Case Series

Osseous Surgery for Crown Lengthening: A 6-Month Clinical Study

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Background: *Despite the fact that surgical crown lengthening is a commonly performed treatment, little is known about the specific surgical endpoints of the procedure or the stability of the newly attained crown height over time. Recent clinical reports have ranged across a spectrum from significant tissue rebound to remarkable stability using similar surgical techniques. The purpose of this study was to assess the stability of surgical crown lengthening procedures performed by various surgeons using specific guidelines to determine surgical endpoints. Specifically, we sought to determine the following: 1) What is the immediate increase in clinical crown height following surgery? 2) How stable is the established crown length over a 6-month period? 3) How much supporting bone is removed to establish the new crown length? 4) How does the position of the flap margin relative to the alveolar bone at surgical closure relate to the stability of crown height?*

Methods: *Twenty-five patients requiring crown lengthening of 43 teeth were included in this study. Clinical indices recorded at eight sites on each molar and six sites on each premolar included plaque, bleeding on probing, probing depth, and relative attachment level from a customized probing stent. Surgical measurements at the same sites included the distance from stent to alveolar bone both before and after osseous surgery and the distance from flap margin to alveolar bone after suturing. Clinical measurements were repeated at 1, 3, and 6 months after surgery. Sites were divided into three groups. All sites on teeth targeted for crown lengthening were labeled treated sites (TT). Interproximal sites on neighboring teeth were labeled adjacent (AA) if they shared a proximal surface with a treated tooth and non-adjacent (AN) if they were on the opposite side, away from the treated tooth.*

Results: *Throughout the entire 6-month healing period, descriptive statistics revealed no significant time or group differences in plaque and bleeding scores. At treated sites, the mean gain of crown height at surgery was 2.27 ± 1.1 mm. This was reduced to 1.91 ± 1.08 mm at 1 month, 1.69 ± 1.02 mm at 3 months, and 1.57 ± 1.01 mm at 6 months. At adjacent sites, the gain of crown length was 2.18 ± 0.98 mm, 1.61 ± 0.98 mm, 1.43 ± 0.96 mm, and 1.30 ± 0.96 mm at surgery, 1, 3, and 6 months, respectively. At non-adjacent sites the crown height increased 1.06 ± 1.07 mm, 1.00 ± 0.93 mm, 0.84 ± 1.00 mm, and 0.76 ± 0.85 mm, respectively. These mean measurements were significantly different for each treatment group at each time interval and appeared not to have stabilized between 3 and 6 months. The mean osseous reduction at treated, adjacent, and non-adjacent sites was 1.13 ± 0.90 mm, 0.78 ± 0.75 mm, and 0.065 ± 0.69 mm, respectively. Frequency distribution of osseous reduction demonstrated that 23.6% of treated sites had 0 mm, 44.3% had 1 mm, 25.4% had 2 mm, 6.2% had 3 mm, and less than 1% had ≥4 mm of bone removed to establish crown height. More bone removal was noted at premolar than at molar sites; however, this was not statistically significant. When tissue rebound following surgery was plotted against post-surgical flap position, it was noted that the closer the flap margin was sutured to the alveolar crest, the greater the tissue rebound during the post-surgical period. This rebound ranged from 1.33 ± 1.02 mm when the flap was sutured ≤1 mm from the alveolar crest, to –0.16 ± 1.15 mm when the flap was sutured ≥4 mm from the alveolar crest.*

Conclusions: *These data suggest that there is a significant tissue rebound following crown-lengthening surgery that has not fully stabilized by 6 months. The amount of tissue rebound seems related to the position of the flap relative to the alveolar crest at suturing. These findings support the premise that clinicians should establish proper crown height during surgery without overreliance on flap placement at the osseous crest.* J Periodontol 2004;75:1288-1294.

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KEY WORDS

Alveolar bone; follow-up studies; surgical flaps; tooth/anatomy and histology; tooth crown/surgery.

According to the 2003 American Academy of Periodontology Practice Profile Survey, one of the most common reasons for periodontal surgery is for purposes of crown lengthening.[1] The crown lengthening procedure is often necessary both to provide adequate retention and resistance form by gaining supracrestal tooth length,[2-5] as well as to prevent impingement of restoration margins on the attachment apparatus by reestablishing the biologic width.[6,7] While many restorative dentists are very specific in their requests for crown lengthening, others simply trust the surgeon to return the patient to them with longer crowns that will allow for adequate restoration. Without specific guidance, the surgical goal may become nothing more than to make the tooth "a little longer." In addition, there is scant information in the literature relating post-surgical flap position at the alveolar crest to the stability of crown lengthening over time. Knowing that an optimal flap placement will enhance the outcome of these procedures may be of significant benefit to the surgeon and restorative dentist alike.

Consistent with studies of the dimensions of the periodontal attachment apparatus described as the biologic width,[8,9] several authors have proposed that crown lengthening procedures optimally create at least 3 mm of tooth structure between the alveolar crest and future restorative margin to allow for proper restoration.[10-12] Ingber et al.,[10] for example, proposed 3 mm to allow 1 mm for the connective tissue attachment, 1 mm for the epithelial attachment, and 1 mm for placement of a margin. Although some clinicians have favored an amount >3 mm,[4,13] the 3 mm distance from crest to crown margin has over the years become fairly ingrained in the dental literature. Attempting to attribute a fixed measurement to the biologic width may indeed disregard surface-to-surface, tooth-to-tooth, and patient-to-patient variability; however, it is our observation that many practitioners delivering surgical crown lengthening therapies commonly rely on the 3 mm figure.

While numerous technique and case report articles are available, few controlled examinations of the post-surgical changes following crown lengthening surgery have been published. Of the controlled studies we reviewed, two had as a surgical goal a 3 mm distance between the alveolar crest and restorative margin[14,15] and a third did not mention a surgical endpoint.[16] Interestingly, each of these studies reported that the desired amount of crown lengthening was either not predictably attained or was subject to change over time.

More recently, Lanning et al. described a technique of measuring the biologic width by presurgical bone sounding.[17] That measurement was added to the amount of supracrestal tooth structure needed for margin placement and used as a guideline to determine the surgical reduction of the alveolar crest. This resulted in ≥3 mm of bone removal at 90% of treated sites, which is far in excess of that reported in the prior studies. However, the authors reported no significant change in the position of the free gingival margin between 3 and 6 months post-surgery.

The purpose of the present investigation was to further assess the short-term stability of surgical crown lengthening procedures using an osseous resective technique and specific guidelines to determine the surgical endpoint. This study sought to answer the following questions: 1) What is the immediate increase in crown height following surgery? 2) What happens to this newly established crown height over time? 3) How much supporting bone is removed during crown lengthening surgery? 4) How does the position of the flap margin relative to the alveolar crest at surgical closure relate to the stability of surgically created crown height?

MATERIALS AND METHODS

The experimental protocol was approved by the Institutional Review Board for human studies, Wilford Hall Medical Center (WHMC), Lackland Air Force Base, San Antonio, Texas. This study evaluated 25 consecutively treated periodontally healthy patients (18 males, seven females) referred to the Department of Periodontics at WHMC for crown lengthening surgery on 43 posterior teeth between December 2001 and August 2002. Medical and dental histories were reviewed and no contraindications to surgical therapy were noted. All but one patient required crown lengthening prior to complete coverage crown or fixed partial denture fabrication; the other patient required surgical access for placement of an amalgam restoration. All patients were restored by the end of the study and prosthetic treatment was begun no sooner than 6 weeks after surgery.

Each patient received an initial examination and treatment planning session. Oral hygiene procedures were reviewed, and scaling and/or prophylaxis were scheduled if deemed necessary by the examining periodontist. After treatment plan presentation, patients were provided information about the study and indicated willingness to participate by providing written informed consent. An alginate impression was then made of each arch to be surgically treated in order to fabricate customized probing stents.

Full-arch probing stents were made from a 2 mm clear copolyester plastic† using a pressure form matrix machine.‡ To insure proper fit after restorative procedures, the teeth to be restored were overwaxed by 1 mm. The stent was then made from a duplicate of the waxed cast and seated firmly on the remaining teeth on which no additional wax was applied. Stents were trimmed to the height of contour of all teeth, and grooves were placed at the sites to be measured with an 1169 fissure bur. To improve visualization, the apical margin of the probing stent was

† Splint Biocryl, Great Lakes Orthodontics, Ltd., Tonawanda, NY.
‡ BioStar, Great Lakes Orthodontics, Ltd.

traced with a black permanent marker. All measurements were taken by one of two calibrated examiners (DD, AM) using a UNC-15 manual probe.§

Surgical procedures were accomplished under local anesthesia with intravenous or oral sedation at patient request. Clinicians included both faculty and residents of the Department of Periodontics at Wilford Hall Medical Center. Three guidelines were given to each surgeon to determine the surgical endpoint for crown lengthening. The first guideline was to place the alveolar crest at a level at least 3 mm from the anticipated crown margin. To allow sufficient room for tooth preparation, the second guideline required surgeons, where possible, to leave at least 9 mm of clinical crown height coronal to the osseous crest. This calculation was derived from anticipating that a tooth in occlusion and awaiting a crown restoration would require 2 mm of occlusal reduction for restorative space, 4 mm axial wall length, and 3 mm distance from restorative margin to the bone. The third surgical guideline was to place flap margins either at or apical to the anticipated restorative margin following suturing. Each case included intrasulcular and/or internally beveled incisions and elevation of full thickness flaps on the buccal and lingual aspects of the alveolar process. Where required, flap thinning was performed in order to minimize tissue thickness. After flap reflection and supracrestal soft tissue removal, osteoplasty and ostectomy were performed using rotating carbide steel burs and hand chisels. Subsequently, all root surfaces were scaled and root planed with sharp curets and/or ultrasonic instrumentation to remove any possible remnants of connective tissue attachment supracrestally.

Both treated and adjacent teeth were monitored for this study and measured sites were divided into three groups. All sites on teeth to be restored and the specific targets of the crown lengthening procedures were identified as treated tooth (TT) sites. Interproximal sites on adjacent teeth were labeled adjacent tooth/adjacent surface (AA) sites if they shared a proximal surface with a treated tooth and adjacent tooth/non-adjacent surface (AN) sites if they were on the side away from a treated tooth (Fig. 1). Measurements were recorded at eight predetermined sites (mesio-facial, MF; mesio-facial furcation, MFF; disto-facial furcation, DFF; disto-facial, DF; disto-lingual, DL; disto-lingual furcation, DLF; mesio-lingual furcation, MLF; mesio-lingual, ML) on each treated molar and six sites (MF, F, DF, DL, L, ML) on each treated premolar in the surgical field. On adjacent teeth, four sites (MF, DF, DL, ML) were recorded for both molars and premolars.

The sequence of clinical measurements is described in Table 1. Using the probing stent, the following baseline measurements were taken for each site at the surgical appointment prior to administering local anesthetic: 1) the presence or absence of plaque (PL); 2) probing depth (PD); 3) the presence or absence of bleeding on probing (BOP); 4) the distance from stent to gingival margin (S-GM); and 5) relative attachment level from base of sulcus to stent (RAL).

Following administration of anesthetic, flap reflection, and debridement, a measurement was made from the stent to the alveolar crest [S-AB(P)]. After osseous resection, a measurement was made at each site from the stent to the post-resection osseous crest [S-AB(X)]. Flaps were then sutured and pressure was applied for 3 minutes, after which a measurement was made from the stent to the sutured marginal tissue position [S-GM(X)]. The probe was then placed under the tissue at each site, and the distance from the sutured flap margin to the bony crest was measured [GM-AB(X)]. The use of periodontal dressing was at the discretion of the surgeon, but dressing use was the exception rather than the rule following surgery.

All patients were prescribed analgesics and twice daily 0.12% chlorhexidine gluconate‖ rinses for the first

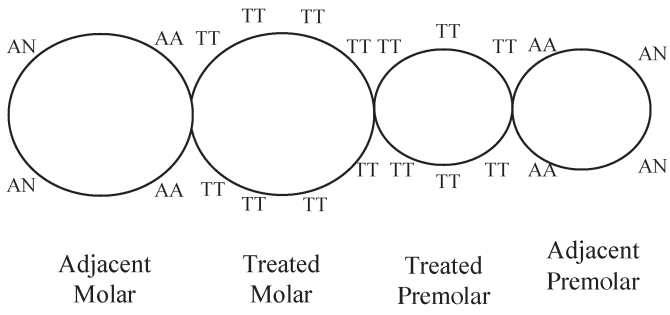

Figure 1.
Measurement sites for treatment groups. Eight sites were measured on each molar and six sites on each premolar.

Table 1.

Sequence of Clinical Measurements

Baseline (presurgery)	Pre-Osseous	Post-Suturing	1 Month	3 Months	6 Months
PI	S-AB(P)	S-GM(X)	PI	PI	PI
PD		S-AB(X)	PD	PD	PD
BOP		GM-AB(X)	BOP	BOP	BOP
SGM			SGM	SGM	SGM
RAL			RAL	RAL	RAL

§ Hu-Friedy, Chicago, IL.
‖ Peridex, Procter & Gamble, Cincinnati, OH.

2 weeks following surgery. Patients were seen for suture removal and prophylaxis between 7 and 10 days and a plaque control regimen was instituted. Additional postoperative visits (including prophylaxis) were performed at 2 and 4 weeks to assess healing and reinforce early oral hygiene measures. Baseline measurements of PL, PD, BOP, S-GM, and RAL were repeated at 1, 3, and 6 months following surgery.

Statistical Analysis

Data obtained for each type of site per patient were averaged and assessed for differences between baseline to post-surgery and to 1, 3, and 6 months. Data were analyzed by repeated measures analysis of variance (ANOVA) to determine presence of an overall effect and Tukey's honestly significant differences (HSD) post-hoc test for multiple comparisons was used to determine which site pairs differed significantly and the extent of those differences. Differences in probing depths and attachment levels at each time point were examined using paired and one sample *t* tests.

RESULTS

Twenty-four of the original 25 patients completed the study and no post-surgical complications were observed. One treated tooth was extracted after 1 month due to non-restorable caries. One patient moved from the area after the 3-month post-surgical appointment and was lost to further follow up. Thus, 1- and 3-month data are reported for 25 patients, while 3- and 6-month data are reported for 24 patients.

Clinical Indices

The mean percentage of TT sites with BOP was 26.6% at baseline. This decreased slightly to 18.6% at 1 month, then rebounded to 23.5% and 22.0% at 3 and 6 months. These differences were not significant at any time point. Similarly, the percentage of TT sites with plaque was 26.3% at baseline, increased slightly to 32.5% and 34.4% at 1 and 3 months, then reduced to 25.7% at 6 months. There was no significant difference between the percentage of TT sites with plaque at any time point. Similarly, no significant changes in PL or BOP were noted at AA or AN sites.

Mean PD measurements for all three treatment groups are reported in Table 2. TT, AA, and AN sites experienced an initial decrease in PD followed by a gradual return toward baseline by 6 months. The decrease in probing depth was statistically significant from baseline to 1, 3, and 6 months for all three groups (P <0.05).

Attachment loss was noted for each of the three treatment groups, as expected, and was noted to be significant for each group compared to presurgical baseline (P<0.05). By 6 months, attachment loss at TT, AA, and AN sites was 1.24 ± 1.09 mm, 0.99 ± 1.14 mm, and 0.49 ± 0.83 mm, respectively.

Change in Crown Length

The mean change in the distance from the probing stent to the free gingival margin from surgery to months 1, 3, and 6 is presented in Table 3. At TT sites, the mean increase in crown length following surgery was 2.27 ± 1.1 mm. This newly established crown height was reduced to 1.91 ± 1.08 mm by 1 month, 1.69 ± 1.02 mm by 3 months, and 1.57 ± 1.01 mm by 6 months. At each time point there was a significant increase in crown height compared to baseline, but the trend toward reduced crown height over time was confirmed by the fact that the mean measurements at 1, 3, and 6 months were all significantly less than the immediate post-surgical values (P<0.005). The amount of crown lengthening post-surgically at TT molar sites was not significantly different from that at TT premolar sites (2.28 ± 1.14 mm versus 2.19 ± 0.80 mm).

For AA sites, an initial mean crown height increase of 2.18 ± 0.98 mm was reduced to 1.61 ± 0.98 mm by 1 month, 1.43 ± 0.96 mm by 3 months, and 1.30 ±

Table 2.

Probing Depth

Time	Treated (TT)	Adjacent (AA)	Non-Adjacent (AN)
Baseline	2.29 ± 0.80	2.43 ± 0.71	2.60 ± 0.71
1 month	1.71 ± 0.74	1.94 ± 0.72	2.21 ± 0.84
3 months	1.86 ± 0.68	2.05 ± 0.75	2.28 ± 0.84
6 months	1.95 ± 0.69	2.11 ± 0.75	2.29 ± 0.69

Within each group, PD decreased significantly from baseline to 1, 3, and 6 months (P<0.05).

Table 3.

Crown Lengthening: Treated and Adjacent Teeth

	Treated (TT)		Adjacent (AA)		Non-Adjacent (AN)	
Time	N	Change ± SD	N	Change ± SD	N	Change ± SD
Baseline/post-surgery	322	2.27 ± 1.1	82	2.18 ± 0.98	77	1.06 ± 1.07
Baseline/1 month	322	1.91 ± 1.08	82	1.61 ± 0.98	77	1.00 ± 0.93
Baseline/3 months	315	1.69 ± 1.02	82	1.43 ± 0.96	77	0.84 ± 1.00
Baseline/6 months	287	1.57 ± 1.01	80	1.30 ± 0.96	75	0.76 ± 0.85

Changes in crown length were significant (P<0.005) for each treatment group at each time interval.

0.96 mm by 6 months. At AN sites the crown length was increased by 1.06 ± 1.07 mm at surgery, which decreased to 0.76 ± 0.85 mm by 6 months. For both groups, the mean crown heights at all time points were also significantly different (P <0.005).

The amount of osseous reduction needed to achieve this additional crown length is reported in Table 4. At TT sites, a mean of 1.13 ± 0.90 mm of bone was removed, compared to 0.78 ± 0.75 mm at AA sites and 0.065 ± 0.69 mm at AN sites. This reduction was statistically significant from baseline for both TT and AA sites (P <0.001) but not at AN sites. The frequency with which different amounts of bone removal at TT sites was achieved is shown in Table 5. At 67.9% of all treated sites, ≤1 mm of osseous reduction was performed during the crown lengthening procedure. Two mm of osseous reduction was achieved at 25.4% of TT sites and ≥3 mm reduction was noted for 6.5% of sites. For treated teeth, osseous reduction at premolar sites was greater than at molar sites (1.37 ± 0.99 mm versus 1.08 ± 0.88 mm), but the differences were not statistically significant.

Table 4.

Osseous Reduction

Treated (TT)		Adjacent (AA)		Non-Adjacent (AN)	
N Sites	Change ± SD	N Sites	Change ± SD	N Sites	Change ± SD
322	1.13 ± 0.90	82	0.78 ± 0.75	77	0.065 ± 0.69

A significant reduction in bone height was achieved at treated and adjacent sites (P <0.001) but not at non-adjacent sites.

Table 5.

Osseous Reduction at Treated Sites

Reduction	N	Percentage
0 mm	76	23.6
1 mm	143	44.3
2 mm	82	25.4
3 mm	20	6.2
≥4 mm	1	0.3

Table 6.

Tissue Rebound at 6 Months Related to Post-Suturing Flap Position

	All Sites	
GM/AB(X)	N	Change ± SD
≤1 mm	64	1.33 ± 1.02
2 mm	193	0.90 ± 0.89
3 mm	127	0.47 ± 0.79
≥4 mm	58	–0.16 ± 1.15

Tissue Rebound Following Surgery

In order to investigate the phenomenon of tissue rebound following crown lengthening surgery, the change in crown length from post-surgery to 6 months was plotted against the flap position relative to the alveolar crest immediately after suturing [GM-AB(X)]. After reviewing the number and distribution of data points, it was decided to group the [GM-AB(X)] measurements into four levels: ≤1 mm, 2 mm, 3 mm, and ≥4 mm. As noted in Table 6, the mean amount of tissue rebound by 6 months was greatest when the flaps were positioned within 1 mm of the alveolar crest and was least when the flap position was initially more coronal. This relationship held true regardless of treatment group, or whether the sites were interproximal or facial/lingual (Tables 7 and 8). No significant difference in tissue rebound was found between premolars and molars in any of the groups. The overall Pearson correlation coefficient between post-suturing flap to bony crest position and post-surgical tissue rebound was –0.422 (P <0.01).

DISCUSSION

The results of this clinical investigation demonstrated that 6 months following surgical crown lengthening procedures, teeth may exhibit a progressive marginal soft tissue rebound which reduces the surgically established crown height. This coronal shift of the soft tissues appears to be related to the positioning of the sutured flap post-surgery relative to the newly created alveolar crestal position both interproximally as well as facial/lingually. Overall, 14.5% of sites were sutured within 1 mm of the post-surgical alveolar crest and rebounded coronally a mean 1.33 ± 1.02 mm by 6 months. Similarly, 43.7% of sites were sutured at 2 mm from the bone margin, 28.7% at 3 mm, and 13.1% at ≥4 mm; these sites were found at 6 months to have rebounded 0.90 ± 0.89 mm, 0.47 ± 0.79 mm, and –0.16 ± 1.15 mm, respectively. There was a significant inverse correlation between the distance from flap to bony crest at the time of suturing and the amount of tissue rebound, indicating a greater rebound when the flap margin was positioned closer to the bony crest. These findings reflect the tendency of the healing periodontium to reform a new supracrestal gingival unit in order to regain that dimension referred to as the biologic width. Most recently, Lanning et al.[17] confirmed the suggestion from prior studies[4,10-13] that the biologic width will reestablish itself after crown length-

Table 7.

Tissue Rebound at 6 Months Related to Post-Suturing Flap Position (treated versus adjacent sites)

	Treated (TT)		Adjacent (AA)		Non-Adjacent (AN)	
GM/AB(X)	N	Change ± SD	N	Change ± SD	N	Change ± SD
≤1 mm	48	1.25 ± 1.06	11	1.55 ± 0.93	5	1.60 ± 0.89
2 mm	135	0.84 ± 0.87	40	1.05 ± 0.93	18	1.05 ± 1.0
3 mm	79	0.58 ± 0.78	19	0.32 ± 0.67	29	0.28 ± 0.84
≥4 mm	25	–0.12 ± 1.33	10	0.60 ± 0.97	23	–0.52 ± 0.85

Table 8.

Tissue Rebound at 6 Months Related to Post-Suturing Flap Position (interproximal versus facial/lingual sites)

	Interproximal		Facial/Lingual	
GM/AB(X)	N	Change ± SD	N	Change ± SD
0 mm	0	N/A	2	1.00 ± 1.40
1 mm	42	1.29 ± 0.99	20	1.45 ± 1.10
2 mm	122	1.15 ± 0.85	71	0.48 ± 0.81
3 mm	94	0.51 ± 0.77	33	0.36 ± 0.82
≥4 mm	47	0.00 ± 1.10	11	–0.81 ± 1.17

ening procedures to its original vertical dimension by 6 months. The current study suggests that in anticipation of the reconstitution of the supracrestal attachment and sulcus, suturing the post-surgical flap less than 3 mm from the bone may of necessity result in significant marginal soft tissue rebound. One may thus clinically question the practice of apically positioning the flap margins to the level of the bony crest during crown lengthening procedures. It would appear that positioning the flap somewhat coronal to the alveolar crest might result in a more predictable and stable amount of surgically created crown length. This may require more aggressive osseous resection if the restorative goal is to provide supragingival crown margins.

Few studies in the literature on surgical crown lengthening report results on the movement of the healing gingival margin based on the initial sutured flap position relative to the alveolar crest. Bragger et al. examined changes in marginal soft tissue levels after 6 weeks and 6 months of healing.[14] This study also sought to create a distance of 3 mm from alveolar crest level to the future restorative margin, and surgical flaps were positioned at the osseous crest. Looking at 43 test teeth in 25 patients, they found that at 96% of sites, ≤2 mm of bone was removed on test teeth and bone removal of ≥3 mm was done in only 4% of sites. This compares favorably to the present study where 93% of sites had ≤2 mm of bone resection and 7% had ≥3 mm. Additionally, they found that when the means of all sites were examined, the 1.3 mm apical displacement of the gingival margin after surgery was maintained at the 6-month examination (1.4 mm). This differs from the current study in which the initial 2.27 mm average apical displacement of the gingival margin at the time of surgery was reduced to 1.57 mm at 6 months.

In a study by Pontoriero et al., 84 teeth in 30 patients receiving surgical crown lengthening were evaluated over a 12-month period.[16] There was no mention of a surgical endpoint given in this study and adjacent teeth were included with the data for crown-lengthened teeth. Mean bone removal was 0.9 mm at interproximal and 1.0 mm at buccal/lingual sites and bone removal ≥2 mm was reported in only 8% of sites. Based on reported data, surgical flaps were placed subcrestally at interproximal sites, leaving the interdental areas denuded, whereas buccal/lingual sites had flaps placed at the bony crest. Such positioning seemed to promote a significant coronal displacement of marginal tissues of 3.2 mm at interproximal and 2.9 mm at buccal/lingual sites, with a resultant mean crown length difference between baseline and 12-month examination of only 0.5 mm interproximally and 1.2 mm at buccal/lingual sites. These results have cast a doubt on the stability of crown lengthening procedures over longer time periods and, similar to our study, seem to indicate that gingival margin regrowth may still be occurring beyond 6 months. Additionally, based on their findings, the authors[16] propose that greater bone removal during crown lengthening procedures should be considered in order to maximize final crown length. Postoperative marginal flap positioning is not discussed in their conclusions as potentially contributing to the amount of rebound witnessed.

In an effort to determine whether a target goal of 3 mm from osseous crest to planned restorative margin was routinely achieved, Herrero et al. evaluated crown lengthening outcomes on 21 teeth in 16 patients treated by surgeons of various skill levels.[15] They noted that the target objective of 3 mm was not routinely achieved. The mean distance from prosthetic margin to alveolar crest was 2.4 mm with the greatest removal at the facial aspects of teeth (2.6 mm) and the least at the distal-lingual aspect (2.2 mm).

More recently, in a 6-month study Lanning et al. followed 72 treated sites in 18 patients receiving crown-lengthening surgery.[17] Individual presurgical biologic

width measurements were used to customize the amount of bone removal indicated from anticipated prosthetic margins. Flaps were subsequently sutured at the alveolar crest; however, post-surgical flap position relative to the bony crest was not measured. A greater amount of osseous resection was done in this study than what has previously been reported in the literature, with 90% of treated sites having had ≥3 mm of bone removed. Additionally, 21% of non-adjacent sites and 39% of adjacent sites on adjacent teeth had ≥3 mm of bone removed. This resulted in a stable gingival margin between the 3- and 6-month examinations, with total mean displacement at 6 months for treated sites being 3.33 mm. The authors[17] concluded that the amount of bone removal in their study may have been a significant factor contributing to the stability of the gingival margin over time.

In the current study, it was noted that the request for crown lengthening came most often for only one or two tooth surfaces rather than the entire tooth. At surgery, this request translated to an amount of osseous resection that was not uniform at all sites around the treated teeth. In fact, it was common for two or three sites on a given tooth to have ≥2 mm osseous reduction, while the remaining sites had minimal or even no reduction. This tended to make the mean osseous reduction (and subsequent increased crown height) at TT sites smaller than actually provided at required sites.

Many factors seem to contribute to the maintenance of tooth structure gained through surgical crown lengthening procedures. Individual patient healing characteristics, reformation of the biologic width, adequacy of positive osseous architecture created during surgery, timing of restorative procedures, and post-operative plaque control may be among these factors. Another factor may be the position of the flap margin after surgery, which was examined in the present study. Some degree of marginal tissue rebound can be anticipated following crown lengthening surgery. It is possible that earlier marginal tissue stability can be achieved if the gingival margin is placed at the time of suturing in a position that accounts for the reformation of the biologic width.

In conclusion, the data presented in this study suggest that there is a significant marginal soft tissue rebound following crown-lengthening surgery that has not fully stabilized by 6 months. The amount of coronal rebound appears to be related to the position of the flap relative to the alveolar crest at suturing. These findings support the premise that clinicians should establish proper crown height during surgery without overreliance on flap placement at the osseous crest to gain necessary crown length.

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