 ± 0.4

Table 6.

Clinical Attachment Level Scores at Baseline, After Surgery, and at 1-, 3-, 6-, 9-, and 12-Month Examination (mean values in mm ± SD)

Examination	Interproximal	Buccal/Lingual
Baseline	3.8 ± 1.6	3.0 ± 2.6
After surgery	4.8 ± 1.7	5.7 ± 2.4
1 month	4.3 ± 1.0	5.0 ± 2.1
3 months	4.6 ± 1.5	4.7 ± 2.0
6 months	4.3 ± 1.4	4.4 ± 2.5
9 months	4.4 ± 1.6	4.2 ± 2.3
12 months	4.4 ± 1.5	4.1 ± 2.6
Difference (baseline-12 months)	–0.6 ± 0.7 (P <0.0015)	–1.1 ± 0.9 (P <0.001)

Table 7.

Mean Distance Between the Reference Point and Gingival Margin at Baseline, After Surgery, and at 1-, 3-, 6-, 9-, and 12-Month Examination (mean values in mm ± SD)

Examination	Interproximal	Buccal/Lingual
Baseline	1.1 ± 1.6	1.6 ± 2.5
After surgery	4.8 ± 1.7	5.7 ± 2.4
1 month	2.7 ± 1.5	4.1 ± 2.3
3 months	2.3 ± 1.6	3.6 ± 2.5
6 months	1.9 ± 1.6	3.2 ± 2.5
9 months	1.8 ± 1.5	3.0 ± 2.4
12 months	1.6 ± 1.4	2.8 ± 2.6
Difference (12 months-baseline)	0.5 ± 0.6 (P <0.0015)	1.2 ± 0.7 (P <0.001)

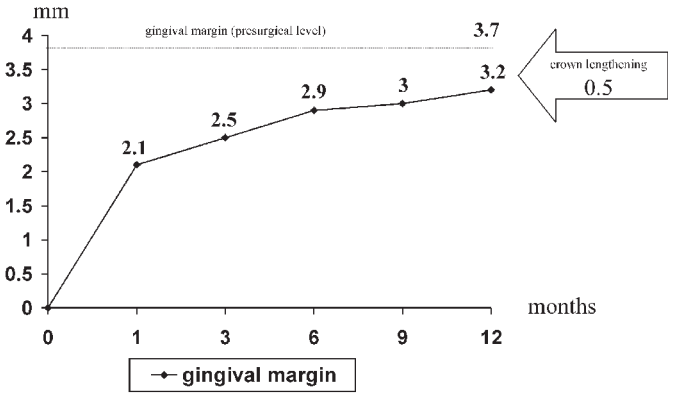

Figure 3.
Interproximal soft tissue regrowth from bone level during the 12-month observation period (mean values).

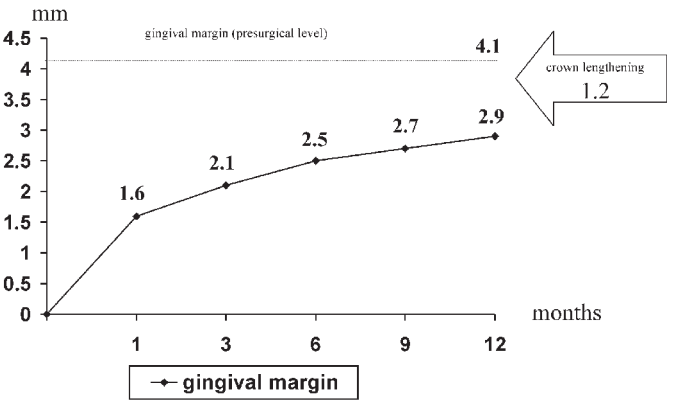

Figure 4.
Buccal/lingual soft tissue regrowth from bone level during the 12-month observation period (mean values).

Table 8.

Postsurgical Gingival Margin Regrowth at 1-, 3-, 6-, 9-, and 12-Month Examination (mean values in mm ± SD)

Examination	Interproximal		Buccal/Lingual	
1 month	2.1 ± 0.8	(P <0.001)	1.6 ± 0.6	(P <0.002)
3 months	2.5 ± 0.7		2.1 ± 0.5	
6 months	2.9 ± 0.6		2.5 ± 0.4	
9 months	3.0 ± 0.5		2.7 ± 0.6	
12 months	3.2 ± 0.8		2.9 ± 0.6	

coronal to the level where the osseous crest and the flap margin, respectively, were located immediately after surgery (Table 8). This postsurgical coronal displacement of the soft tissue margin was statistically significant at both interproximal (P <0.001) and buccal/lingual sites (P <0.002).

A closer analysis of the data revealed that the pattern of tissue regrowth which occurred during healing appeared to be affected, within patients, by the different amounts of crestal bone reduction performed during surgery (P <0.04).

On the other hand, between patients, this coronal displacement of the gingival margin seemed to be influenced by variations in the healing response (P <0.001) not related to age or gender and by the different tissue biotype. In fact, the coronal regrowth of the soft tissue margin at interproximal and buccal/lingual sites was significantly more pronounced (P <0.001) in patients with thick tissue biotype as compared to that recorded in patients with thin tissue biotype (Table 9).

DISCUSSION

The results of the present clinical investigation demonstrated that, during a 1-year healing period following apically positioned flap surgery and osseous resection, the marginal periodontal tissue showed a distinct tendency to grow in a coronal direction from the level defined at surgery. At the end of the study, the gingival margin was 3.2 mm (interproximal) and 2.9 mm (buccal/lingual) coronally from where the osseous crest was located immediately following surgery. In other words, the amount of the available crown length increased from the presurgical level of 0.5 mm at interproximal and 1.2 mm at buccal/lingual sites. The postsurgical soft tissue remodeling occurred in conjunction with positive clinical measurements, as shown by the low plaque and gingival index scores throughout

Table 9.

Gingival Margin Regrowth by Tissue Biotypes at the 1-, 3-, 6-, 9-, and 12-Month Examination (mean values in mm ± SD)

	Interproximal			Buccal/Lingual		
Examination	Normal (N = 41)	Thick (N = 20)	Thin (N = 23)	Normal (N = 41)	Thick (N = 20)	Thin (N = 23)
1 month	2.1 ± 0.8	2.2 ± 0.6	2.0 ± 0.5	1.6 ± 0.5	1.7 ± 0.6	1.6 ± 0.3
3 months	2.6 ± 0.9	2.8 ± 0.5	2.2 ± 0.5	2.2 ± 0.5	2.3 ± 0.3	2.1 ± 0.5
6 months	2.9 ± 0.7	3.0 ± 0.5	2.6 ± 0.6	2.4 ± 0.4	2.7 ± 0.4	2.4 ± 0.6
9 months	3.0 ± 0.8	3.3 ± 0.4	2.7 ± 0.6	2.6 ± 0.5	2.9 ± 0.4	2.6 ± 0.6
12 months	3.1 ± 0.7	3.6 ± 0.5	2.8 ± 0.7	2.9 ± 0.8	3.1 ± 0.8	2.6 ± 0.4
		P <0.001			P <0.001	

the study. It was also observed that the PD values tended to return to the presurgical values, with no difference between the baseline (interproximal: 2.7 mm, buccal/lingual: 1.4 mm) and the final examination (interproximal: 2.8 mm, buccal/lingual: 1.3 mm). However, a difference was found between the CAL measurements obtained at the completion of the study and those recorded presurgically, revealing an expected loss of clinical attachment (interproximal: 0.6 mm, buccal/lingual: 1.1 mm).

These findings may suggest a tendency of the periodontium to reform a new "physiological" supracrestal gingival unit. The regrowth of the soft tissue from the level where the osseous crest was defined at surgery had already begun 1 month after surgery, when the gingival margin reached about 60% of its final coronal position at interproximal sites and about 40% at buccal/lingual sites.

The factors influencing the amount of coronal displacement of the marginal periodontal tissue seemed to be related to the different tissue biotypes, since patients with thick tissue biotype demonstrated significantly more coronal soft tissue regrowth than patients with thin tissue biotype and to the natural biological differences in interindividual patterns of healing response.

Few studies on surgical crown lengthening in the current literature report results on the location of the gingival margin after treatment in relation to the level of the alveolar osseous crest defined during surgery.[7,8]

van der Velden[7] investigated in 7 patients the position of the interproximal gingival margin 3 years following surgical denudation of the interdental alveolar bone. The results showed that the location of the gingival margin was found at a mean distance of 4.3 mm coronally from where the bone level was defined at surgery; the mean PD was 2.2 mm; and the mean PI was 0.8. These findings concur with those in the present study where 1 year after treatment, the mean coronal displacement of the interproximal gingival margin was 3.2 mm, the mean interproximal PD was 2.8 mm, and the mean PI for the interproximal surfaces was 0.5.

The results of the present study differ, however, considerably from those obtained by Bragger et al.[8] where, during 6 months of healing after surgical crown lengthening, the mean changes in the periodontal tissue levels from those defined after surgery were reported to be minimal. In this study, the authors showed that, in 43 teeth in 25 patients who underwent clinical crown lengthening, the mean apical displacement of the gingival margin was 1.3 mm following surgery; that during healing, this value remained stable; and at the 6-month final examination, the soft tissue margin was almost identical (1.4 mm) to that recorded immediately after surgery.

Furthermore, the mean probing depth values in the Bragger et al. report were somewhat deeper 6 months after surgery (2.2 mm) as compared with those recorded before surgery (1.9 mm).

The reason for these opposite patterns of marginal periodontal tissue alteration after surgical crown lengthening may be due to differences in the interpretation and/or execution of the surgical technique, which is assumed to be an apically positioned flap with osseous resection. In fact, this unusual soft tissue healing after surgical resective therapy might be related to the position of the flap margin after suturing in relation to the location of the alveolar crest. Bragger et al. reported that, "the alveolar crest was reduced, thereby creating a distance of 3 mm to the future reconstruction margin."[8] This may imply, since the flap margin was at a mean distance from the reference point of 1.3 mm, that the bone level after surgery was apically located with respect to where the flap margin was sutured. As a consequence, despite the apparent stability of the tis-

sue margins following surgery as expressed by the mean values, 30% of the sites showed an increase in the amount of gingival recession during the healing period and 33% demonstrated a coronal regrowth of the gingival margin. Alterations of the periodontal tissues similar to those found in the present report and the van der Velden study were observed by different authors[17-21] following treatment of intrabony defects by the apically repositioned flap technique with osseous recontouring. In these studies, the authors found that the gingival margin after apically repositioned flap procedures and osseous recontouring shifted during 6 to 12 months of healing to a more coronal position[17-19] and that after this period, it remained unchanged during 5 to 7 years of maintenance,[20,21] demonstrating a predictable stability in properly maintained patients.

In conclusion, considering the coronal displacement of the gingival margin observed in the present study following surgery, it may be suggested that:

1. When surgical resective therapy is performed to gain access for proper restorative measures to deep subgingivally located carious lesions, endodontic perforations, crown-root fractures, or preexisting margins of failing restorations, an early (during healing) definition of the previously inaccessible margins is recommended.

2. When surgical resective therapy is performed to increase the clinical crown length to permit an adequate retention of a reconstruction, a greater removal of osseous support, in relation to the amount of the remaining periodontium, should be considered.

3. When in esthetically important, visible areas the prosthetic reconstruction margins are planned to be positioned in an intrasulcular location, a close monitoring of the different degree of tissue regrowth which occurs during healing among patients should be recommended to determine the achieved gingival margin stability and, therefore, to assess the ideal time for the definitive restorative procedures.

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