Establishment of supracrestal tissue dimensions following crown lengthening procedures in humans

Fatme Mouchref Hamasni, *DCD, CES, DSO*
Assistant Professor, Department of Periodontics & Implant Dentistry, Faculty of Dental Medicine, Lebanese University, Hadath, Lebanon

Zeina Majzoub, *DCD, DMD, Dott. Odont., CAGS, MScD*
Former Professor of Periodontology and Research, University of Padova, Institute of Clinical Dentistry, Padova, Italy
Professor of Periodontology and Research, Former Chairperson, Department of Research, Lebanese University, School of Dentistry, Hadath, Lebanon
Department of Periodontics & Implant Dentistry, Faculty of Dental Medicine, Lebanese University, Hadath, Lebanon

ABSTRACT

Background: The standard application of a mean value of 2.04 mm for the biologic width has been demonstrated to result in inconsistent amounts of tooth extension following crown lengthening procedure (CLP). BW has been recently replaced by the height of supracrestal gingival tissues (SGT) that includes the BW and sulcular depth. The question whether SGT dimension established at tissue maturation postoperatively is not significantly different from the pre-surgical dimension has not been fully answered.

Objectives: The aims of the present prospective clinical investigation are to compare the preoperative and the 24-week height of SGT buccally, lingually/palatally and interproximally following surgical CLP and assess the temporal changes in the gingival marginal level from right after surgery to the 24-week healing time.

Material and Methods: Twenty adult systemically healthy patients requiring CLP were recruited for the study. CLP was performed at 33 teeth and the patients followed up to 24 weeks. The following parameters were recorded using a customized stent for measurement reproducibility: stent-gingival margin (SGM) (baseline, right after surgery, and 24 weeks), stent-bone crest (SBC) (baseline and 24 weeks).

Results: There were no statistically significant differences between SGT at baseline and at 24 weeks for any of the 4 tooth sides. Significant differences were found between SGM right after surgery and SGM at 24 weeks for the mesial and distal sides ($P<0.001$) in contrast to the buccal and lingual/palatal sides where such differences were not detected ($P=0.63$ and 0.64 respectively).

Conclusions: The preliminary results of this investigation suggest the following: 1) The presurgical SGT dimension can be used as a guideline measurement in crown lengthening as it is re-established apically with a similar apico-coronal dimension 24 weeks postoperatively; 2) over time, crown height extension is more significantly reduced at the interproximal aspects suggesting greater postsurgical tissue rebound interproximally.

Key Words: crown lengthening procedure, supracrestal gingival tissues, biologic width, osseous resection

Corresponding author:
Fatme Mouchref Hamasni / tima@cyberia.net.lb

INTRODUCTION

The creation of an adequate space for the proper placement of prosthetic margins on a compromised tooth can be achieved surgically (crown lengthening procedure), orthodontically,[1] or by combination of both.[2] Clinical crown lengthening is defined as a surgical procedure that aims at exposing sound tooth structure for restorative purposes via apical repositioning of the gingival tissue with or without removal of alveolar bone.[2] Crown lengthening procedure (CLP) has been generally performed applying the concept of the biologic width (BW) that stems from an early histologic description in cadavers and uses a mean value of 2.04 mm as the indicator for the amount of osseous resection needed during surgery. This average value has been challenged in various clinical investigations where inconsistent amounts of crown extension have been reported following surgical CLP.[4-8]

The total height of supracrestal gingival tissues (SGT) which includes the BW plus the sulcular depth has been proposed as a more representative dimension

to apply in CLP as it accounts for the variability of sulcular depth. SGT measurement rather than that of BW could also eliminate the inherent inaccuracies in locating the bottom of the sulcus.[9] SGT values have been demonstrated to vary between individuals, arches, gingival morphotypes, tooth types, and sites.[6,10,11] This variability of SGT underlines the need for patient-customized surgical crown extension based on individual soft and hard tissue parameters.

While several clinical studies seem to agree that SGT is a predetermined dimension that re-establishes itself at tissue maturation postsurgically,[12,13,14] other investigations have reported that SGT reformed at tissue maturation postoperatively is significantly different from that recorded at baseline prior to CLP.[6,9,15] These inconsistencies warrant additional research to further investigate this issue.

The objectives of the present prospective clinical study are to compare the preoperative and the 24-week dimensions of SGT buccally, lingually/palatally and interproximally following surgical CLP and assess temporal alterations of the gingival margin between baseline and the 24-week healing period.

MATERIALS AND METHODS

Study population

Twenty adult systemically healthy patients were recruited from a private clinical practice and the Department of Periodontology (Lebanese University, School of Dentistry, Hadath, Lebanon). All patients were informed about the study aims and requirements and signed the written consent form approved by the Scientific Review Board of the institution.

To be included in the study, the patients had to fulfill the following inclusion criteria: 1) age above 18 years; 2) adequate oral hygiene levels evidenced by a FMPS $\leq$ 20% after initial prophylaxis;[16] 3) teeth requiring crown lengthening that do not present pathologic tooth mobility, unfavorable crown-to-root ratio, short root trunk or furcation involvement.

Exclusion criteria included: 1) absence of teeth adjacent to those requiring CLP; 2) presence of attachment loss due to chronic or aggressive periodontitis; 3) ongoing orthodontic therapy; 4) altered passive eruption at the involved teeth; 4) medications known to be associated with gingival overgrowth such as cyclosporin, calcium channel blockers, diphenylidantoin, etc.; and 5) smoking.

The study population provided a total of 33 experimental teeth requiring CLP and 28 control teeth which shared a proximal surface with the experimental teeth.

Experimental procedures

One to 2 months prior to baseline examination, all patients received a comprehensive dental examination, oral hygiene instructions, and full-mouth prophylaxis. All experimental teeth had temporary provisional restorations made (Fig.1a). Tooth preparation was not modified until the end of the experimental period and final clinical evaluation.

At baseline alginate impressions of the surgical areas were made to provide casts for the fabrication of acrylic stents allowing reproducibility of clinical and surgical measurements from fixed reference points throughout the follow-up period. For this purpose, a modified copy of the temporary crown (MSC) with no interproximal contacts and extending to but not apically to the gingival margin was fabricated with 4 vertical slots parallel to the long axis of the experimental teeth allowing the insertion of a periodontal probe 0.5 mm in diameter ;one mid-buccally, one mid-lingually/palatally, and 2 interproximally at the mesial and distal surfaces corresponding to the contact point locations (Figs.1b-1c).

At surgery, plaque index PI (Silness & Löe)[17] and gingival index GI (Löe & Silness)[18] were evaluated in the surgical area. Following local anesthesia and prior to flap reflection, the distance between the coronal edge of the MSC and the gingival margin (SGM0) was recorded using the MSC at the experimental teeth requiring crown lengthening: This measurement was made at 4 sites (mid-buccal, mid-lingual/palatal and mid-interproximal) at all experimental teeth using a calibrated periodontal probe and rounded to the nearest 0.5 mm. The same measurement SGM0 was similarly recorded on the control teeth using available fixed anatomical reference points on the crown.

A split-full thickness flaps were elevated on the buccal and lingual/palatal aspects of the experimental and adjacent teeth (Fig.1d). Following removal of the

supracrestal soft tissues, the direct bone level was measured to the nearest 0.5 mm form the reference stent to the crestal bone (SBC0) at the mid-buccal, mid-lingual/palatal and mid-interproximal aspects of the experimental teeth.

The height of supracrestal tissues (SGT0) was then calculated by subtracting the SBC0 measurement from that of the free gingival margin SGM0 recorded just prior to flap elevation.

Osteoplasty and ostectomy were then carried out using coarse round diamond burs mounted on a high-speed hand piece with copious water irrigation and hand chisels. The amount of bone removal during CLP was dictated by the assumption that pre-surgical SGT will re-establish itself postsurgically, i.e. the distance between the definitive restorative margin and the newly established osseous crest will be equal to SGT height measured prior to flap elevation (Fig.1e).

The buccal and lingual flaps were subsequently apically positioned ensuring maximum coverage of the buccal and lingual/palatal crestal bone using 5-0 monofilament interrupted vertical mattress sutures. At this time, the distance between the stent and the sutured gingival margin (SGM1) was measured at the individual 4 aspects of the experimental teeth (Figs.1f-1g).

Follow-up clinical measurements

Sutures were removed 10 days following surgery. No further modification of tooth preparation or alteration in the existing margins of the temporary restoration was made during the 6-month follow-up period.

Plaque and gingival indices were re-evaluated in the surgical area at 12 and 24 weeks. The distance between the coronal edge of the MSC and the gingival margin was recorded as previously described at 24 weeks (SGM24) (Fig.1h).

In addition, at the 24-week evaluation period, the distance between the stent and the alveolar crest (SBC24) at the mid-buccal, mid-lingual/palatal, and mid-interproximal surfaces of the experimental and adjacent teeth was recorded under light local anesthesia using the MSC (Fig.1i). SGT24 was then calculated as described above.

Statistical analysis

Data were summarized using means and standard deviations for continuous variables. The paired t-test was applied to compare baseline and 24-week postoperative values of SGT separately for buccal, lingual/palatal and interproximal measurements. In case the variables did not follow a normal distribution, the nonparametric Wilcoxon signed rank test was used. Friedman's test was applied to detect changes in SGM values from right after surgery till 24 weeks.

RESULTS

All patients maintained adequate levels of oral hygiene and low gingival indices throughout the early and late healing periods.

At baseline, comparison of SGT measurements at the 4 sides of all experimental and control teeth is summarized in Table 1. SGT at the buccal aspect was significantly lower than the other tooth sides ($P<0.05$). No significant differences were found between SGT values at lingual/palatal, mesial and distal aspects ($P>0.05$). When SGT was compared for the 33 experimental teeth between baseline and 24 weeks postoperatively separately for each side of the teeth (mesial, buccal, distal, and lingual/palatal) and for the average SGT (mean SGT value for all 4 surfaces), the results (Table 1) demonstrated no statistically significant differences between SGT at baseline and at 24 weeks for any of the 4 sides or for the overall average ($P>0.05$ for the paired t-test and non-parametric Wilcoxon signed rank test). Similar findings were observed for the control teeth at individual sites and mean all around SGT values. P values were all superior to 0.05 indicating statistically non significant differences between baseline and the 24-week SGT dimensions at the control teeth.

Over time comparisons of mean SGM for the experimental teeth at the individual sites (mesial, buccal, distal, and lingual) were computed and summarized in Table 2. Friedman's test was used for detecting changes in SGM from right after surgery until 24 weeks postoperatively. Statistically significant differences were found between SGM1 and

Fig. 1. Clinical pictures showing the experimental step-by-step procedure.

SGM24 for the mesial and distal sides ($P<0.05$). In contrast, no significant differences were evidenced between SGM1 and SGM24 for the buccal and lingual/palatal sides ($P=0.63$ and 0.64 respectively).

A similar trend was found at the control teeth relative to SGM values. Friedman's test was used for detecting changes in SGM from right after surgery till 24 weeks post surgery. There was a significant decrease in SGM over time at the mesial and distal sides of the teeth ($P=0.006$ and 0.001, respectively) while no significant change in SGM dimensions was found at the buccal and lingual aspects after surgery.

DISCUSSION

In the present study, significantly lower SGT values were observed at the mid-buccal sites when compared with the interproximal and lingual sites. Similar conclusions can be extrapolated from the findings of Barboza et al[11] although the authors did not perform comparative statistical tests. Mean SGT values ranging between 2.2 mm and 3.0 mm at the central buccal sites versus average measurements ranging between 2.6 mm and 3.2 mm at the lingual sites and between 3.4 mm and 4.2 mm at the interproximal surfaces were reported. Similarly, Perez et al[6] found mean SGT dimensions of 3.47 mm at mid- buccal and mid-lingual sites versus averages ranging between 3.47 mm and 4.05 at the line angles of proximal surfaces. Kois[19] attributed this discrepancy between buccal and interproximal sites to the difference in the amount of scalloping between bone and gingiva. No such site-level variation in SGT measurements could be demonstrated in the human histologic study conducted by Vacek et al[7] When comparing the dentogingival tissue dimensions between tooth surfaces, the authors concluded that no statistically significant differences were evident for any of the tissue dimensions including epithelial

Table 1. Comparison of SGT values at experimental teeth before surgery and 24 weeks postoperatively.

N= 33	Baseline Mean (SD) (mm)	24 Weeks After Surgery Mean (SD) (mm)	P-value
SGT Mesial	3.24 (0.82)	3.54 (0.50)	0.105
SGT Buccal	3.00 (0.91)	2.82 (0.50)	0.361
SGT Distal	3.16 (1.11)	3.42 (0.66)	0.293
SGT Lingual	3.56 (1.10)	3.34 (0.66)	0.283
Overall SGT	3.24 (0.62)	3.28 (0.32)	0.756

Table 2. Comparison of SGM values at experimental teeth between baseline and the 24-week evaluation interval.

N=23	Baseline (SGM0) Mean (SD) (mm)	Right After Surgery (SGM1) Mean (SD) (mm)	24 Weeks (SGM24) Mean (SD) (mm)	P-value*
Mesial	2.80 (0.90)	5.07 (0.84)	3.64 (1.01)	<0.05
Buccal	4.93 (1.17)	6.70 (1.00)	6.39 (1.28)	0.63
Distal	3.20 (1.30)	5.30 (0.96)	4.13 (1.03)	<0.05
Lingual	4.26 (1.69)	5.65 (1.33)	5.11 (1.45)	0.64

* P-value for the t-test between SGM1 and SGM24

attachment, connective tissue attachment and sulcus depth.

When considering the mean figures of SGT at the site-level, the present study reported average mid-buccal values inferior or equal to 3 mm. These figures are similar to those demonstrated by Tristão et al[10] in a histomorphometric evaluation of the midbuccal SGT in humans (2.75 ± 0.59 mm). Conversely, Barboza et al[11] Perez et al,[6] reported higher figures for the mid-facial surfaces (3.47 mm). The differences between the SGT dimensions observed in the present study and those in the 2 above mentioned reports could be attributed to the location of the measurement site (mid-interproximal versus line-angles), to differences in tooth types, differences in gingival morphotypes (thick versus thin), and measurement rounding (rounding up to the nearest 0.5 mm versus the nearest millimeter).

In the present study, the corono-apical dimension of SGTs re-established itself postsurgically at all sites in the experimental and control teeth. This finding is in line with the conclusions of Lanning et al[14] but in contradiction with those of Perez et al[6] and Arora et al[9] who demonstrated that the mean SGT values obtained 6 months postsurgically were reduced when compared to preoperative dimensions. These differences could be related to: 1) measurement rounding; 2) the surgical procedure itself where ostectomy and osteoplasty would have resulted in greater changes in the local anatomic tooth-related and bone-related variables; 3) tissue biotype where thin gingival morphotypes tend to have more postoperative recession when compared to thicker biotypes; and

4) differences in postsurgical bone resorption as a result of osseous recontouring.[4,20-22] The results of the present study and those of Lanning et al[14] tend to confirm the hypothesis of a genetically predetermined SGT height to be used as a guideline in CLP procedures.

Tissue rebound associated with a coronal displacement of the gingival margin was observed in the postoperative period, mainly at the interproximal sites that demonstrated significantly greater creeping than both buccal and lingual surfaces. Postsurgical tissue rebound has been documented in a number of studies.[5,8] No documentation is currently available relative to the significant differences in gingival tissue rebound between buccal/lingual and interproximal sites following CLP. This differentiated behavior can be attributed to the inherently greater SGT interproximal values.

Based on the preliminary results of this clinical study, it can be concluded that the presurgical SGT dimension can be used as a guideline measurement in crown lengthening as it is re-established apically with a similar apico-coronal dimension 24 weeks following CLP. In addition, greater postsurgical tissue rebound should be expected interproximally than at the buccal and lingual/palatal surfaces.

Aknowledgments:
The authors reported no conflicts of interest related to this study.

REFERENCES

1. Ingber JS. Forced eruption. Part I. A method of treating isolated one-and two wall intrabony osseous defects-rationale and case report. J Periodontol 1974;45:199-206.

2. Rosenberg ES, Garber DA, Evian CI. Tooth lengthening procedures. Compend Cont Ed 1980;1:161-172.

3. American Academy of Periodontology. AAP Glossary of Terms 2001.

4. Brägger U, Lauchenauer D, Lang NP. Surgical lengthening of the clinical crown. J Clin Periodontol 1992;19:58-63.

5. Deas DE, Moritz AJ, McDonnell HT, Powell CA, Mealey BL. Osseous surgery for crown lengthening: A 6-Month clinical study. J Periodontol 2004;75:1288-1294.

6. Perez JR, Smukler H, Nunn ME. Clinical evaluation of the supraosseous gingivae before and after crown lengthening. J Periodontol 2007;78:1023-1030.

7. Vacek JS , Gher ME, Assad DA, Richardson AC, Giambarresi LI. The dimensions of the human dentogingival junction. Int J Periodont Rest Dent 1994;14(2): 154-65.

8. Pontoriero R, Carnevale G.Surgical crown lengthening: a 12-month clinical wound healing study. J Periodontol 2001;72(7):841-8.

9. Arora R, Narula SC, Sharma RK, Tewari S. Evaluation of supracrestal gingival tissue after surgical crown lengthening: A 6-month clinical study. J Periodontol 2013;84:934-940.

10. Tristão GC, Barboza CAB Jr, Rodrigues DM, Barboza EP. Supracrestal gingival tissue measurement in normal periodontium: A human histometric study. Int J Periodont Rest Dent 2014;34:97-102.

11. Barboza EP, MonteAlto RF, Ferreira VF, Carvalho WR. Supracrestal gingival tissue measurements in healthy human periodontium. Int J Periodont Rest Dent 2008;28:55-61.

12. Shobha KS, Mahantesha, Seshan H, Mani R, Kranti K. Clinical evaluation of the biological width following surgical crown-lengthening procedure: a prospective study. J Indian Soc Periodontol 2010;14:160–167.

13. Ganji KK, Patil VA, John J. A comparative evaluation for biologic width following surgical crown lengthening using gingivectomy and ostectomy procedure. Int J Dent 2012(2012):479241.

14. Lanning SK, Waldrop TC, Gunsolley JC, Maynard GJ. Surgical crown lengthening: Evaluation of the biologic width. J Periodontol 2003;74:468-474.

15. Ayubian N. Evaluation of dimensional changes of supra-osseous gingiva following crown lengthening. J Periodontol Implant Dent 2010;2:61-65.

16. O'Leary TJ, Drake RB, Naylor JE. The plaque control record. J Periodontol 1972;43:38.

17. Silness J, Löe H. Periodontal disease in pregnancy II. Correlation between oral hygiene and periodontal condition. Acta Odontol Scand 1964;24:747-759.

18. Löe H, Silness J. Periodontal disease in pregnancy I. Prevalence and severity. Acta Odontolo Scand 1963;21:533-551.

19. Kois JC. New paradigms for anterior tooth preparation. Rationale and technique. Oral Health 1998;88(4):19-22,25-7,29-30.

20. Pennel BM, King KO, Wilderman MN, Barron JM. Repair of the alveolar process following osseous surgery. J Periodontol 1967;38:426-431.

21. Donnenfeld OW, Hoag PM, Weissman DP. A clinical study on the effects of osteoplasty. J Periodontol 1970;41:131-141.

22. Wilderman M.N, Pennel B.M, King K, Barron J.M. Histogenesis of repair following osseous surgery. J Periodontol 1970;41:551-565.