

**DOI:**

<https://doi.org/10.14436/2447-911x.18.2.068-098.arc>

**Submitted:**

June 22, 2021

**Revised and accepted:**

July 02, 2021

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**How to cite:**

Guimarães D, Rebollal J. Proposal of a planning protocol for performing aesthetic clinical crown augmentation surgery. *J Clin Dent Res.* 2021 May-Aug;18(2):68-98.

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The authors report no commercial, proprietary or financial interest in the products or companies described in this article. Patients displayed in this article previously approved the use of their facial and intra-oral photographs.

# Proposal of a planning protocol for performing aesthetic clinical crown augmentation surgery

**ABSTRACT:**

**Introduction:** Crown lengthening surgery for esthetic purposes is based on parameters previously described in the literature; however, there is a difficulty in organizing them and then create a reproducible protocol to make this procedure feasible for dentists.

**Objective:** By presentation of a clinical case, the proposal for use of a table is introduced, created to gather such parameters.

**Results:** At first, the table may seem complex; however, the correct insertion and analysis of data allows planning in a clear and precise manner.

**Conclusions:** Even though it has been used by the authors for some years, the table should be validated by the use by other professionals in the field.

**Keywords:** Gingivoplasty. Osteotomy. Gummy smile. Altered passive eruption.

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## INTRODUCTION

The excessive gingival exposure when smiling, also known as gummy smile, is a common esthetic concern. Although it is not a pathological clinical condition, the dentist should know and identify the various factors involved to provide the patient with an adequate solution.<sup>1,2,3</sup> Since the etiology of gummy smile is usually multifactorial, a correct diagnosis should ideally be conducted by a multidisciplinary team.

The smile is considered gingival if it presents exposure of more than 3 mm of the gingival band, a condition found when there is disharmony between one or more of the following parameters: position of the lower edge of the upper lip, position of the maxillary bone, position of teeth and position of the gingival margin in relation to the anatomical crown.<sup>4-7</sup> The prevalence of gummy smile is 10% in individuals aged 20 to 30 years, and it affects more females<sup>8,9</sup> (10.7% in men and 14% in women).

The excessive gingiva exposure is associated with the following clinical conditions, isolated or combined.<sup>5,10-15</sup>

- ◆ Vertical maxillary excess.
- ◆ Short upper lip.
- ◆ Lip hypermobility.
- ◆ Dentoalveolar extrusion.
- ◆ Altered passive eruption.
- ◆ Inflammatory or drug-induced gingival hyperplasia/hypertrophy.

Diagnosing the etiology, determining whether it is single or multiple, defines which treatment option will be most appropriate for each case. The construction of diagnosis is initiated by evaluating the dynamics of smile, position of the incisal edge, lip length and the width/height ratio of upper central incisors. It is important to emphasize that gingival exposure is influenced by sex, ethnicity and age.<sup>16,17</sup> Typically, women, white and young individuals have a higher smile than men, black and elderly individuals, respectively.

### Altered passive eruption

Esthetic crown lengthening, used in the treatment of altered passive eruption, is a tool that, combined with techniques to control the upper lip mobility (surgical lip repositioning, placement of bone cement and botulinum toxin), contributes to the correction of gummy smile and consequently to the construction of a harmonious smile.

The treatment of altered passive eruption is a procedure of great responsibility, since it is irreversible and significantly changes the smile esthetics. Therefore, it should not be performed randomly, and it should respect biological and esthetic precepts. Aiming at optimizing the result, this paper presents a table that, when correctly filled, may guide and facilitate the accomplishment of surgery.

### Determination of adequate length of upper teeth

The starting point for planning esthetic crown lengthening is the position of the incisal edge of upper central incisors (UCI), guided by the lower lip curvature.

After establishing the proper position of the incisal edge of UCI and their preexisting width is recorded, their ideal cervical-incisal length (height) can be determined, since the mean width/height ratio of the upper central incisor is 80%.<sup>18,19,20</sup> For example, an UCI that is 8 mm wide should be 10 mm high. This ratio applies in most cases; however, in some situations, it can be modified for better harmony.

In frontal view, the position of the gingival margin of upper canines is the same or close to that of the UCI, varying according to the curvature of the upper arch and/or gender. The position of the gingival margin of upper lateral incisors is usually 0.5 to 1 mm below the imaginary line

joining the UCI and upper canine zeniths, remembering that the UCI and canines zeniths are usually slightly distally displaced, while those of other teeth are in the center of the crown.<sup>18,21</sup>

It is natural for professionals to feel insecure when planning esthetic crown lengthening surgery. How much gum tissue should I remove? Will I need osteotomy? How do I calculate the biological distance for this case? With these and other questions in mind, we created a logical sequence and a table (Table 1) for planning the esthetic crown lengthening, aiming to organize and facilitate calculations, making the accomplishment and result of surgery more predictable. Table 2 contains only data that will be used in surgery. To fill Table 2, just follow the steps described to fill Table 1. At first, just fill it and analyze the limitations presented, then correct them, changing the planning, if necessary.

↓ **Table 1:** Table for planning of esthetic crown lengthening.

PARAMETERS FOR EVALUATION		15	14	13	12	11	21	22	23	24	25
1	Position of incisal edge										
	<b>Correct</b>										
	<b>Incorrect</b>										
2	Current length of visual crown (mm)										
3	Width of central incisors (mm)										
4	Current width/height ratio of central incisors										
5	Regressive Gradation Ratio										
6	Desired length of visual crown (mm)										
7	Desired increase Result of subtraction: line 6 minus line 2 (mm)										
8	Existing keratinized mucosa band (mm)										
9	Distance from the gingival margin to the CEJ. Quantity of covered enamel (mm).										
10	Result of subtraction: line 9 minus line 7 (mm)*										
11	Length of biological distance according to the phenotype** (mm)										
12	Distance from current gingival margin to future bone crest: Line 7 + line 11 (mm)										
13	Distance from current gingival margin to the current position of bone crest on the tomography (mm)										
14	Osteotomy required *** Result of subtraction: line 12 minus line 13										
15	Future clinical crown length line 2 + 7 + 11										
16	Anatomical crown length line 2 + line 9										

\*negative result = root exposure; zero result = gingival margin coincident with the JAC; positive result = remaining enamel covered.

\*\*thin phenotype = 2 mm; intermediate phenotype = 2.5 mm; thick phenotype = 3 mm.

\*\*\*negative result = unstable biological distance - risk; zero result = no need for osteotomy; positive result = amount of osteotomy to be performed



↓ **Table 2:** Data to be Applied during surgery, after filling Table 1.

DATA FOR SURGERY	15	14	13	12	11	21	22	23	24	25
LINE 6 with <b>CORRECTED</b> visual crown length (mm)										
LINE 15 with <b>CORRECTED</b> future clinical crown length (mm)										

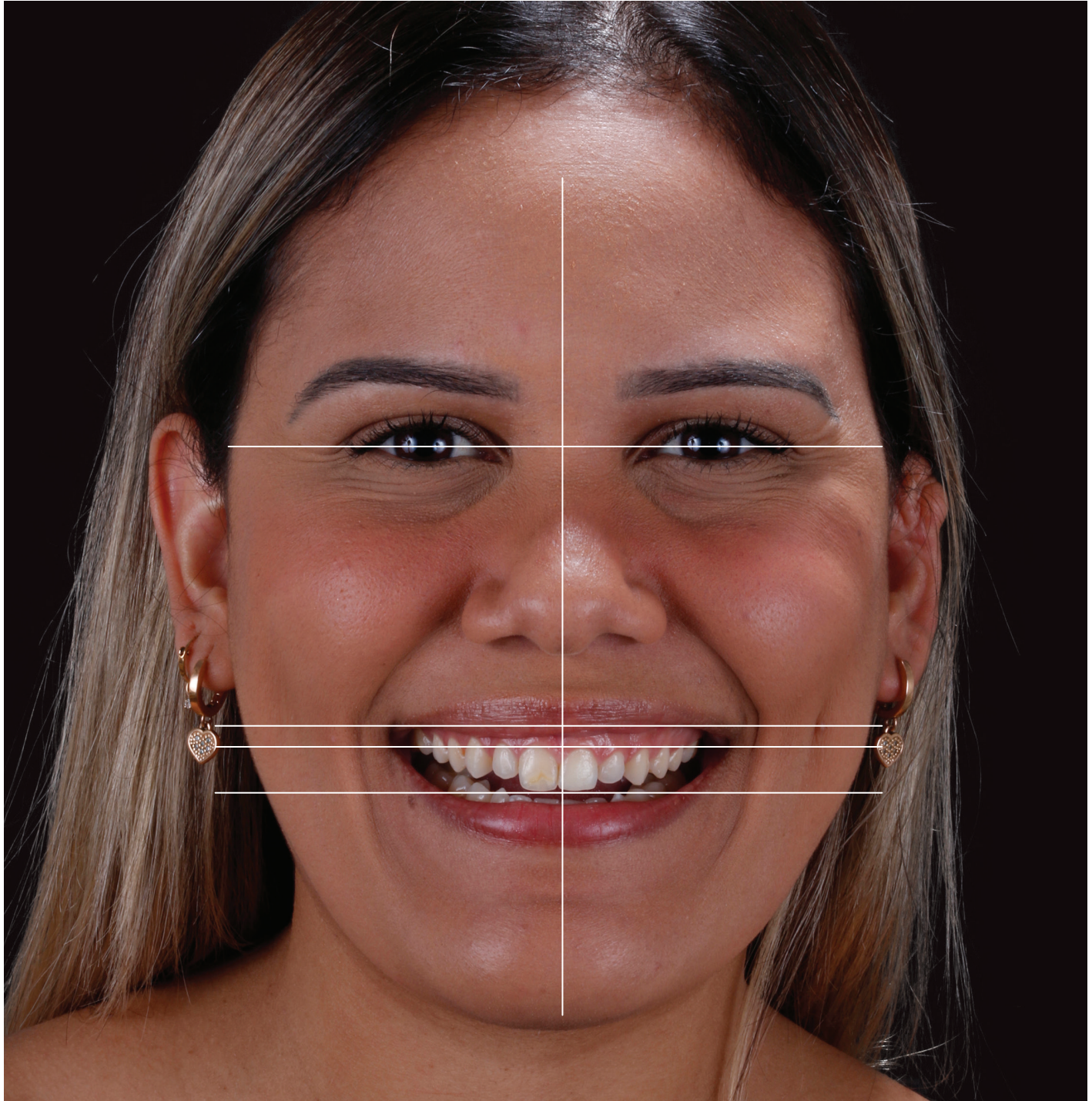
### CASE REPORT

In this case, in which the patient complained of “small teeth and asymmetrical exposure of gingiva” (Fig 1), when tracing the lines derived from the “T” of esthetics, it was observed that the lower lip curvature was symmetrical with the face and commissures, parallel with the bi-pupillary plane (Fig 2). The upper lip contraction showed asym-

metry, in which the left side, due to greater muscle contraction, was higher than the right side (Fig 3). When there is asymmetrical contraction of the lip, we usually plan for a greater increase in teeth on the side where the lip is higher, even if the length of the visual crown of homologues is different.



↑ **Figure 1:** (A-C) Initial extraoral photographs.



↑ **Figure 2:** Forced smile, with “T” of the esthetic and derived lines. Note the apicocoronal discrepancy between homologous teeth in the upper dental arch.





↑ **Figure 3:** (A-C) Greater gingival exposure on the left side, due to asymmetrical upper lip contraction.



By finding the interpupillary distance, measured with a ruler in Figure 4, we were able, in other photographs of the patient's face (Figs 5 and 6), to calibrate a virtual ruler based on the previously measured interpupillary distance. It was observed that, with the lips at rest, the UCI were exposed in only 1 mm (Fig 5), an amount smaller than the mean for women.<sup>16</sup> Figure 6 evidences a dentogingival exposure of 10.5 mm in forced smile. When comparing the figures, a 9.5-mm apical displacement of the lip (10.5 mm minus 1 mm) was noted, characterizing the hypermobility of the lip.<sup>22</sup>

There was harmony between the facial thirds. With this condition, when using the golden ratio ruler, we were able to obtain an important reference, namely the position of the incisal edge (Fig 7).



↑ **Figure 4:** Measurement of interpupillary distance.



↑ **Figure 5:** 1-mm exposure of the UCI with the lips at rest.



↑ **Figure 6:** 10.5-mm exposure in forced smile.





< **Figure 7:** Evaluation of the position of the incisal edge, with the golden ratio ruler.



The incisal edge of tooth 11 was in correct position, while the edge of tooth 21, due to wear, was 0.5 mm apical to that of tooth 11. With 8.4 mm being the width of both, the height of tooth 11 with 10.5 mm and that of tooth 21 with 10 mm was planned, following the 80% width/height ratio, since tooth 21 would be restored later. After defining

the UCI length, it was noticed that the gingival margins of teeth 12, 13, 14 and 15 were in adequate position (Fig 8). By drawing horizontal lines on the cusp tip of teeth 23, 24 and 25, which were well positioned in apicocoronal direction in relation to the upper dental arch line, the apicocoronal discrepancy of their homologues was noticed (Fig 9).



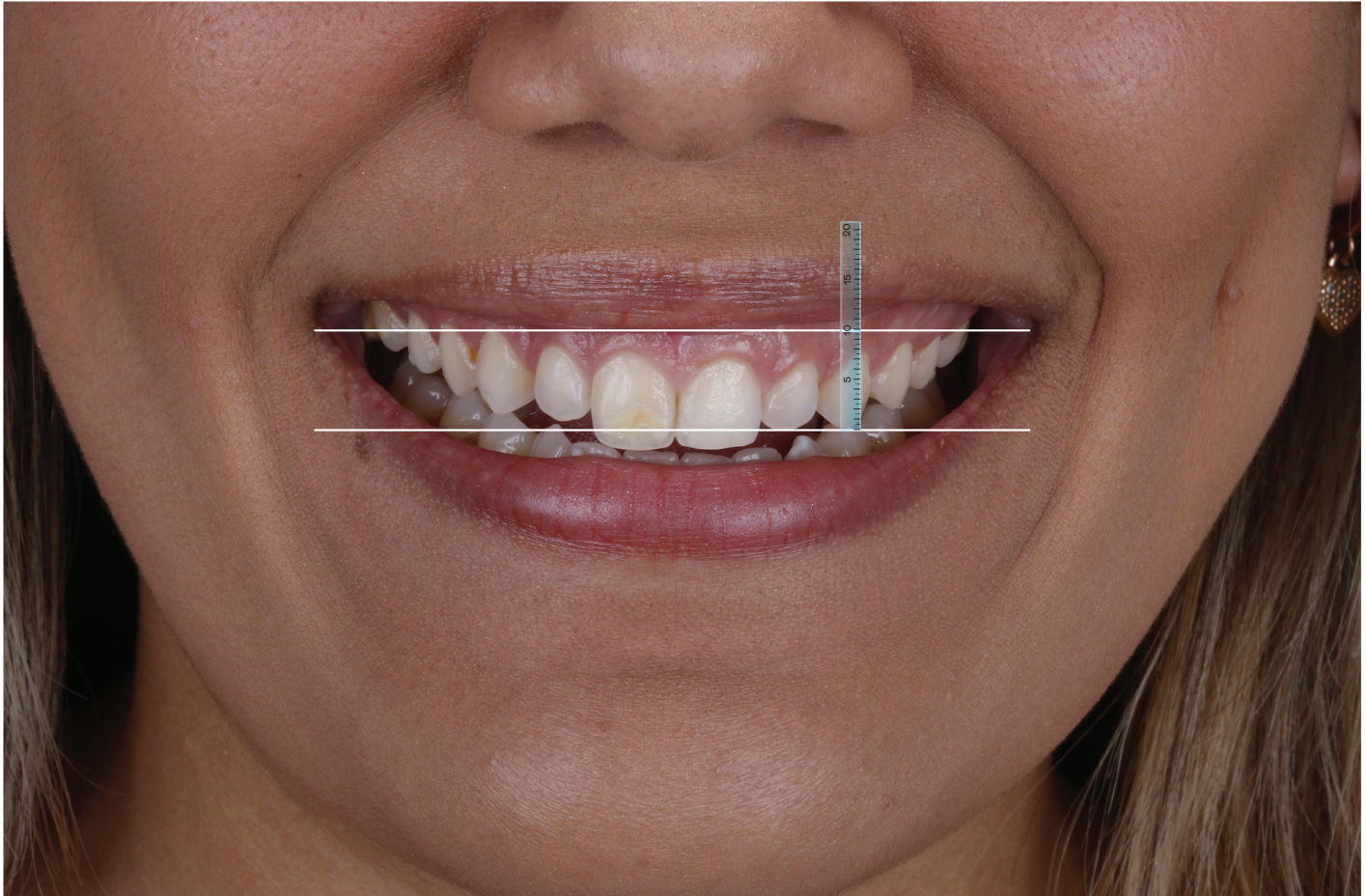
↑ **Figure 8:** Determination of UCI height. Note the harmony of position of the upper lip on the right side with the desired length of the UCI and the position of the gingival margin of teeth on the right side.



↑ **Figure 9:** Note the discrepancy in the apicocoronal position between homologues.

Since the UCI should be 10.5 mm long, tooth 23 with 9.5 mm was planned. However, at this length, its gingival margin would be 0.3 mm below the gingival margin of tooth 13. Thus, its desired length was changed to 9.8 mm. Conversely, tooth 13 should receive a restorative addition in its cusp tip, so that it would have the same position and length as tooth 23, provided the disocclusion and occlusion allowed (Fig 10).



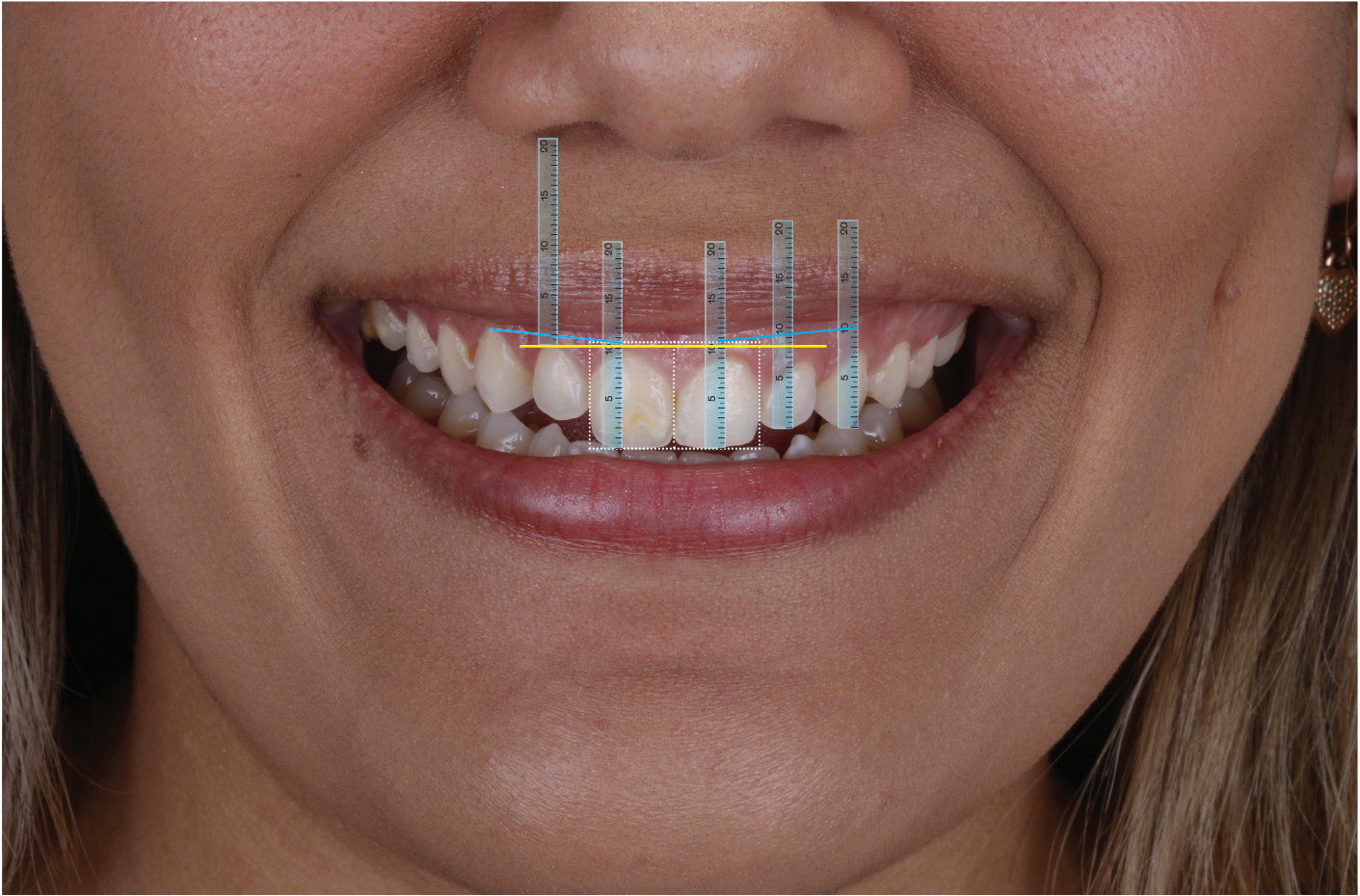


↑ **Figure 10:** Calculation of the increase in the gingival margin of tooth 23, based on the margin of tooth 13, which is at a suitable height compared to the length of the UCI.

After calculating the length of central incisors and canines, the position of the gingival margin of lateral incisors was then determined. Regardless of the discrepancy of the lateral incisal edge, its future gingival margin was calculated 1 mm below the line passing through the

future zenith of the central incisor and canine. Since the margin of tooth 12 was in correct position, it was planned to change only the position of the margin of tooth 22. Thus, its length, starting from the current incisal edge, would be 8 mm (Fig 11).

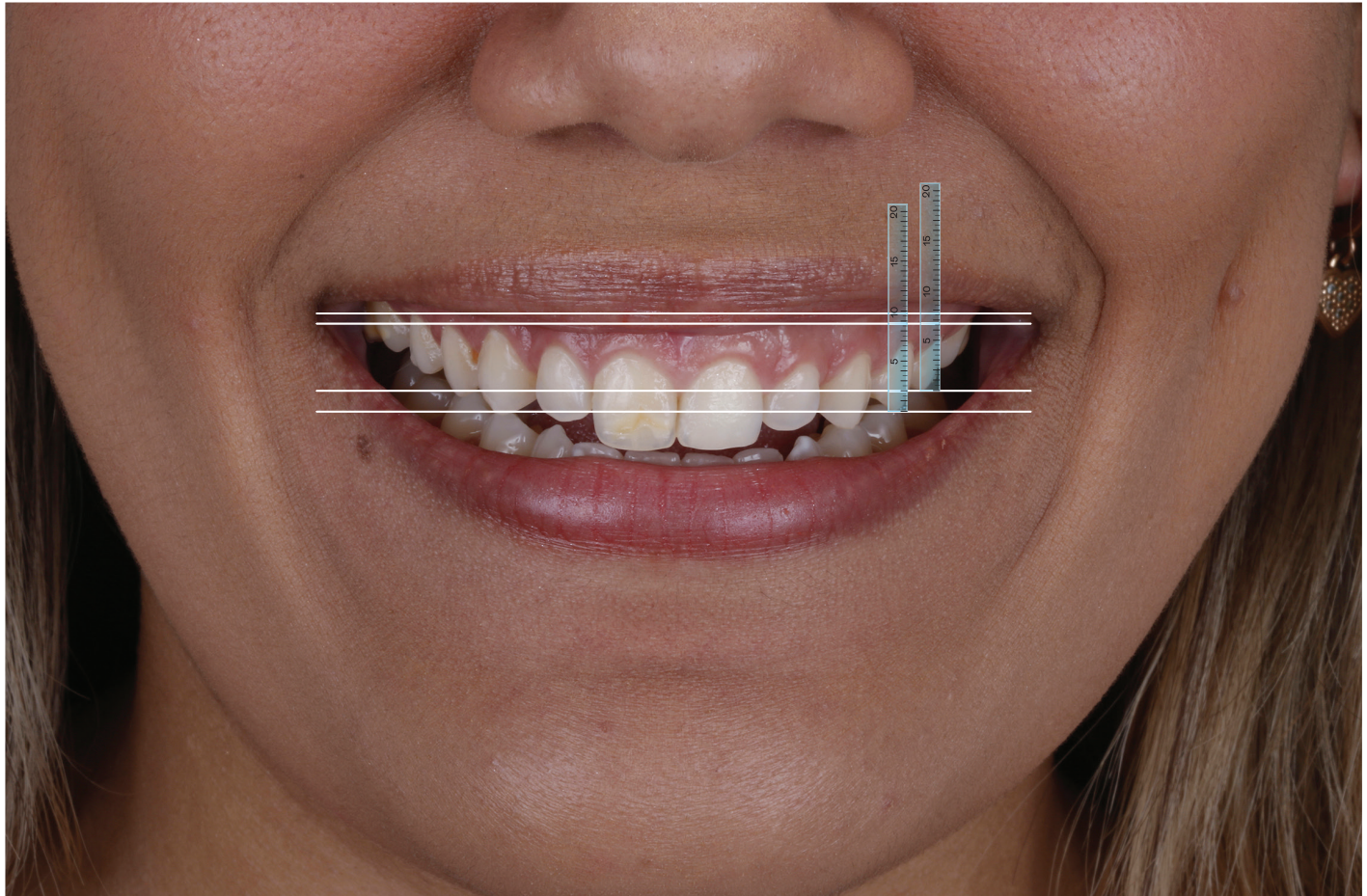




↑ **Figure 11:** Planning the future gingival margin of tooth 22, 1 mm below the line joining teeth 21 and 23 zeniths. Note the coincidence of the planned margin of tooth 22 with the current margin of tooth 12.

The same rationale was followed for calculation of pre-molars:

- ◆ The length of tooth 24 should be 7.5 mm (2 mm less than the canine), but its margin, to match its homologue, should be 7.9 mm.
- ◆ The length of tooth 25 should be 6.5 mm (1 mm less than the first premolar), but its margin, to coincide with its homologue, should increase to 7.5 mm (Fig 12).



↑ **Figure 12:** Calculation of gingival margin augmentation of teeth 24 and 25, based on the margin of teeth 14 and 15.

Alike tooth 13, it was necessary to verify the possibility of addition to the cusp tips of teeth 14, 15 and 16.

Despite the asymmetric behavior of the upper lip, it was decided, together with the patient, to keep the gingival margins of homologues at the same level.

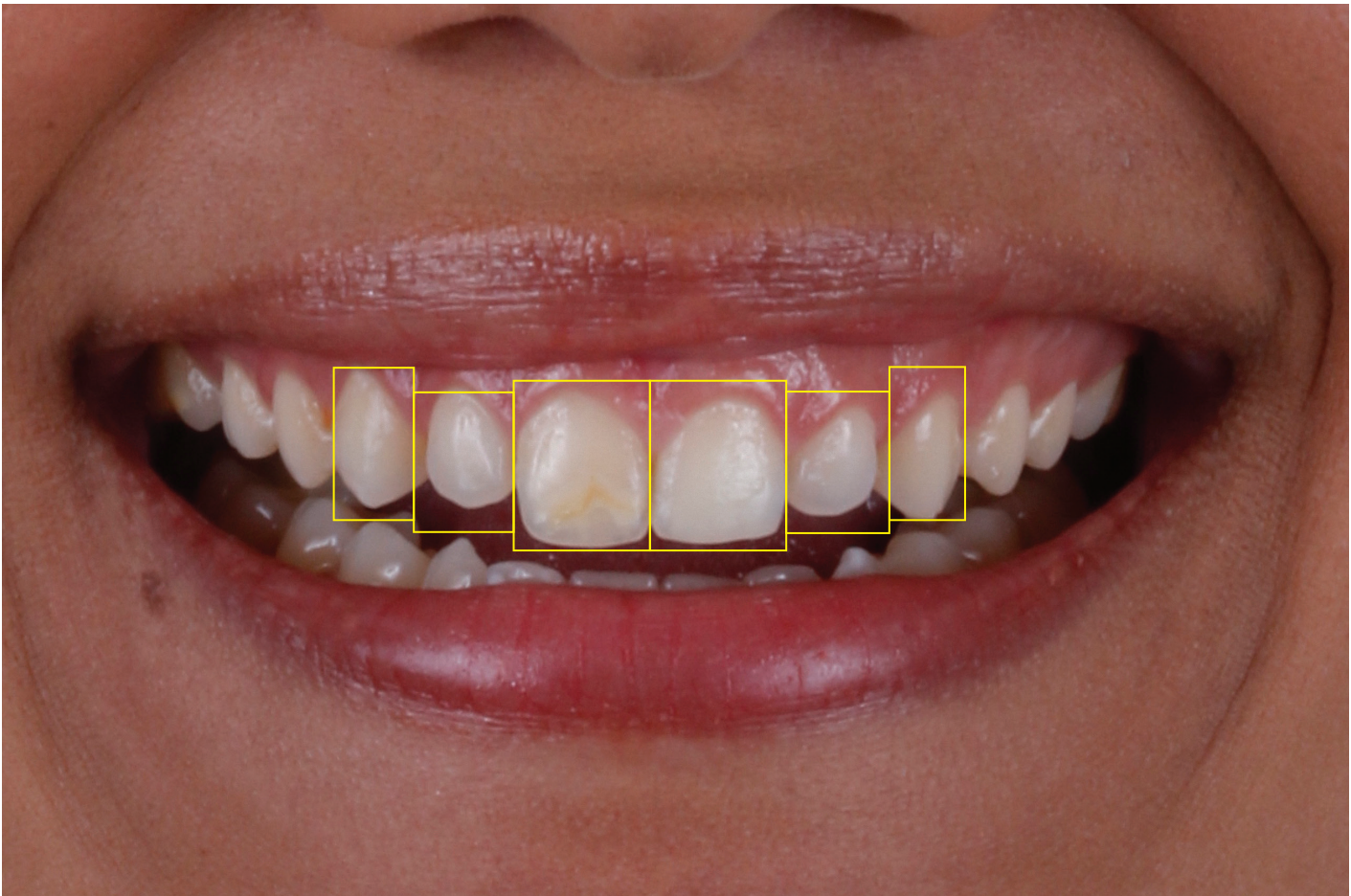
The purpose of this decision was to avoid significant root exposure of teeth on the left side and, in the future, refer the patient to correction of the increased contraction on the left side, with physical therapy.



The regressive gradation ratio (RGR) is a ratio used to calculate, in frontal view, the degree of disappearance of teeth as they move away from the midline.

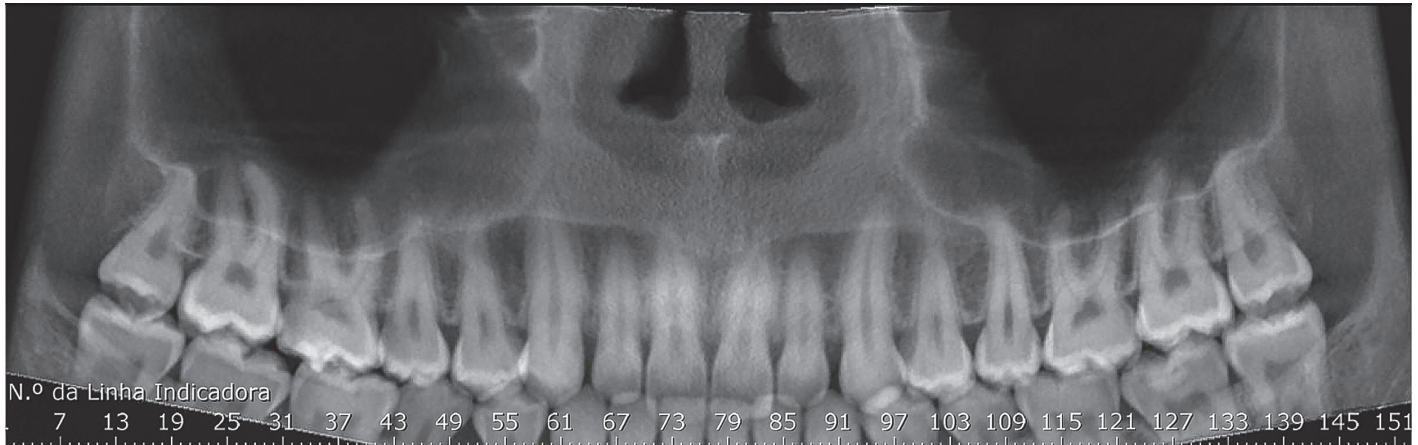
The RGR is variable and is commonly correlated with the patient's facial pattern. Usually, if the face is short, the RGR found is 80%; if it is average, the RGR is 70%; and if the face is elongated, the RGR is 62%. In the RGR of 80%, the UCI have reduced dominance and, in the 62%, the

UCI are dominant.<sup>23</sup> In the present case, the RGR found was 75% (canines with 75% of mesiodistal exposure of the lateral incisors, and lateral incisors with 75% of exposure of the UCI), and a small decrease in the dominance of UCI in relation to the other anterior teeth was noticed (Fig 13). Since planning would involve changing the anatomy with composite resin restorations, it was decided not to change the planning of the gingival margin position, to increase the dominance of the UCI.

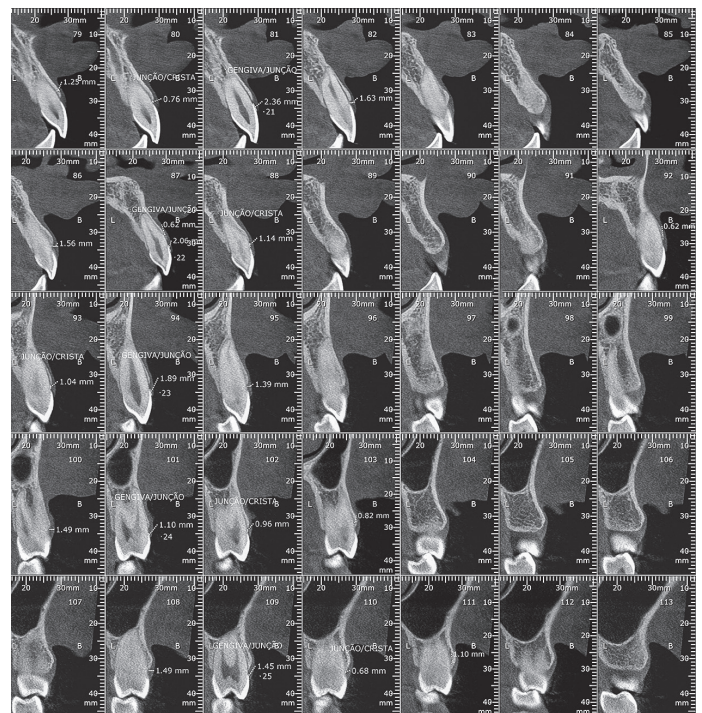


↑ **Figure 13:** RGR = 75%.

At that moment, tomography with separation of the lips validates or even limits the delineation of rationale. The verification of measurements of the buccal aspect of the periodontium and its relationship with the anatomical crown allows the planning (Figs 14 and 15).



↑ **Figure 14:** Panoramic reconstruction of the maxilla.



→ **Figure 15:** Sagittal sections on elements of interest for surgery.

Thus, in this case, the presence of the gummy smile was identified only in the left posterior region, with associated etiologies of lip hypermobility and altered passive eruption.

After analyzing the exams, the possibility of controlled increase in the exposure of teeth on the left side was noticed, to compensate for the present discrepancy. In this case, there were the following treatment possibilities:

- A. Orthodontic treatment and crown lengthening.
- B. Crown lengthening combined with composite resin or ceramic veneers.

In both possibilities, to correct the asymmetrical upper lip contraction, physical therapy would be necessary.

The patient ruled out the proposal for orthodontic correction due to the long duration of treatment and opted for crown lengthening associated with composite resins.

With all data previously collected, Table 3 was filled.

In tooth 23, to perform the planned 1.9 mm gingivoplasty, a band of keratinized mucosa of at least 3.9 mm would be required. In the planned case, there was an insufficient range (3.3 mm) to perform gingivoplasty and still maintain at least 2 mm of keratinized tissue.<sup>24</sup> Thus, it would be necessary to perform gingivoplasty with a maximum of 1.3 mm, maintaining a range of at least 2 mm, and positioning the flap apically (Table 4).

↓ **Table 3:** Filled table.

PARAMETERS FOR EVALUATION		15	14	13	12	11	21	22	23	24	25
1	Position of incisal edge	<b>Correct</b>				X			X	X	X
		<b>Incorrect</b>	X	X	X	X		X	X		
2	Current length of visual crown (mm)	6.0	7.2	8.5	7.2	9.5	9.0	6.5	7.9	6.9	5.6
3	Width of central incisors (mm)	-	-	-	-	8.4	8.4	-	-	-	-
4	Current width/height ratio of central incisors	-	-	-	-	88%	93%	-	-	-	-
5	Regressive Gradation Ratio	75%	75%	75%	75%	75%	75%	75%	75%	75%	75%
6	Desired length of visual crown (mm)	6.0	7.2	8.5	7.2	10.5	10	8.0	9.8	7.9	7.5
7	Desired increase Result of subtraction: line 6 minus line 2 (mm)	0	0	0	0	1.0	1.0	1.5	1.9	1.0	1.9
8	Existing keratinized mucosa band (mm)	>3	>3	>3	>3	4.1	4.7	3.9	3.3	3.0	4.2
9	Distance from the gingival margin to the CEJ. Quantity of covered enamel (mm).	1.2	1.3	2.4	2.4	2.7	2.4	2.1	1.9	1.1	1.4
10	Result of subtraction: line 9 minus line 7 (mm)*	1.2	1.3	2.4	2.4	1.7	1.4	0.6	0	0.1	-0.5
11	Length of biological distance according to the phenotype** (mm)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
12	Distance from current gingival margin to future bone crest: Line 7 + line 11 (mm)	3.0	3.0	3.0	3.0	4.0	4.0	4.5	4.9	4.0	4.9
13	Distance from current gingival margin to the current position of bone crest on the tomography (mm)	2.5	2.8	3.5	4.3	3.2	3.1	3.2	2.9	2.1	2.1
14	Osteotomy required *** Result of subtraction: line 12 minus line 13	0.5	0.2	-0.5	-1.3	0.8	0.9	1.3	2.0	1.9	2.8
15	Future clinical crown length line 2 + 7 + 11	9.0	10.2	11.5	10.2	13.5	13.0	11.0	12.8	10.9	10.5
16	Anatomical crown length line 2 + line 9	7.2	8.5	10.9	9.6	12.2	11.4	8.6	9.8	8.0	7.0

\*negative result = root exposure; zero result = gingival margin coincident with the JAC; positive result = remaining enamel covered.

\*\*thin phenotype = 2 mm; intermediate phenotype = 2.5 mm; thick phenotype = 3 mm.

\*\*\*negative result = unstable biological distance - risk; zero result = no need for osteotomy; positive result = amount of osteotomy to be performed.



↓ **Table 4:** Results of lines 7 and 8, demonstrating the impossibility of the desired gingivoplasty on tooth 23.

PARAMETERS FOR EVALUATION		15	14	13	12	11	21	22	23	24	25
7	Desired increase Result of subtraction: line 6 minus line 2 (mm)	0	0	0	0	1.0	1.0	1.5	<b>1.9</b>	1.0	1.9
8	Existing keratinized mucosa band (mm)	>3	>3	>3	>3	4.1	4.7	3.9	<b>3.3</b>	3.0	4.2

It is necessary to verify that the planned length of the visual crown does not exceed the length of the anatomical crown. This must be done in line 10. If it does not surpass, the result will be “zero” or positive. Thus, the incisions will be performed according to planning in line 6 (Table 5).

In tooth 25, the result of line 10 was negative; thus, its planning needed to be revised. This means that, after incision, root exposure could occur. In this case, as a composite resin restoration was planned, there would be no problem if there was a small exposure of 0.5 mm. Thus, there was no need to change the results for line 15 (Table 6).

In line 14, a negative result was observed for teeth 12 and 13, which cautioned to an unstable biological distance (greater than the planned distance of 3 mm). The positive result indicates the amount of osteotomy needed and, when zero, the bone crest position will not change (Table 7).

Since there would be preservation of keratinized tissue band in the region of tooth 23, the table was highlighted so that this fact could be remembered during surgery.

In conclusion, only the results from Table 4 were used for surgery: the corrected length of the visual crown and the corrected length of the future clinical crown (Table 8).

↓ **Table 5:** Results of line 6.

PARAMETERS FOR EVALUATION		15	14	13	12	11	21	22	23	24	25
6	Desired visual crown length (mm)	6.0	7.2	8.5	7.2	10.5	10	8.0	9.8	7.9	7.5

↓ **Table 6:** Results of line 10.

PARAMETERS FOR EVALUATION		15	14	13	12	11	21	22	23	24	25
10	Result of subtraction: line 9 minus line 7 (mm)	1.2	1.3	2.4	2.4	1.7	1.4	0.6	0	0.1	-0,5

↓ **Table 7:** Results of line 14.

PARÂMETROS DE AVALIAÇÃO		15	14	13	12	11	21	22	23	24	25
14	Osteotomy required** Result of subtraction: Line 12 minus line 13	0.5	0.2	-0.5	-1.3	0.8	0.9	1.3	2.0	1.9	2.8

↓ **Table 8:** Results of desired length of visual crown and future clinical crown to be used for surgery.

DATA FOR SURGERY		15	14	13	12	11	21	22	23	24	25
LINE 6 with <b>CORRECTED</b> visual crown length (mm)		6.0	7.2	8.5	7.2	10.5	10	8.0	9.8	7.9	7.5
LINE 15 with <b>CORRECTED</b> future clinical crown (mm)		9.0	10.2	11.5	10.2	13.5	13	11.0	12.8	10.9	10.5

Based on the aforementioned measurements, a digital wax-up was performed with changes to the gingival margins and additions to the incisal edges. This corrected plan was printed, and a restorative mock-up was made from it (Fig 16).





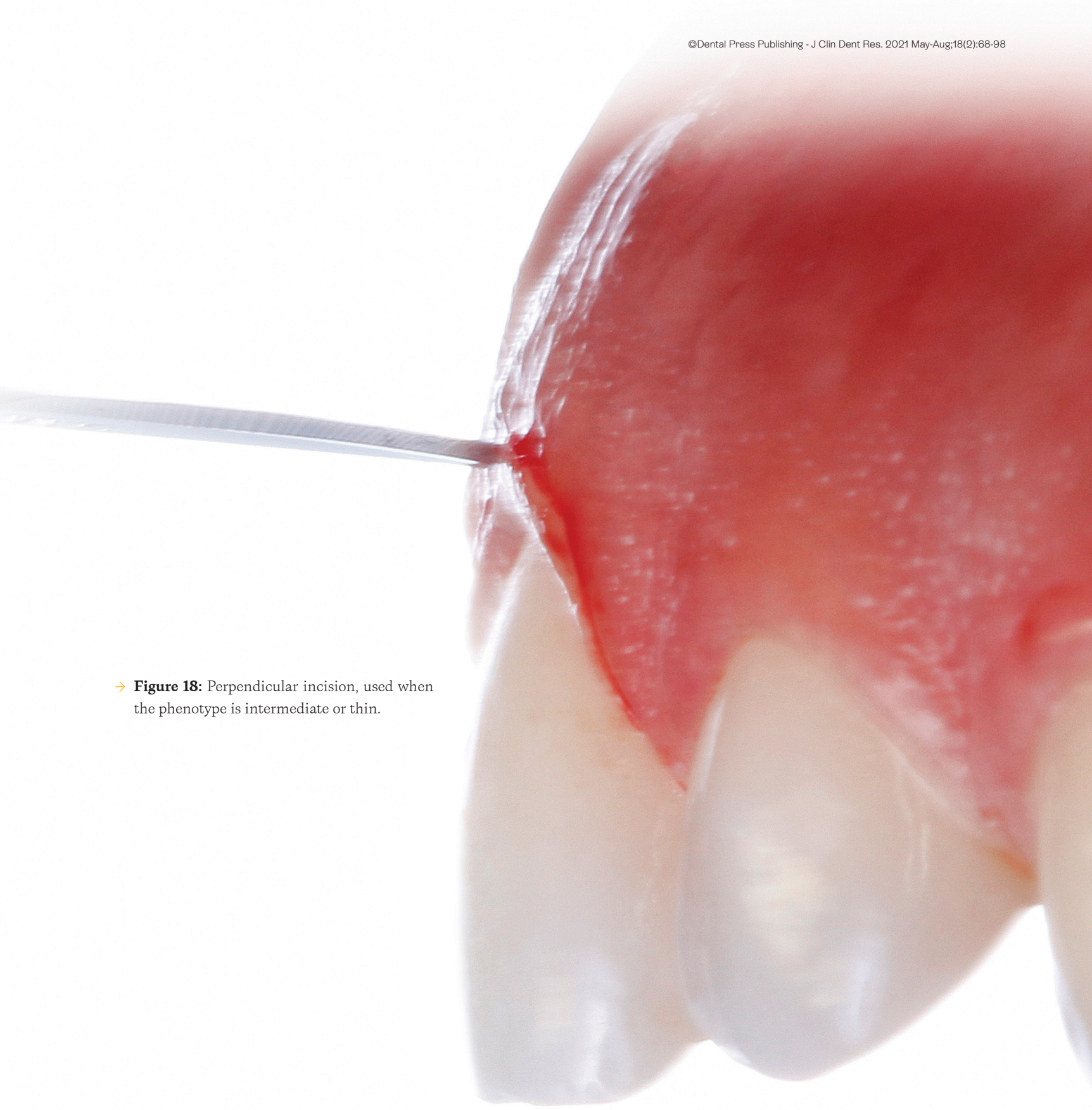
↑ **Figure 16:** (A-C) Frontal and lateral views, with the restorative mock-up.

Since the patient approved the planning and restorative mock-up, surgery was performed (Figs 17 to 35).



↑ **Figure 17:** (A-C) Intraoral views of the upper arch.





→ **Figure 18:** Perpendicular incision, used when the phenotype is intermediate or thin.



← **Figure 19:** Gingivoplasty. In tooth 23, due to absence of an adequate band of keratinized mucosa, the incision was made behind the planned, since in this region the flap would be positioned apically.

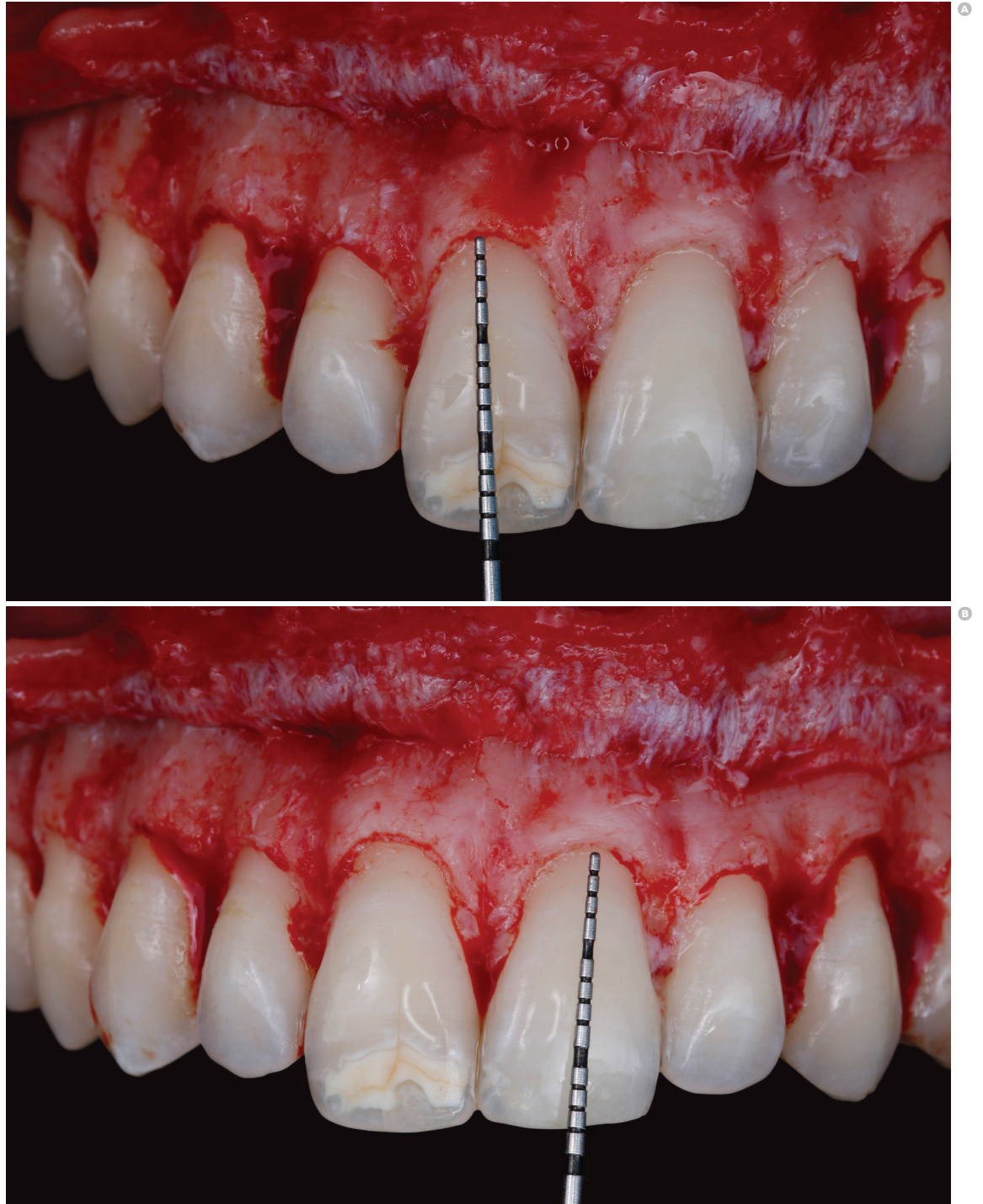


← **Figure 20:** Full flap raised.



← **Figure 21:** Completed osteoplasty and osteotomy.





↑ **Figure 22:** (A, B) Clinical crown of teeth 11 and 21 with 13.5 mm and 13 mm respectively, due to the 0.5-mm difference in the incisal edges.



↑ **Figure 23:** Mixed flap: total flap and divided flap. The total flap was obtained with sufficient dimensions for osteoplasty. The split flap was performed to allow suture anchorage and, consequently, its apical positioning, since there was not enough keratinized tissue band in this region. Note the periosteum attached to the bone tissue.



↑ **Figure 24:** (A-C) Immediate postoperative period. Note the suture located in the root portion of tooth 23, with the purpose of apically repositioning the flap in this region.



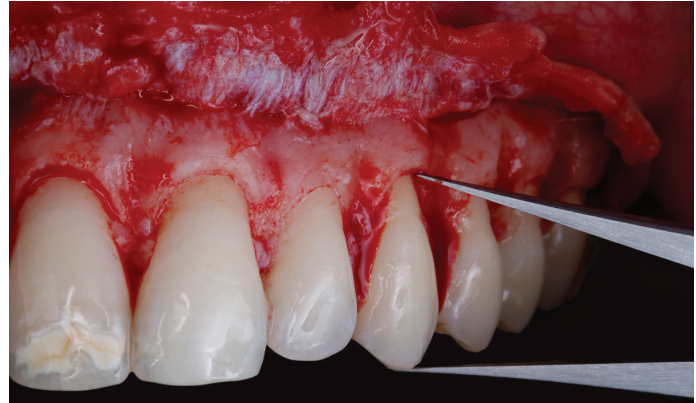
→ **Figure 25:** Detail of the planning of tooth 23. Caliper measuring 9.8 mm, according to the planned length. It is noted that, if the incision was made in this caliper marking, the remaining keratinized mucosa band would be less than 2 mm. The band in this region was 3.3 mm and the planned gingivoplasty would be 1.9 mm, leaving only 1.4 mm. Therefore, the gingivoplasty should be, at most, 1.3 mm, to keep a remaining band of at least 2 mm, also requiring apical positioning of the flap in at least 0.6 mm.







↑ **Figure 26:** Planned crown lengthening of 12.8 mm measured with a caliper, before osteotomy.



↑ **Figure 27:** Planned crown lengthening of 12.8 mm measured with a caliper after osteotomy.



↑ **Figure 28:** Visual crown measuring 9.8 mm after apical positioning of the flap, checked with a caliper. Observe the preservation of a keratinized tissue band of at least 2 mm.



↑ **Figure 29:** Seven days postoperatively.



↑ **Figure 30:** (A-C) Three-month postoperatively.



↑ **Figure 31:** (A-C) Intraoral views in the three-month postoperative period.



→ **Figure 32:** (A, B) Three-month postoperative period. Visual crown measurement of the canine with 9.5 mm.

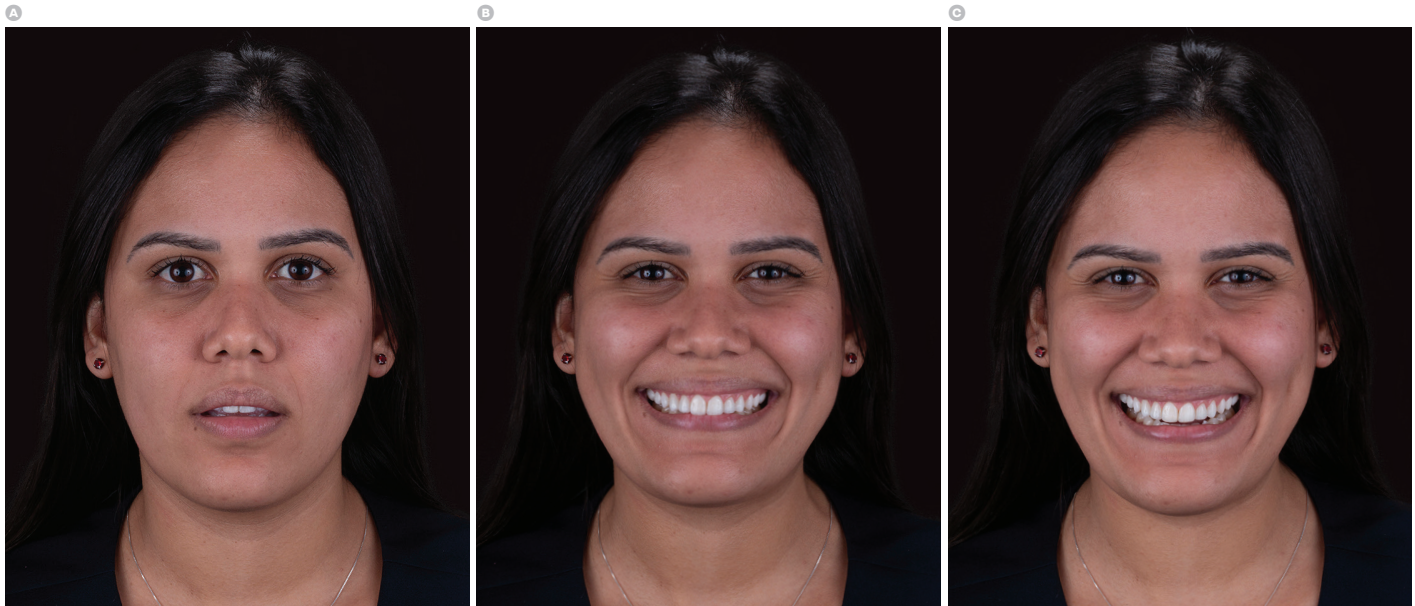




↑ **Figure 33:** Band of keratinized mucosa on tooth 23 before surgery.



↑ **Figure 34:** Keratinized mucosal band on tooth 23 after surgery, maintained due to the apically positioned flap.



↑ **Figure 35:** (A-C) After cosmetic treatment with composite resins, performed by colleague Emílio Akaki.

## DISCUSSION

When a tomography is requested to lengthen the esthetic clinical crown, the radiology center should send the measurements of the supracrestal distances and their relationship with the anatomical crown. Such measurements should be checked with a caliper by physical examination or with a virtual ruler in digital examination. In the treatment of altered passive eruption, these measurements should not be used in isolation, but with the purpose of aiding planning, which should be based on facial parameters (interpupillary distance, which is usually 50% of the width between the zygomatic bones<sup>25</sup>) and their relationship with the teeth (in average, the width of UCI is the length of the interpupillary distance divided by 7<sup>26</sup>). Also, when defining the position of the gingival margin, the RGR will

indicate the degree of dominance of the UCI and consequently whether their proportion should be increased or decreased, since the position of the UCI margin impacts the definition of all others. Thus, the purpose of the table is to organize and interconnect this information, to make surgery more predictable and assertive.

## CONCLUSION

The technique of esthetic crown lengthening can be used both for cases of gummy smile and for simpler cases, with change in the position of the gingival margin of all or some teeth. The proposed table may appear complex at first glance. However, the correct insertion and analysis of data makes planning during surgery easier and more reproducible.

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