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One- versus two-stage crown lengthening surgical procedure for aesthetic restorative purposes: A randomized controlled trial

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Abstract

Aim: This randomized controlled trial aimed to assess the efficacy of a two-stage crown lengthening intervention (SCL) in the aesthetic zone compared with a one-stage crown lengthening procedure (CCL).

Materials and methods: Thirty subjects were randomly assigned to either SCL (n = 15) or CCL (n = 15) groups. SCL consisted of full-thickness flaps followed by bone recontouring and gingivectomy 4 months postoperatively, if required. In CCL, osseous recontouring after submarginal incisions was performed, followed by flap repositioning. Records were obtained at baseline, 4 months (only in SCL), 6 months and 12 months. Primary outcome was the precision in achieving a pre-determined gingival margin position. Other outcomes considered were changes in the gingival margin position and keratinized tissue width (KTW) at 12 months, and patient-reported outcomes (PROMs).

Results: Surgical precision was comparable between groups (0.2 ± 0.4 mm in the CCL group and −0.2 ± 0.5 mm in the SCL group). Four patients in the SCL group (27.7%) did not require a second-stage surgery. KTW was significantly higher in the SCL group (6.3 ± 1.4 mm versus 5.0 ± 1.4 mm, $p = 0.017$). SCL resulted in a lower impact on quality of life when compared to the CCL group.

Conclusions: Both approaches were highly accurate obtaining the desired crown length. SCL was associated with a lower reduction in KTW and more favourable oral health-related quality of life (OHIP-14).

KEYWORDS
aesthetic crown lengthening, crown lengthening, periodontal surgery, randomized clinical trial

Trial registration: ClinicalTrials.gov Registration Number NCT04409366.

1 | INTRODUCTION

Crown lengthening (CL) is a surgical procedure used to either facilitate restorative dentistry or improve patient's aesthetic demands when there is excessive gingival exposure during smile or when gingival enlargement prevents from adequate oral hygiene practices (Lee, 2004). In fact, crown lengthening surgical procedures have been estimated to represent approximately 10% of all periodontal surgical procedures (AAP, 2004).

Depending on their main objective, CL surgical interventions have been categorized as aesthetic or functional, depending on if they aim to improve aesthetic outcomes in situations of excessive gingival display and/or altered passive eruption, or for restorative purposes, in situations where subgingival caries or fractures require the exposure of subcrestal sound tooth structure. However, both have in common the objective of the re-establishment of the supracrestal tissue attachment, since it is well known that the impingement of this space, either with restoration margins or with apically positioned flaps, may result in bone resorption, gingival recession, chronic inflammation or gingival hypertrophy (Jepsen et al., 2018). Furthermore, functional and aesthetic objectives may converge in the restorative treatment of the anterior maxilla when the balance between the so-called pink and white aesthetics is not adequate. In CL surgical interventions aimed to satisfy high aesthetic demands, it is imperative to achieve an ideal position of the gingival margins (Herrero et al., 1995) and maintain this position long term (Deas et al., 2014). This outcome, however, is not always predictable, since factors such as the position of the gingival margin relative to the bone crest (Deas et al., 2014; Lanning et al., 2003), the extent of ostectomy performed (Deas et al., 2004), the patient's periodontal phenotype, the healing time (Pontoriero & Carnevale, 2001) and the experience of the surgeon (Herrero et al., 1995) may influence the result. A recent systematic review has evaluated the evidence of CL performed for restorative reasons (Pilalas et al., 2016), identifying 4 non-randomized and 1 randomized controlled clinical trial. These studies, however, were considered as high risk of bias, and no study had more than 6-month follow-up or stated unequivocally whether the postoperative outcome was adequate for the intended restorative purposes. Furthermore, they did not identify any trial comparing surgical techniques. Therefore, there is minimal evidence regarding the efficacy of these surgical interventions.

Conventional crown lengthening procedures are typically accomplished by apically positioned flap (APF) with/without osseous resection (Palomo & Kopczyk, 1978). They are usually carried out as a one-stage procedure in which submarginal scalloped incisions and full-thickness flaps are followed by bone recontouring to re-create the space for adequate supracrestal tissue attachment. Incision design and the amount of bone recontouring are usually guided by the pre-surgical assessment of the CEJ either through transgingival probing or by radiographic examination. However, this information may not be accurate (Christiaens et al., 2018) and result in unfavourable outcomes, such as marginal tissue rebound or gingival recession. To overcome some of these limitations, an alternative CL surgical approach in two stages was proposed (Sonick, 1997). This surgical approach involves two-staged surgical interventions. In the first surgical phase, after raising a full-thickness flap following intra-sulcular incisions, the space for supracrestal tissue attachment is re-created by ostectomy and osteoplasty by direct visualization of the CEJ anatomy, and then the flap is re-positioned and sutured. Three to four months later, once the supracrestal tissue attachment is re-established, a second minimally invasive surgical intervention is carried out, if needed, by only minor gingival recontouring to attain the ideal gingival margin contours. This approach is expected to reduce the risk associated with the initial removal of soft tissue based on anatomical landmarks that may be difficult to determine with precision, such as the CEJ or the bone crest. Unfortunately, despite the claimed therapeutic advantages and theoretical improved treatment outcomes, the efficacy of the two-stage intervention has not been assessed properly in controlled studies. It was, therefore, the aim of this randomized clinical trial to assess the efficacy of a two-stage surgical crown lengthening procedure (SCL) compared with the standard one-stage (CCL) intervention in clinical situations where the objective of the CL procedure was aimed for aesthetic restorative purposes.

Clinical Relevance

Scientific rationale for the study: Little is known regarding the efficacy of different aesthetic crown lengthening surgical interventions.

Principal findings: Both crown lengthening surgical approaches (one- versus two-stage) demonstrated comparable clinical outcomes. However, patients receiving the two-stage intervention reported a lower impact on their quality of life. Additionally, a wider band of KTW was observed in the group that received the two-stage intervention.

Practical implications: Two-stage aesthetic crown lengthening not only resulted in similar clinical outcomes when compared with conventional (one-stage) crown lengthening approach, but also had a higher acceptance by patients.

2 | MATERIALS AND METHODS

2.1 | Study design

This study was designed as a parallel-arm, single-centre, randomized controlled clinical trial (RCT) with a 12-month follow-up. The study protocol was approved by the institutional ethic committee (Internal Code 11/057-E, Hospital Clínico de San Carlos, Madrid) and registered at ClinicalTrials.gov (NCT04409366).

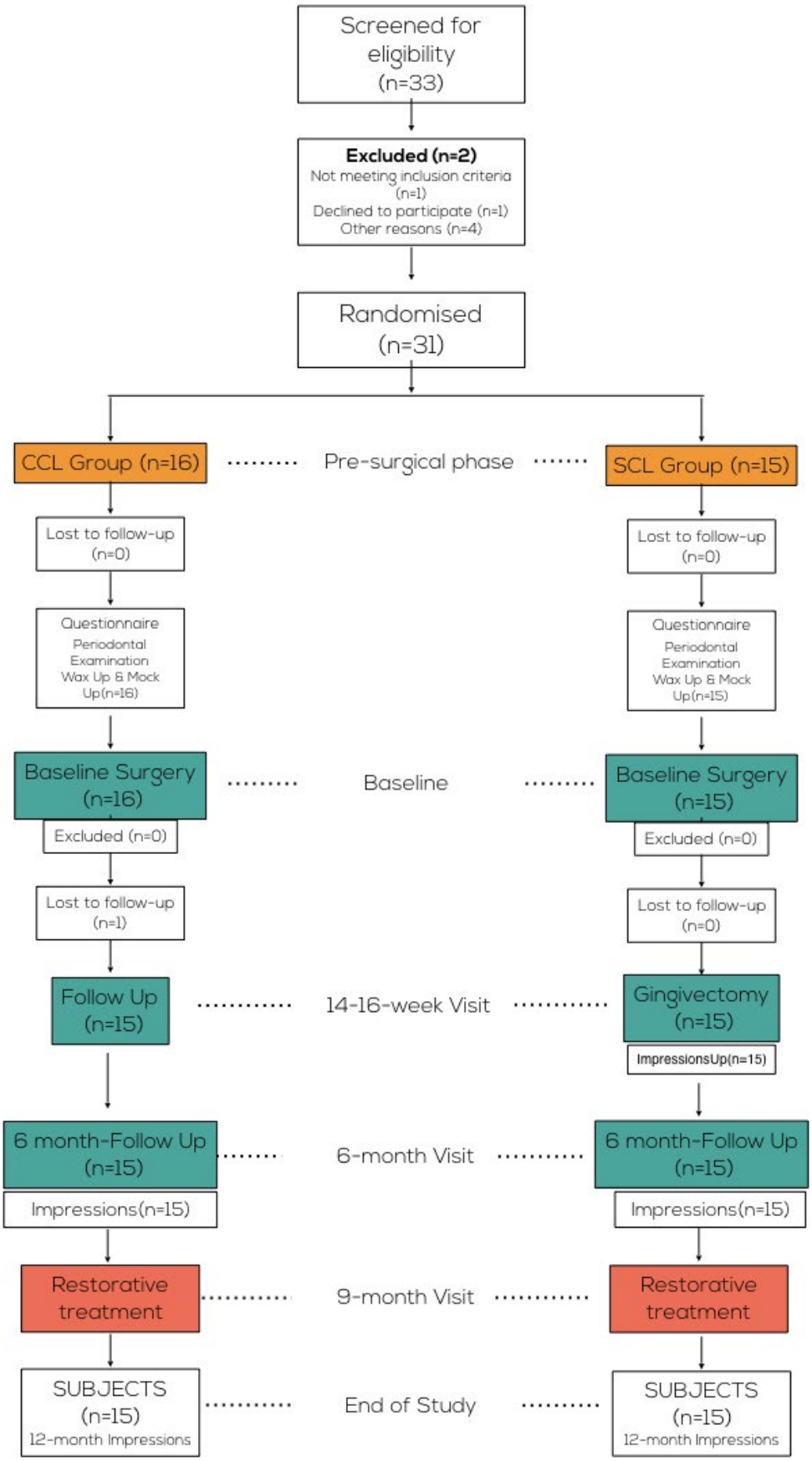

FIGURE 1 CONSORT flow chart

2.2 | Patient population

Patients were recruited in the Postgraduate Clinic of Periodontology at the University Complutense in Madrid (Spain), from among those in need of surgical CL in the anterior maxillary sextant for aesthetic restorative purposes, if they fulfilled the following criteria:

1. older than eighteen years of age;
2. more than 20 teeth in the mouth;
3. with full-mouth plaque and bleeding scores lower than 15%; and
4. without probing pocket depth and/or attachment loss >4 mm.

Patients were excluded if they were pregnant or breastfeeding; were smokers; were treated with antimicrobial and/or anti-inflammatory drugs within two months prior to entering the study; or were currently undergoing orthodontic therapy.

Patients were finally recruited after all the expected risks and benefits of the intervention were explained and if agreed to participate by signing the ethical committee approved informed consent (Figure 1).

2.3 | Randomization and Masking

Recruited patients were randomly assigned (1:1) to the two-stage crown lengthening protocol (staged crown lengthening; SCL) or the conventional one-stage crown lengthening procedure (conventional crown lengthening; CCL) using a computer-generated list. Only the study coordinator (OG) had access to the list, ensuring allocation concealment. The study coordinator revealed the assigned group to the surgeon immediately before the surgical procedure. Due to the nature of the interventions, surgeons and patients could not be masked, but the clinical examiners evaluating the outcomes were masked to the treatment allocation (GC and MR).

2.4 | Surgical trial interventions

2.4.1 | Pre-surgical phase

All patients completed a questionnaire regarding their medical history and received an intra-oral clinical examination to detect the presence of any oral infection or dental condition that would prevent the surgical procedure. Full-mouth periodontal examination included recording of keratinized tissue width, gingival recession and probing pocket depth at six sites/tooth, excluding third molars. Full-mouth series of periapical radiographs were obtained in all patients. Impressions of the upper maxilla using polyvinyl siloxane (PVS, Elite HD, Zhermack, Mexico) were made to create a diagnostic wax-up, from which a mock-up was prepared and accepted by the patient prior to initiation of the corrective phase. All models were stored for final comparisons. The mock-up was transformed into a surgical guide that was also used as a reference to evaluate the final position of the gingival margin and postoperative clinical outcomes.

2.4.2 | Conventional Crown Lengthening; CCL

Using the surgical guide, submarginal internal bevel incisions were performed on the buccal aspect of the affected teeth. A full-thickness flap was raised up to the mucogingival junction (Dominguez et al., 2020). Ostectomy and osteoplasty were carried out by means of rotatory instruments and surgical chisels, as necessary, to achieve the necessary space between the bone crest and the restorative margin according to the pre-surgical plan. The CEJ was not the reference point since, in many cases, the position of the final margin of the restoration was planned apical to the actual position of the CEJ. Exposed root surfaces were carefully instrumented manually with curettes, and finally, vertical internal mattress sutures were placed to position the gingival margin at the level of the margin of the planned restoration. Sutures were removed after 7 days (Figure 2).

2.4.3 | Two-stage Crown Lengthening (SCL)

In the first surgical intervention, intra-sulcular incisions were performed and a full-thickness flap was raised up to the mucogingival junction. Ostectomy and osteoplasty were performed to establish the space for supracrestal tissue attachment, following the restorative plan and using the pre-surgical blueprint as the reference to determine the final position of the restoration margin, instead of the CEJ (Lee, 2004). Then, the flaps were re-positioned and secured with internal mattress sutures, placing the gingival margin at the original level. Sutures were removed at 7 days (Figure 3). In the second stage, after 3-4 months, minor gingival recontouring was performed, if necessary, to attain the desired gingival margin position according to the pre-surgical plan.

2.4.4 | Post-surgical care

Follow-up visits were performed at 4, 6 and 12 months post-surgery. Polyvinyl siloxane (PVS) impressions and photographs were obtained at all these time points. Supragingival plaque removal on the entire dentition was performed at these visits using a rubber cup (Pro-Cup; KerrHawe, Bioggio, Switzerland) and prophylaxis paste (Detartrine; Septodont, Cedex, France). Final restorations were delivered between 6 and 9 months from baseline. All restorations were minimally invasive and did not involve a subgingival margin.

2.5 | Outcome measures

2.5.1 | Clinical parameters

The following clinical parameters were recorded by two calibrated examiners (GC and MR) using a UNC-15 probe (Hu-Friedy®, Chicago, USA) at six sites per tooth in all teeth present, excluding third molars, at baseline, 6-month and 12-month visits:

- Clinical crown length (CL): Distance from the gingival margin to the incisal edge on the midbuccal. This parameter was also registered at 14 to 16 weeks after the initial intervention in the SCL group.
- Amount of keratinized tissue (KT): Distance from the gingival margin to the mucogingival junction on the midbuccal. This parameter was also registered at 14 to 16 weeks after the initial intervention in the SCL group.
- Gingival display upon smiling: Distance from the gingival margin of the central incisors to the lower edge of the upper lip.
- Supracrestal tissue dimension: Distance from the gingival margin to the alveolar bone crest (GM-ABC) as determined by bone sounding following local anaesthesia at baseline, 6 months and 12 months.

2.5.2 | Measurements in Models

PVS impressions were made at baseline (T0) and one week later (T1) to generate, respectively, the baseline and the mock-up models. Only in the SCL group, new impressions were taken in the same manner at 14 to 16 weeks (T2). Subsequently, impressions were taken at 6 months (T3) and 12 months (T4) in both groups. An experienced laboratory technician, who was aware of the study purpose, fabricated dental casts from these impressions, which were scanned with a three-dimensional (3D) laser scanner (D250, 3Shape) and stereolithographic (STL) files were generated. These STL files were transferred to a digital shape sampling and processing software where 3D models were generated (Geomagic Studio, 3D Systems, Morrisville, North Carolina, USA). For each patient, the pre-surgical and post-surgical 3D models were superimposed based on an already described procedure combining best matching of manually selected surfaces and automated alignments (Gonzalez-Martin et al., 2014). The merged models were then saved as a WRP file and compared using the same software package. The baseline model (T0) or the mock-up model (T1) were used as reference for comparison with the post-surgical models (T2 only in SCL group, T3 and T4 in both groups). Differences in the vertical position of gingival margin were measured using T0 as a reference to measure the changes in the gingival margin over time and using T1 (mock-up) as reference to assess the position of the gingival margin relative to the planned position (Figure 4).

2.5.3 | Patient-reported outcomes (PROMs)

A validated Oral Health Impact Profile (OHIP-14sp) for adults in Spain (Montero-Martin et al., 2009) was filled by all participating subjects at two weeks and six months after the initial surgical procedure. Each response was categorized on a scale of 0 to 4 (0 = never, 1 = hardly ever, 2 = occasionally, 3 = fairly often and 4 = very often).

2.6 | Data analyses

2.6.1 | Sample Size Calculation

The primary outcome variable (T1-T4) was the difference in mm between the ideal gingival margin (T1) and the position of the

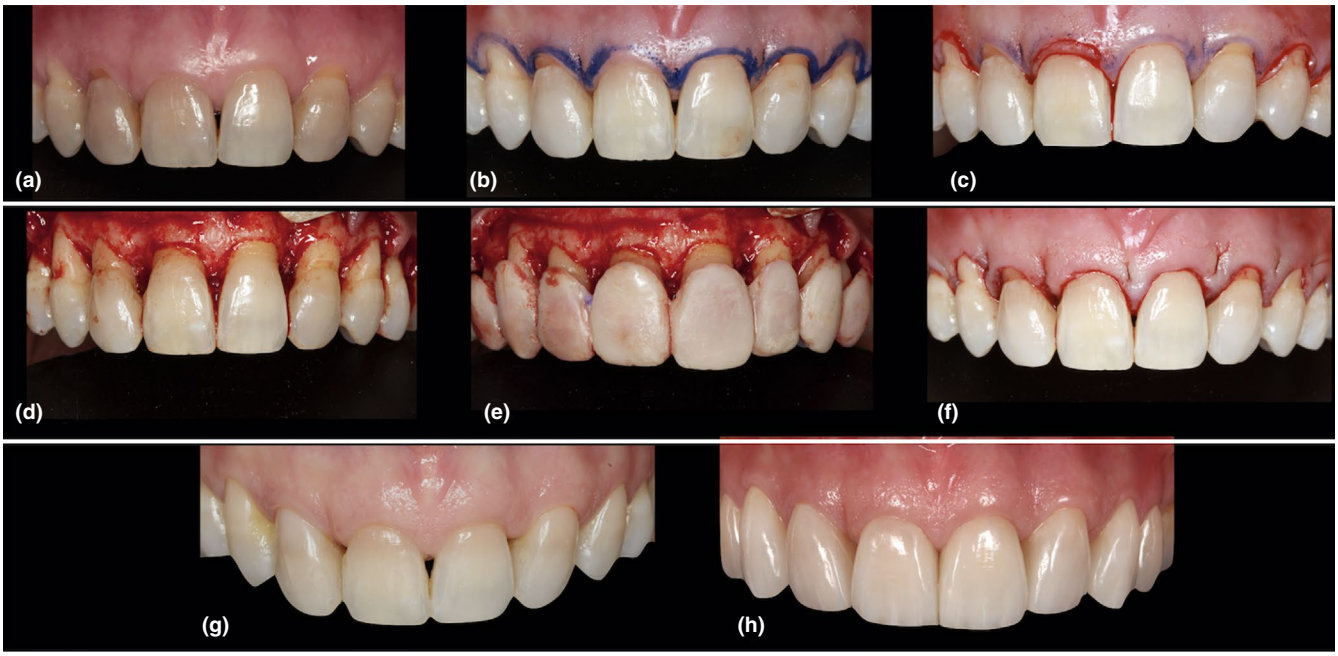

FIGURE 2 Sequence of intra-oral photographs from a representative case in the CCL group. (a) Initial presentation. (b) Surgical aim after mock-up confirmation. (c) Gingivectomy following an internal bevel incision and tissue removal. (d) Full-thickness flap elevation. (e) Suture using single vertical internal mattress. (f) Mock-up to guide bone ostectomy and osteoplasty. (f) Single vertical internal mattress sutures. (g) Six-month follow-up. (h) Result at 12 months after delivery of final restorations

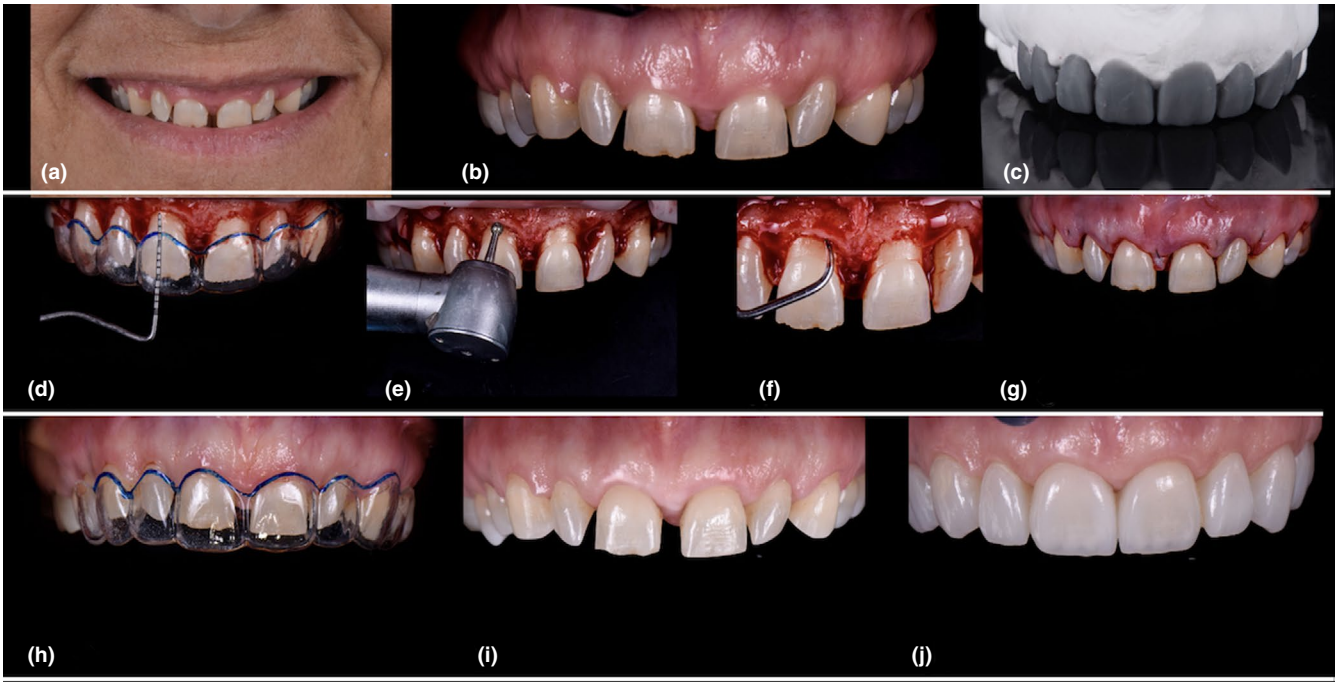

FIGURE 3 Sequence of photographs from a representative case in the SCL group. (a) Extraoral initial presentation. Note the excessive gingival display. (b) Intra-oral photograph revealing the evident lack of gingival harmony. (c) Wax-up to envision surgical and prosthetic objectives. (d) Full-thickness flap elevated and surgical stent in place. (e & f) Ostectomy and osteoplasty using rotary and hand instruments. (g) Suture using single vertical internal mattress. (h) Gingivectomy at 3 months following an internal bevel incision and tissue removal. (i) 6-month follow-up. (j) Result at 12 months after delivery of final restorations

gingival margin at 12 months (T4). The sample size calculation was based on an estimated standard deviation (SD) =0.4 mm and an expected difference between groups of 0.5 mm. To detect statistically significant differences ($p < 0.05$) with and 80% power, a minimum of 11 subjects per group were needed. In order to compensate for possible dropouts, a final sample of 30 patients was aimed.

2.6.2 | Statistical analysis

The patient was considered the unit of analyses. All patients contributed with 6 teeth (from 1.3 to 2.3) to the analyses. If more teeth were included in the surgical intervention, they were not included in the data analysis. The normality distribution of the quantitative variables was examined using the Shapiro–Wilk test. Statistical significance between groups at baseline was analysed using the independent sample t test for continuous variables, while the chi-square test was used for categorical outcomes. Differences between groups at baseline, 6-month and 12-month visits and their changes were determined by Student's t test for quantitative outcomes. In addition, clinical variables were compared with repeated measures ANOVA with post hoc Bonferroni's correction considering the visit for the intra-group comparisons, the group (CCL or SCL) for the inter-group comparisons and the interaction between time and group.

3 | RESULTS

3.1 | Population

Between April 2013 and October 2017, 33 subjects were screened. Two subjects were excluded since they did not meet the study criteria or refused to participate (Figure 1). One patient was lost to follow-up in the control group after the surgical procedure. Hence, 30 patients were included in the final data analyses (15 in the CCL group and 15 in the SCL group). Table 1 displays the demographic characteristics of these participants. In both groups, female gender was predominant, while mean age was similar (40.5 ± 14.1 in the CCL group and 37.5 ± 15.7 in the SCL group; $p = 0.579$). Among the patients in the SCL group, 11 patients (73.3%) needed a second-stage gingival recontouring surgery (i.e. gingivectomy and/or gingivoplasty) in 25 out of the 90 teeth (2.3 ± 1 mean number of teeth per patient). In 8 of these patients (72.7%), the amount of soft tissue removed to obtain the planned crown length was ≤1 mm (Table 2).

3.2 | Linear Measurements in the models

No differences in terms of crown length were observed between groups at any follow-up visit (Table 3). The evaluation of the precision to establish the difference between the planned and the final gingival margin position at 12 months (T1-T4) rendered similar results

between the SCL and CCL procedures (−0.2 ± 0.5 and 0.2 ± 0.4, respectively; $p = 0.075$). In 12 out of 15 patients in both groups (80.0%), the final crown length (T4) was within ±0.5 mm, respectively, to the planned dimension (T1) and 100% within ±1.0 mm.

3.3 | Clinical Parameters

Clinical parameters at baseline and at the different follow-up visits are presented in Table 4. At baseline, no differences between groups were observed in regard to the clinical crown length, the GM-ABC or KT width, with the exception of canines, that presented a higher amount of KT in the SCL compared with the CCL group (6.9 ± 1.9 mm and 5.3 ± 1.2 mm, respectively; $p = 0.009$). In the SCL group, there was a significant increase in crown length at the 4-month visit and an additional significant increase between the 4- and 6-month visits. There was a significant increase in crown length from baseline to the 6-month visit in both groups ($p < 0.001$), but differences between groups were not statistically significant. The position of the gingival margins did not change significantly between the 6- and 12-month visits in both groups.

Similarly, a significant reduction in KT width between baseline and the 6-month visit was observed in both groups ($p < 0.001$), without significant changes occurring in both groups between 6 and 12 months. KT width was significantly higher in the SCL group at 6 months compared with the CCL group (6.5 ± 1.5 versus 5.0 ± 1.4 mm, respectively; $p = 0.009$) and at 12 months (6.3 ± 1.4 versus 5.0 ± 1.4 mm, respectively; $p = 0.017$), regardless of the tooth type. Similarly, GM-ABC was significantly higher in the SCL when compared to CCL group at the 6-month visit (3.3 ± 0.6 versus 2.8 ± 0.5 mm, respectively; $p = 0.026$). This statistically significant difference disappeared at the 12-month visit.

3.4 | Patient-reported outcomes

Patient-reported discomfort at 2 weeks post-surgery was significantly higher in the CCL group compared with SCL group (OHIP-14 = 6.6 ± 5.6 versus 2.6 ± 3.3, respectively; $p = 0.039$). This difference in the patients' assessment of the surgical impact in their quality of life was maintained at 6 months (0.2 ± 0.6 in the SCL group and 2.1 ± 2.7 in the CCL group; $p = 0.020$).

4 | DISCUSSION

Although the literature is replete with reports and case series of aesthetic crown lengthening, there is a scarcity of data from controlled clinical studies. A recent systematic review evaluated the outcomes of pre-restorative crown lengthening surgery (Pilalas et al., 2016), identifying 4 non-randomized and 1 randomized controlled clinical trials with a high risk of bias, not focussed in the aesthetic area and no study with more than 6-month follow-up. Additionally, one study has evaluated the outcomes of flap versus flapless CL approaches for aesthetic purposes (Ribeiro et al., 2014).

The present investigation, therefore, represents the first long-term (1-year) randomized clinical trial evaluating the efficacy of two surgical interventions (SCL versus CCL) aimed for CL for aesthetic restorative purposes. Both surgical procedures attained similar restorative objectives since the final position of the gingival margin respective to the planned position was not significantly different (CCL=0.2 ± 0.4 mm / SCL=−0.2 ± 0.5 mm; $p = 0.075$). All sites in both groups were within a range of ±1.0 mm respective to the target position at 12 months. Similarly, there were no significant differences in the changes in the position of the gingival margin between baseline and 12 months. However, approximately 75% of the subjects in the SCL group required a second-stage gingival recontouring, although in only 27,7% of the teeth and with minimal gingival recontouring (maximum of 1 mm). These results point out that the increase in the final clinical crown dimension was largely due to the osseous surgery rather to the secondary gingival recontouring and that this position remained stable between 6 and 12 months in both groups.

Another relevant finding was the significant difference in the width of KT comparing both treatment approaches. KT width was significantly narrower in the CCL compared with the SCL group both at 6 and 12 months, which may support the indication of the SCL intervention in situations with limited baseline keratinized tissue. Interestingly, in spite of the elongated treatment time and the possibility of undergoing two separate surgical procedures, subjects in the SCL group reported less discomfort and higher quality of life.

Previous reports have highlighted the importance of pre-surgical planning in CL procedures in cases of high aesthetic demands and the need of a reference blueprint to effectively define the desired dimensions in reference to the definitive restoration (Lee, 2004). Since the dimensions of the space available for the supracrestal tissue attachment may vary across and within subjects, even around the same tooth (Perez et al., 2008), the extent of osseous resection at different sites was not standardized on the basis of average values in this study (Gargiulo et al., 1961; Vacek et al., 1994), but rather individualized in function of a meticulous pre-surgical and intra-surgical analysis of each site. In fact, the outcomes of this RCT confirmed that meticulous planning based on a thorough clinical (e.g. probing to bone) and radiographic examination leads to achieve the planned treatment outcomes using either CL modality. These results are in agreement with previous reports describing the conventional CL procedure as a predictable method to increase the clinical crown by recreating a new space for the supracrestal soft tissue attachment (Arora et al., 2013; Deas et al., 2014; Pontoriero & Carnevale, 2001). However, while some of these clinical investigations reported a significant reduction in the increased CL obtained at surgery during the follow-up, in the present study the final marginal position was within 0.2 mm of the desired position. Even in studies in which the reported mean position of the gingival margin was generally stable, a non-negligible percentage of teeth experienced GM displacement during healing, mainly during the first three months postoperatively

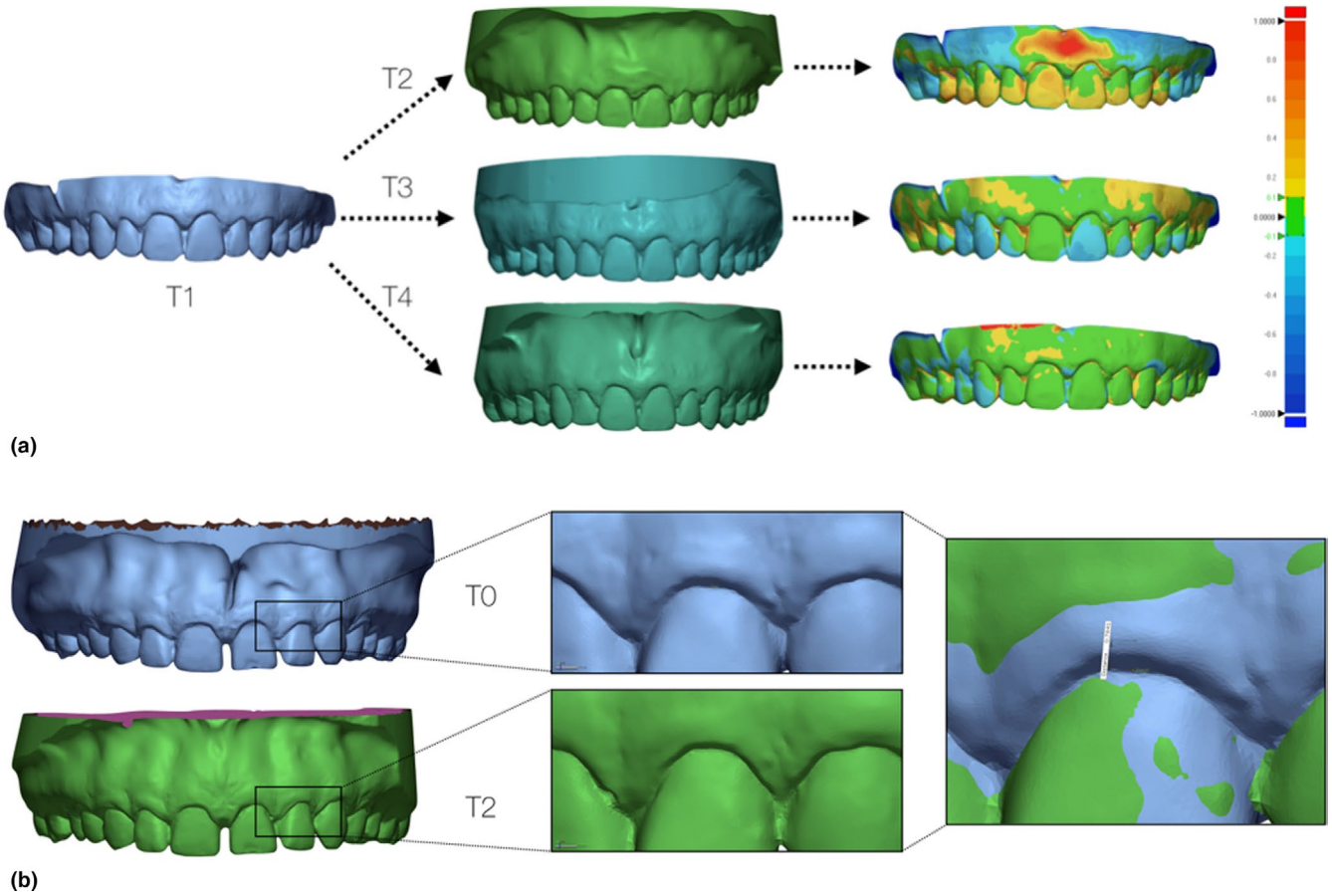

FIGURE 4 (a) Accuracy of the obtained gingival goals using superimposition of scanned models. T1 is the digital stl file of the impression of the accepted mock-up, and it was subsequently compared with T2 (3-month follow-up [only in SCL group]), T3 (6-month follow-up) and T4 (12-month follow-up). (b) Detail of the vertical gingival migration of the gingival margin after 4 months of follow-up in a test group

TABLE 1 Demographic data of the study population (CCL—conventional crown lengthening / SCL—staged crown lengthening)

	CCL	SCL	*p* value
Gender (n, %)			
Male	2 (13.3%)	2 (13.3%)	1.000
Female	13 (86.7%)	13 (86.7%)	
Age (years)	40.5 (14.1)	37.5 (15.7)	0.579
Smoking Status (n, %)			
Smoker	0 (0%)	0 (0%)	1.000
Non-smoker	15 (100%)	15 (100%)	

(Bragger et al., 1992). This undesirable rebound has been attributed to technical (flap positioning, amount of osseous resection) and anatomical (periodontal phenotype) factors (Lanning et al., 2003).

When comparing both surgical interventions, the staged approach may offer the advantage that osseous recontouring is performed without prior soft tissue resection. This allowed for direct visualization of the bone and controlled recontouring in function only of the space needed for supracrestal tissue attachment, and not depending on the submarginal soft tissue scalloping that is usually determined by the pre-surgical bone sounding and radiographic data, which may not be accurate (Christiaens et al., 2018). Even though the results from the CCL approach rendered excellent results with minimal tissue rebound, the SCL approach allowed for the evaluation of the added surgical needs to attain the ideal gingival margin position according to the restorative planning at approximately 4 months post-CL surgery. The results of this study confirm that minimal gingival recontouring (≤1 mm) was required in 2/3 of the patients, which underlines that this surgical approach is more conservative and safer as some degree of potential soft tissue rebound has been reported in approximately half of the sites undergoing CCL (Deas et al., 2014). Although in this study both surgical procedures predictably attained the desired final clinical crown dimensions, the SCL procedure achieved these outcomes with significantly higher width of KT and more favourable patient-reported outcomes. Preserving KM may be particularly relevant in the treatment of cases of excessive gingival display due to altered passive eruption presenting minimal amounts of KT (Coslet et al., 1977). Furthermore, previous reports suggest that minimally invasive surgical approaches have also rendered similar results in the amount of crown lengthening attained when compared with open flap surgeries, also reporting improved patient-reported outcomes (Ribeiro et al., 2014). A potential

TABLE 2 Participants in the SCL (staged crown lengthening) group and the need for second-stage surgery (gingival recontouring) after the first surgical procedure

Patient Id	Need of gingivectomy	No. of teeth in need of gingivectomy	Tooth type	Amount of gingiva resected (mm)
1	Yes	1	21	0.5
2	Yes	2	22, 23	0.5
3	Yes	1	21	3
4	Yes	3	13, 11, 21	0.5
5	No	-	-	
6	Yes	4	13, 12, 22, 23	1.5
7	Yes	4	13, 11, 21, 23	0.5
8	No	-	-	
9	Yes	2	11, 12	0.5
10	Yes	2	11, 21	0.5
11	No	-	-	
12	No	-	-	
13	Yes	1	21	1
14	Yes	2	12, 22	1
15	Yes	3	12, 11, 22	1.5

TABLE 3 Differences in crown length between the 3-month (T2), 6-month (T3) and 12-month (T4) visits, compared with baseline (T0) and the desired result (mock-up; T1), per study group. Data are expressed as means and standard deviations (SD)

	Conventional crown lengthening				Staged crown lengthening				
	All	Canines	Lateral incisors	Central incisors	All	Canines	Lateral incisors	Central incisors	*p* value*
Difference in crown length with the baseline situation (mm)									
T0-T2	NA	NA	NA	NA	0.5 (0.4)	0.4 (0.5)	0.5 (0.4)	0.6 (0.4)	-
T0-T3	1.2 (0.7)	1.0 (0.6)	1.2 (0.8)	1.4 (0.8)	0.8 (0.5)	0.6 (0.5) ‡	0.9 (0.6)	0.8 (0.6)	0.099
T0-T4	1.1 (0.6)	0.8 (0.4)	1.2 (0.7)	1.4 (0.7)	0.7 (0.5)	0.6 (0.5)	0.9 (0.5)	0.8 (0.6)	0.167
Difference in crown length with the ideal result (mock-up)									
T1-T2	NA	NA	NA	NA	−0.3 (0.6)	−0.2 (0.6)	−0.3 (0.7)	−0.3 (0.8)	-
T1-T3	0.0 (0.7)	0.1 (0.7)	−0.1 (0.7)	−0.2 (0.8)	−0.4 (1.0)	−0.6 (0.9)	−0.5 (0.9)	−0.3 (1.2)	0.309
T1-T4	0.2 (0.4)	0.4 (0.3)	0.1 (0.6)	0.1 (0.6)	−0.2 (0.5)	−0.2 (0.7)	−0.2 (0.5)	−0.1 (0.6)	0.075

*p value for *all* teeth.

‡significant intra-group difference ($p < 0.05$) when compared to T0-T2.

disadvantage of SCL may be related to extended chair-side time due to the potential need of a second surgery, although it needs to be highlighted that the usual chair-side time for a minimal gingivectomy is normally low.

Another possible advantage of the staged surgical approach is to avoid the need of provisional restorations during the healing phase since the flaps are re-positioned back to the original situation prior to surgery. This may be relevant in cases in which CCL may result in a marked crown lengthening, requiring to perform extensive restorative work with provisionals in order to minimize aesthetic concerns and/or sensitivity.

This RCT has, however, several limitations. Firstly, there were inherent difficulties to ensure appropriate blinding of the treatment groups. Secondly, clinical parameters (crown length and keratinized tissue dimension) were not registered at 3 months in the CCL group. Dynamics of the changes in the gingival margin position post-surgically have been extensively evaluated in the literature before (Deas et al., 2014; Pontoriero & Carnevale, 2001); however, these data would have provided interesting information to compare those variations in between groups. It also exists a potential limitation related to the somehow different follow-up from the last surgical intervention in each group. While in the CCL group, the final follow-up was 12 months from the surgical procedure, in the SCL group, the final follow-up took place at 8 to 9 months from secondary gingivectomy. Although it has been reported in the literature that some coronal rebound of the gingival margin may be expected between 9 and 12 months after surgery (Pontoriero and Carnevale, 2001), that was not the case in our study, in which no significant differences in the position of the gingival margin were detected between the 6- and 12-month follow-up visits. Therefore, it is unlikely that any further

TABLE 4 Clinical parameters of the included participants expressed as means and standard deviations (SD) by study group

	Conventional crown lengthening				Staged crown lengthening				
	All	Canines	Lateral incisors	Central incisors	All	Canines	Lateral incisors	Central incisors	*p* value*
Crown length (mm)									
Baseline	8.4 (1.3)	8.8 (1.3)	7.7 (1.3)	8.8 (1.5)	7.8 (0.9)	8.1 (0.9)	7.0 (1.0)	8.3 (1.2)	0.111
3 months	NA	NA	NA	NA	8.9 (0.6) ‡	9.2 (0.8) ‡	8.3 (0.6)‡	9.5 (1.0)‡	-
6 months	9.5 (1.1) ‡	9.8 (1.1) ‡	8.5 (1.2) ‡	10.1 (1.1) ‡	9.3 (0.7) §, §	9.5 (0.9) §, §	8.5 (0.6) ‡	10.0 (0.9) §, §	0.579
12 months	9.4 (1.1) ‡	9.7 (1.0) ‡	8.5 (1.3) ‡	10.1 (1.3) ‡	9.2 (0.7) §, §	9.3 (0.9) §, §	8.4 (0.6) ‡	10.0 (0.9) §, §	0.571
Keratinized tissue width (mm)									
Baseline	6.1 (1.5)	5.3 (1.2)	6.5 (2.0)	6.3 (1.9)	7.2 (1.8)	6.9 (1.9) †	7.6 (1.8)	7.0 (1.8)	0.07
3 months	NA	NA	NA	NA	6.8 (1.4) ‡	6.6 (1.5) ‡	7.2 (1.4) ‡	6.5 (1.7) ‡	-
6 months	5.0 (1.4) ‡	4.5 (1.1) ‡	5.4 (1.7) ‡	5.2 (1.8) ‡	6.5 (1.5) §, §	6.3 (1.7) §, §, §	6.9 (1.4) §, §, §	6.3 (1.7) §, §	0.009
12 months	5.0 (1.4) ‡	4.5 (1.2) ‡	5.3 (1.7) ‡	5.2 (1.7) ‡	6.3 (1.4) §, §	6.2 (1.5) §, §, §	6.6 (1.5) ‡, ‡, ‡	6.1 (1.5) §, §	0.017
GM-ABC (mm)									
Baseline	3.4 (0.6)	3.4 (0.7)	3.2 (0.9)	3.4 (0.9)	3.7 (0.7)	3.5 (0.7)	3.8 (1.2)	3.7 (0.6)	0.244
6 months	2.8 (0.5) ‡	2.7 (0.5) ‡	2.7 (0.5) ‡	2.9 (0.7) ‡	3.3 (0.6)	3.1 (0.7)	3.4 (0.7) †	3.4 (0.6) †	0.026
12 months	3.1 (0.7)	3.0 (0.6) §, §	3.0 (0.8)	3.1 (0.8)	3.2 (0.6)	3.2 (0.8) ‡	3.2 (0.8)	3.4 (0.5)	0.565
Gingival exposure upon smile (mm)									
Baseline	-	-	-	3.0 (0.9)	-	-	-	3.0 (1.6)	0.914
6 months	-	-	-	1.4 (0.9) ‡	-	-	-	1.8 (1.4) ‡	0.326
12 months	-	-	-	1.4 (0.9) ‡	-	-	-	1.9 (1.4) ‡	0.184
OHIP–14									
2 weeks	6.6 (5.6)	2.6 (3.3)	0.039						
6 months	2.1 (2.7)	0.2 (0.6)	0.020						

Note: GM-ABC, distance from the gingival margin to the alveolar bone crest determined by bone probing

Abbreviation: OHIP, Oral Health Impact Profile; NA, not applicable.

**p* value for *all* teeth.

†Significant inter-group difference ($p < 0.05$) for that tooth type.

‡Significant intra-group difference ($p < 0.05$) when compared to baseline.

§Significant intra-group difference ($p < 0.05$) when compared to 3-month visit (or 6-month visit for GM-ABC).

variation in the position of the gingival margin would occur in the SCL group afterwards. It must be stated that the CL protocol for this particular study (Pontoriero and Carnevale, 2001) included an apically positioned flap, so the possibility of soft tissue rebound may be delayed in time. Last, the limited sample size of the study emphasizes the need for future studies involving larger populations, with diverse local and systemic characteristics, and longer follow-up periods to provide a better understanding of possible influencing factors, such as the periodontal phenotype or the use of a surgical guide, in the outcomes of CL surgical interventions.

Both aesthetic crown lengthening modalities rendered similar outcomes regarding the primary aim of these interventions, which were the maintenance of the lengthened clinical crown and the position of the gingival margins in relation to the restorative planning. However, the two-stage surgical intervention achieved a wider band of keratinized tissue and was associated with more favourable patient-reported outcomes.

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CONFLICTS OF INTEREST

The authors have no conflicts of interest to declare regarding the conduction of this study.

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