Healing Time for Final Restorative Therapy After Surgical Crown Lengthening Procedures: A Review of Related Evidence

Ramzi V. Abou-Arraj,* Zeina A. K. Majzoub,†‡ Carolyn M. Holmes,§ Maria L. Geisinger,* and Nicolaas C. Geurs*

Focused Clinical Question

In healthy patients who receive surgical crown lengthening, how much healing time should be allowed for the positional changes of the gingival margin before final restoration?

Clinical Scenario

A 59-year-old woman presented to the University of Alabama at Birmingham School of Dentistry in August 2011 for replacement of her existing porcelain-fused-to-metal crowns on the maxillary anterior teeth for esthetic reasons. Clinical examination revealed a diagnosis of developmental mucogingival deformity manifested by gingival excess in the maxillary anterior sextant. An esthetic evaluation was performed and identified excessive gingival display attributable to short clinical crowns and excluded vertical maxillary excess and short or hypermobile upper lip as etiologic factors. After signing a written informed consent, the patient underwent an esthetic crown lengthening procedure to correct this mucogingival deformity, followed by prosthodontic rehabilitation. The patient and restoring dentist were concerned with the healing time that should elapse before the teeth were permanently restored. Figures 1 through 5 illustrate the initial presentation of the patient, surgical crown lengthening procedure, and final restorations.

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Key Words: Crown lengthening; evidence-based dentistry; wound healing.

Background

Surgical crown lengthening is performed for functional purposes (to expose tooth structure for restorative therapies) and for esthetic reasons (to treat excessive gingival display and gingival margin discrepancies). The concept of the biologic width, including the junctional epithelium and connective tissue attachment, has been the cornerstone of achieving successful crown lengthening. Historically, the dimension of the biologic width ranges from 1.91 to 2.04 mm based on cadaver studies.[1,2] However, this established range is an average and may not apply to all sites, teeth, or individuals.[2-6] A systematic review identified tooth type, tooth site, presence of restoration, healing time after surgical crown lengthening, and periodontal disease status as possible factors affecting the dimension of the biologic width.[7] The reformation of the biologic width occurs coronal to the osseous crest after crown lengthening procedures and dictates the final position of the gingival margin postoperatively. However, numerous factors affect the positional changes of the gingival margin, including: 1) gingival biotype;[8,9] 2) immediate post-suturing position of the flap margin;[9,10] 3) interindividual variations of the biologic width;[4,5,11] 4) amount of osseous resection;[12] 5) post-surgical bone remodeling;[13-17] and 6) the clinician's experience.[12] In addition, healing time is considered a crucial factor for the maturation and stability of the periodontal tissues before placing permanent restorations, especially in esthetic areas. This review of the literature aims to find the best evidence to determine the optimal healing time required after surgical crown lengthening before finalizing the restorative/prosthetic procedures. Determining the minimum time necessary for gingival margin stability is critical to ensure minimal treatment delays and adequate continuity of care while allowing for adequate healing to produce optimal functional and esthetic results from prostheses.

* *Department of Periodontology, School of Dentistry, University of Alabama at Birmingham, Birmingham, AL.*

† *Private practice, Padova, Italy.*

‡ *Department of Periodontology, Lebanese University, Hadath, Lebanon.*

§ *Lister Hill Library of the Health Sciences, University of Alabama at Birmingham.*

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Search Strategy

A literature search of PubMed, the Cochrane Database, EBSCO, and Scopus using the following search terms was initiated in June 2013 and updated on a weekly basis through January 2014: crown lengthening AND wound healing OR time OR time factors OR periodontal attachment loss OR periodontal index OR periodontal pocket OR periodontium OR alveolar process OR epithelial attachment OR gingiva OR gingival OR periapical tissue OR periodontal ligament OR gingival diseases OR "biologic width" OR "biological width" OR "soft tissue" OR "soft tissues" OR connective tissue OR mouth mucosa OR mucosa OR mucosal OR tissue preservation OR recession OR supracrest* [tw] OR rebound OR keratins OR keratin* [tw] OR papill* [tw] OR tissue OR tissues AND cohort studies [mh] OR meta-analysis [pt] OR meta-analysis as topic [mh] OR randomized controlled trial [pt] OR randomized controlled trials as topic [mh] OR systematic [sb] OR cohort [tw] OR "meta analysis" [tw] OR "randomized controlled" [tw] OR systematic [tw]. tw indicates text word, mh is MeSH heading, pt is publication type, and sb is subset of the PubMed database.

Search Outcome

Forty-one abstracts and 21 full articles were reviewed. Fifty-five papers were eliminated because their findings did not specifically discuss the positional changes of the periodontal tissues in relation to the healing time. Seven publications[5,8-11,18,19] are included in this review and summarized in Table 1.

Discussion

Surgical crown lengthening is a classic periodontal procedure used to increase the clinical crown length for functional and/or esthetic indications. The positional changes of the gingival margin after crown lengthening were directly or indirectly investigated in several studies,[5,8-11,18,19] whereas others focused on changes to the alveolar bone.[12,16,17,20,21] However, less detailed information is available relative to the effect of healing time on the final position of the gingival margin, especially when restorative therapy is planned. Postoperative healing and maturation of the periodontal tissues after surgical crown lengthening involves bone remodeling in terms of density with possible crestal height resorption[13-15,17] and corresponding soft tissue changes in the form of regrowth, stability, or recession. Despite the relative impact of the abovementioned factors on the final position of the gingival margin, a certain healing time must elapse for these changes to take effect. Furthermore, from a clinical practice standpoint, both referring restorative dentists and patients are concerned with the timing of delivery of the definitive restorations. It is commonly accepted that 6 to 12 weeks of healing after surgical crown lengthening are sufficient before impressions and placement of final restorative margins in posterior areas,[12,22-24] whereas 3 to 6 months is accepted as a more appropriate healing time on anterior teeth.[5,18,25] These clinical standards propose that esthetic concerns are the main parameter that governs this decision, whereas the same influencing biologic and surgical factors may play an essential role in the healing process irrespective of tooth location in the arch. Hence, proper understanding of the length of the postoperative healing phase in clinical practice is lacking and is seldom based on scientific data. It is noteworthy that the vast majority of the reviewed surgical crown lengthening studies[5,9-12,16,18,19,22] are short-term in nature (≤6 months) with very few longer-term exceptions.[8,20,21]

Several publications used the presurgical height of supracrestal gingival tissues (inclusive of both biologic width and sulcus depth) as an initial guideline for performing a customized osseous resective surgery because it better accommodates individual variations in biologic width reformation and leads to a predictably stable gingival margin in the postoperative phase.[4,5,11] In contrast, other reports failed to demonstrate the consistency of this measurement in similarly designed studies.[9,19] These authors showed that the height of supracrestal gingival tissues was decreased relative to the

FIGURE 1 Initial presentation of a 59-year-old female patient. **1a** Extraoral view demonstrating excessive gingival display at smile. **1b** Intraoral frontal view showing short clinical crowns, provisional restorations, discrepant gingival margins, and canted gingival line

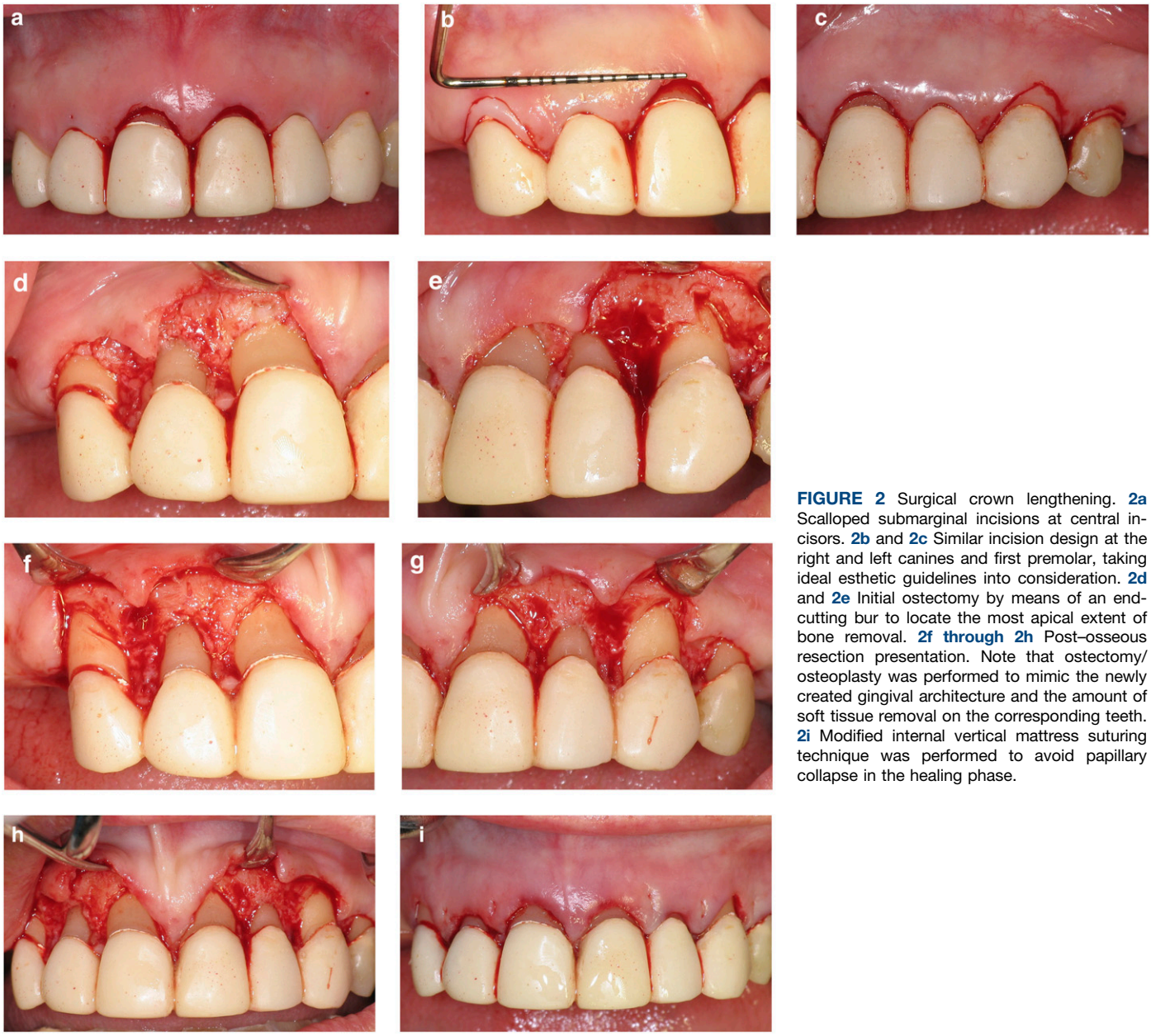

FIGURE 2 Surgical crown lengthening. **2a** Scalloped submarginal incisions at central incisors. **2b** and **2c** Similar incision design at the right and left canines and first premolar, taking ideal esthetic guidelines into consideration. **2d** and **2e** Initial ostectomy by means of an end-cutting bur to locate the most apical extent of bone removal. **2f through 2h** Post–osseous resection presentation. Note that ostectomy/osteoplasty was performed to mimic the newly created gingival architecture and the amount of soft tissue removal on the corresponding teeth. **2i** Modified internal vertical mattress suturing technique was performed to avoid papillary collapse in the healing phase.

FIGURE 3 Healing 3 weeks postoperatively. Sutures were removed at 2 weeks after crown lengthening.

FIGURE 4 Healing 6 weeks postoperatively immediately after apical relocation of preparation margins and cementation of new provisional crowns. Note the slight discrepancy between gingival margins of the right and left central incisors.

FIGURE 5 Presentation 8 months postoperatively and 1 month after delivery of final full-ceramic restorations. Note the correction of marginal discrepancy between the central incisors during the remainder of the healing phase and the esthetic outcomes.

baseline dimension; therefore, these reports indicate that the stability of the gingival margin could not be predicted in the healing phase.[9,19]

This literature review reveals a current body of evidence that indicates that a recommended healing time after surgical crown lengthening is mostly based on 6-month prospective controlled clinical trials and a 1-year prospective study. Overall, there seems to be a consensus that significant gingival rebound after surgical crown lengthening is mostly correlated with short flap-to-osseous crest distance at suturing and thick-flap biotype.[8-10] Additionally, the remodeling of the underlying alveolar bone should not be disregarded as an influencing factor on gingival positional changes. Although it is extremely difficult to assess the post-surgical resorption of the height of the alveolar crest in clinical trials, one investigation used a non-invasive technique (computer-assisted densitometric image analysis) to show that 85% of crestal bone density was restored at crown lengthening sites at 6 months postoperatively.[16] These findings were corroborated in a 12-month radiographic study that showed evidence of an intact lamina dura reformation in >60% of interproximal crown lengthening sites at 6 months after surgery and in 100% of the specimens at 12 months after surgery.[21] Furthermore, no radiographic changes to the interproximal bone level were noted from time points immediately after ostectomy up to the 12-month follow-up visits.[21] Although no information was provided on the positional changes of the gingival margin in either of the aforementioned studies, the nearly complete restoration of the underlying bone density at 6 months may represent a sign of tissue maturation. ■

Clinical Bottom Line

It is concluded that the allocated healing time after surgical crown lengthening should not differ between anterior and posterior areas of the mouth. The same biologic principles guide the healing process irrespective of tooth location. However, anatomic factors, most notably biologic width and gingival soft tissue biotype, and surgical factors, including the amount of osseous reduction and flap position at suturing, vary between tooth sites and positions and should be assessed to predictably achieve stable clinical outcomes at 6 months postoperatively. Using the premeasured biologic width as an indicator to predict postoperative gingival position, the gingival dimension remained stable or varied <0.5 mm from the original dimension at the involved sites at 6 months after crown lengthening. Despite the methodologic differences in the studies using this concept, the amount of positional change can be minimized and predicted at 6 months postoperatively, provided an adequate consideration of the surgical and anatomic factors is performed. However, when flaps are positioned at or apical to the osseous crest, >6 months may elapse before gingival regrowth is finalized, particularly in patients with thick tissue biotypes.[8-10]

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CORRESPONDENCE:
Dr. Ramzi V. Abou-Arraj, University of Alabama at Birmingham, SDB 412, 1919 7th Ave. S., Birmingham, AL 35294-0007. E-mail: rva@uab.edu.

TABLE 1 Summary of Reviewed Relevant Publications

Reference	Patient Group	Study Type (Level of Evidence)	Methods	Key Results	Comments
Brägger et al., 1992[18]	n = 25 patients requiring CL for restorative indications	Prospective controlled clinical trial	Study aimed at assessing GM level alterations over 6 months after CL. PI, GI, GM, PD, and CAL were assessed presurgically and 6 weeks and 6 months after surgery. GM was also recorded after suturing. CL was performed on 43 test teeth, whereas 42 contralateral teeth served as control sites. Osseous surgery was conducted to allow ≥3 mm between the osseous crest and future restorative margin. Close flap adaptation was obtained.	During surgery, bone removal of ≥3 mm was done in only 4% of sites, whereas ≤2 mm of bone was removed at 96% of sites. The mean apical displacement of GM immediately after suturing was 1.3 mm, became 1.5 mm at 6 weeks, and was finalized at 1.4 mm at 6 months. Between 6 weeks and 6 months, 85% of test sites showed no change or a change within ±1 mm. However, 12% of the test sites showed an apical displacement of GM of 2 to 4 mm.	The GM position was fairly stable from the time of suturing until 6 months after surgery. It may be related to consistently achieving 3 mm between the osseous crest and future restorative margin and to "close" flap adaptation, suggesting a flap position significantly coronal to the osseous crest at the time of suturing. Nonetheless, placement of the final restorations in esthetic areas should be delayed for 6 months after surgery because of the possibility of additional recession (as noted in 12% of sites).
Pontoriero and Carnevale, 2001[8]	n = 30 patients (84 teeth) requiring surgical CL for restorative reasons	Prospective clinical trial	Study aimed at assessing GM-level alterations over 12 months after CL. PI, GI, PD, GM, and CAL were recorded on B/L and IP of all experimental teeth at baseline and 1, 3, 6, 9, and 12 months postoperatively. Tissue biotype was evaluated as normal, thin, or thick. During surgery (APF + osseous), flaps were positioned at or apical to the osseous crest, and the amount of bone resection and achieved CL were recorded.	Coronal regrowth of GM averaged 3.2 ± 0.8 mm at IP sites ($P < 0.001$) and 2.9 ± 0.6 mm at B/L sites ($P < 0.002$) at 12 months after surgery. At 1 month after surgery, coronal regrowth of GM reached ≈60% of its final position at IP sites and 40% at B/L sites. Consequently, the achieved CL immediately after surgery decreased to 0.5 ± 0.6 mm at IP sites ($P < 0.0015$) and 1.2 ± 0.7 mm at B/L sites ($P < 0.001$) at the 12-month exam. More coronal regrowth was noted in patients with thick tissue biotype.	Flap positioning is not discussed as a factor in tissue rebound. However, the flaps were placed at or apical to the osseous crest, which may explain the significant tissue rebound over 12 months. One year or more is needed to achieve stable gingival margins if this type of surgical approach is applied, especially in patients with thick biotypes. No control teeth were included.

TABLE 1 (Continued) Summary of Reviewed Relevant Publications

Reference	Patient Group	Study Type (Level of Evidence)	Methods	Key Results	Comments
Lanning et al., 2003[5]	n = 18 patients requiring CL for restorative indications	Prospective controlled clinical trial	Study aimed at evaluating the positional changes of the periodontal tissues 6 months after CL. Sites were labeled as treated tooth, adjacent tooth/adjacent site, or adjacent tooth/non-adjacent site. PI, GI, GM, PD, CAL, and BW were assessed presurgically and at 3 and 6 months postoperatively. The amount of bone removal was based on future prosthetic margin and the premeasured BW. Flaps were apically positioned at the osseous crest.	Bone removal ≥3 mm was performed in 90% of sites. The authors believe that this may have contributed to the GM stability between the 3- and 6-month postoperative visits. The amount of apical displacement of GM was 3.07 mm at treated tooth sites and ≈0.5 mm less at adjacent tooth/adjacent sites and adjacent tooth/non-adjacent sites at 3 months after surgery ($P < 0.05$). GM position remained stable between 3 and 6 months postoperatively. BW was found to reform to baseline dimensions at treated tooth sites at 6 months postoperatively, whereas it decreased at adjacent tooth/adjacent sites and adjacent tooth/non-adjacent sites ($P < 0.05$).	The amount of bone resected in this study is greater than in previous reports (≥3 mm at 90% of treated sites). This was the first study to demonstrate reformation of BW to its original dimension when the bone crest was positioned to accommodate the future prosthetic margin and space for the BW. It is noteworthy that final restorations were placed on 98% of teeth by the end of the 6-month trial.
Deas et al., 2004[10]	n = 25 patients requiring CL for restorative indications	Prospective controlled clinical trial	Study aimed at evaluating the stability of surgical CL procedures over a period of 6 months. Sites were labeled as treated tooth, adjacent tooth/adjacent surface, or adjacent tooth/non-adjacent surface. PI, GI, GM, PD, and CAL were assessed presurgically and at 1, 3, and 6 months postoperatively. The amount of bone removal was recorded during surgery. GM and GM–osseous crest distance was also recorded after suturing.	During surgery, bone removal of ≥3 mm was done in only 7% of sites, whereas ≤2 mm of bone was removed at 93% of sites. The amount of CL tended to decrease over time (measurements at 1, 3, and 6 months were all significantly less than the immediate post-surgical values). There was a significant inverse correlation between the distance from flap to osseous 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 (rebound of 1.33 ± 1.02 mm when the flap was ≤1 mm coronal to the osseous crest versus -0.16 ± 1.15 mm when it was ≥4 mm coronal to it).	Similar bone removal pattern to that of Brägger et al.,[18] but different results were observed regarding the GM stability over time. In this study, close flap adaptation at the time of suturing was not systematically achieved. Placing the flap at the osseous crest was associated with significant tissue rebound and did not maintain the crown length achieved by surgery. Therefore, GM regrowth may still be occurring beyond 6 months.

TABLE 1 (Continued) Summary of Reviewed Relevant Publications

Reference	Patient Group	Study Type (Level of Evidence)	Methods	Key Results	Comments
Perez et al., 2007[19]	n = 19 patients requiring CL for restorative indications	Prospective controlled clinical trial	Study aimed at determining the viability of TSP and at comparing SOG measurements from baseline to 6 months postoperatively. Full-mouth TGGPI, MGI, and PD were measured at baseline, surgery, and 6 months postoperatively, whereas SOG was measured at surgery and 6 months. TSP viability was evaluated compared with direct BL measurements at the time of surgery. The amount of bone removal was based on future prosthetic margin and the premeasured SOG. Flaps were apically positioned but achieved maximum coverage of facial and lingual bone.	TSP was found to reliably identify the position of the osseous crest (83.4% to 91.9% agreement with direct BL measurements). Overall SOG dimensions at 6 months were found to decrease 0.56 mm from baseline dimensions ($P < 0.001$). Hence, baseline SOG was not systematically replicated at 6 months. Based on these results, baseline SOG dimension cannot be reliably used as a sole guideline for the amount of bone removal in CL procedures.	These findings were in disagreement with those of Lanning et al.[5] and did not find SOG to predictably reform to its original dimension 6 months after CL. However, Lanning et al.[5] discussed BW and not SOG; the differences in results could be attributed to differences in PD, measurement resolution (rounding to the nearest 0.5 or 1 mm), etc. In addition, the difference, although statistically significant, may not be clinically significant ($\approx$0.5 mm).
Shobha et al., 2010[11]	n = 15 patients requiring CL for restorative indications	Prospective controlled clinical trial	Study aimed at evaluating the positional changes of periodontal tissues and BW after CL from baseline to 6 months postoperatively. Sites were labeled as treated tooth, adjacent site, or non-adjacent site. PI, GI, GM, CAL, BL, PD, and BW were assessed presurgically and at 1, 3, and 6 months postoperatively. The amount of bone removal was based on future prosthetic margin and the premeasured BW.	Significant apical displacement in GM at 1 month after surgery that remained stable up to 6 months ($\approx$2 mm, $P < 0.001$). BW was reestablished to its original dimension on the treated tooth at 6 months postoperatively.	No information was provided concerning flap position at suturing. Predictable stability in GM position may be achieved at 6 months using the premeasured BW concept. This is in agreement with Lanning et al.[5] and in disagreement with Perez et al.[19] and Arora et al.[9]

TABLE 1 (Continued) Summary of Reviewed Relevant Publications

Reference	Patient Group	Study Type (Level of Evidence)	Methods	Key Results	Comments
Arora et al., 2013[9]	n = 53 patients requiring CL for restorative indications	Prospective controlled clinical trial	Study aimed at evaluating the alterations of periodontal tissue levels and influencing factors at 6 months after surgery. Sites were labeled as treated tooth, adjacent tooth/adjacent surface, or adjacent tooth/non-adjacent surface. PI, GI, GM, PD, BOP, CAL, SGT, and BL-TSP were assessed presurgically and at 3 and 6 months postoperatively. Periodontal biotype was recorded as flat-thick or scalloped-thin at baseline. The amount of bone removal was based on future restorative margin and the premeasured SGT. Flaps were placed at or apical to the anticipated crown margin.	SGT on the treated tooth at 6 months postoperatively was found to be $\approx$0.5 mm less than SGT at baseline ($P =$ 0.001). Significant soft tissue rebound of 0.77 $\pm$ 0.58 mm was noted at 6 months postoperatively. This rebound was significantly correlated with the flap-to-osseous crest distance at suturing ($r = -0.601$, $P < 0.001$) and thick-flap biotype ($r = 0.325$, $P < 0.001$).	The SGT results concur with those of Perez et al.[19] The influencing parameters for the tissue rebound also concur with the findings of Pontoriero and Carnevale[8] and Deas et al.[10] Again, SGT reforms with 0.5 mm less than baseline. Although this difference was statistically significant, the question remains whether it has clinical significance.

CL = crown lengthening; GM = position of the gingival margin; PI = plaque index; GI = gingival index; PD = probing depth; CAL = clinical attachment level; IP = interproximal; B/L = buccal/lingual; APF = apically positioned flap; BW = biologic width; TSP = trans-sulcular probing; SOG = supraosseous gingiva; BL = bone level; TGGPI = Turesky-Gilmore-Glickman plaque index; MGI = modified gingival index; SGT = supracrestal gingival tissue; BOP = bleeding on probing.

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