Esthetic crown lengthening in the treatment of gummy smile

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Abstract

The aim of this article was to evaluate 1 year after surgery a surgical protocol that included gingivectomy and an apically positioned flap plus osseous resective surgery to correct excessive gingival display (EGD) in patients with altered passive eruption (APE) of the maxillary anterior teeth. Six female patients aged 18 to 22 years were diagnosed with APE type 1B. Surgical crown lengthening with flap surgery and bone recontouring was performed to achieve the biologic width. Photographic images were analyzed to evaluate the stable improvement of crown length before the procedure (baseline), immediately after surgery (immediate postoperative), and at 3 and 12 months postsurgery. Moreover, a lip repositioning procedure was also performed in one case to complement the periodontal therapy. Compared with baseline, an increase of 1.6 mm in the mean tooth crown height was observed in the photographic analysis at 12 months. A minimal difference was observed between the mean tooth crown height immediate postoperative and at 12 months, which indicates stability of the gingival margin. In conclusion, the surgical protocol outlined in this article describing esthetic crown lengthening for the treatment of APE/gummy smile resulted in predictable outcomes and stability of the gingival margin 1 year after surgery.

Introduction

A harmonious smile is considered a symbol of beauty in modern society. A multifaceted scenario, including tooth form and position, gingival tissue levels, and lip position determine smile esthetics, which has been a focus of dental treatment. There has been particular interest in the treatment of excessive gingival display (EGD), commonly termed gummy smile, and periodontal plastic surgery techniques have been used to improve smile esthetics. EGD is characterized by an overexposure of the maxillary gingiva during smiling or speaking. This condition occurs in 10.57% of the population, affecting people (predominantly females) of 20 to 30 years of age.

Possible etiologic factors for EGD include plaque or drug-induced gingival enlargement or overgrowth, altered passive eruption (APE), short clinical crowns, vertical maxillary excess, hyperactive or short upper lip presence or a combination of these clinical conditions. From the clinical perspective, APE is associated with increased gingival band width and gingival exposure during smiling. In a normal eruption phase, the gum tissue migrates apically, with gradual exposure of the tooth crown stabilizing at the cervical level. Thus, mostly due to developmental or genetic factors,

Fig 1 Changes in tooth dimensions and gingival display of cases 1 to 6 from baseline (a), immediate postoperative (b), 3 months (c), and 12 months (d) after the crown lengthening surgery.
The alteration in APE may lead to the persistence of an excessive amount of soft tissue over the enamel surface, resulting in an excessive quantity of gingival tissue at the maxillary anterior teeth during smiling.1

In addition, APE has been subclassified into two types:10 type 1 is characterized by an excessive amount of attached gingiva with shorter crowns, while type 2 is a gummy smile associated with a normal gingival dimension. In addition, two possible subcategories (A and B) have been suggested, depending on the relationship of the bone crest (BC) to the cementoenamel junction (CEJ) of the tooth (BC–CEJ). In subcategory A, the BC–CEJ is > 1.5 mm, allowing adequate space for the insertion of a connective tissue attachment to the root surface. In subcategory B, this space is minimal and does not allow for a correct biologic width.11 Depending on the classification, different possible treatments are indicated. The treatment plan for APE type 1B should include the management of the periodontal tissue and incorporate gingivectomy and apically positioned flap plus osseous resective surgery (esthetic crown lengthening surgery).12 However, APE type 2 showing excessive growth of the maxillary process generally requires a multidisciplinary treatment plan, including orthognathic surgery and orthodontic treatment.13 It is empha-
sized that APE type 1 treatment is a challenge and is risky because excessive bone resection on the maxillary anterior teeth may lead to residual gingival recession. On the other hand, a limited resection may result in coronal regrowth of the gingival margin, reducing the length of the postsurgical clinical crowns. Therefore, an adequately planned surgical procedure is essential to guarantee proper treatment of APE and satisfy patients’ expectations.

In some cases, where the EGD is caused by the combined etiology of a hyperactive upper lip and APE, other techniques are associated with crown lengthening surgery to resolve the EGD. In these cases, procedures such as botulinum toxin injection or lip repositioning have been proposed. The lip repositioning technique is accomplished by a single partial-thickness elliptical incision in the depth of the anterior maxillary vestibule. Then, the lip mucosa is sutured to the mucogingival line. This technique was designed to be shorter in duration and less aggressive than orthognathic surgery, and also causes fewer postoperative complications.

The aim of this case series was to evaluate the efficiency of a surgical protocol consisting of gingivectomy and an apically repositioned flap combined with osseous resective surgery to correct EGD in patients with APE at the maxillary anterior teeth. The gingival margin stability obtained with the crown lengthening procedure was evaluated at 3- and 12-months postsurgery.

Case description

Inclusion criteria

Six periodontally and systemically healthy female patients aged 18 to 22 years who were non-smokers sought treatment. They were dissatisfied with their smile esthetics due to the overexposure of the maxillary gingiva during smiling or speaking. During the clinical intraoral examinations, the patients’ oral cavities were examined under natural light using sterile instruments to record the plaque index (PI) and the gingival index (GI) using the criteria proposed by Silness and Loe. Only patients with a PI and GI of < 20% were included in the study. Moreover, all patients presented inadequate tooth width and height proportions in the superior anterior maxilla. These parameters were detected using a specific probe (Chu’s Aesthetic Gauges; Hu-Friedy). Transgingival probing (TP) using a conventional periodontal probe (Hu-Friedy) detected a BC–CEJ distance of < 1.5 mm in the superior anterior teeth. Based on this, the patients were diagnosed with APE type 1B, and surgical crown lengthening with flap surgery and bone recontouring was the indicated treatment (Figs 1a and 2a).

Esthetic crown lengthening and frenectomy surgery

Local anesthesia was induced using a 4% articaine solution with epinephrine 1:100,000 (Nova DFL). The surgical procedure was initiated with gingival demarcation on the mid-buccal aspect of the teeth using a specific probe (Chu’s Aesthetic Gauges) (Fig 2b and c). After the gingival demarcation, the CEJ positions were checked with a conventional periodontal probe (Hu-Friedy) detected a BC–CEJ distance of < 1.5 mm in the superior anterior teeth. Based on this, the patients were diagnosed with APE type 1B, and surgical crown lengthening with flap surgery and bone recontouring was the indicated treatment (Figs 1a and 2a).

An intrasulcular incision was made, and a conservative full-thickness flap to the level of the mucogingival junction (MGJ) was
raised on the buccal aspect, including teeth 13 to 23 (Fig 2g). Teeth 14 and 24 were also affected by the APE and included in the flap. The BC–CEJ distance was measured on the midbuccal aspect, then carbide steel burs and hand chisels were used for ostectomy and osteoplasty, aiming to attain a 2-mm BC–CEJ distance (Fig 2h and i). No interproximal crestal bone was removed.

The flap was repositioned, and single interrupted sutures (Cytoplast PTFE sutures, PERIO USP, 4/0) were used to stabilize the flap (Fig 2j). In all cases, the labial frenum was closely attached to the gingival margin in the superior incisive region. Then, a frenectomy was made (Fig 2k) to complete the removal of the frenum using the conventional technique described by Devishree et al.18 The frenum was engaged with a hemostat tweezer inserted into the depth of the vestibule, and incisions were placed on the upper and underneath surfaces of the tweezer using a No. 15 C blade. The triangular resected portion of the frenum was removed, and a blunt dissection was performed on the bone to relieve the frenum attachment. The edges of the wound were sutured with single interrupted sutures (Cytoplast PTFE sutures, PERIO USP, 4/0) (Fig 2l).

The patients were prescribed 0.12% chlorhexidine gluconate (Periogard; Colgate) and instructed to rinse gently twice daily for 15 days. Tooth brushing was to be discontinued in the surgical area during this time. An antibiotic (Azithromycin, 500 mg, once daily) was prescribed for 3 days to prevent possible postoperative infection. A nonsteroidal anti-inflammatory (Nimesulide, 100 mg, 12/12 h) and an analgesic (Dipyrrone, 500 mg, 6/6 h) were also prescribed.
The 7-day postoperative healing was uneventful and the sutures were removed. For case 1, a restorative phase was carried out 3 months after the surgical crown lengthening procedure to close the diastema between teeth 11 and 21 using composite resin (Fig 1d). Patient photographs were taken before the surgery (baseline), immediately after the surgery (immediate postoperative), after 3 months, and after 12 months (Fig 1a to d). The photographs were analyzed to evaluate the stability of the results of the crown lengthening procedure. Distortions between the photographs were adjusted using mathematic calculations following the modified sequence proposed by Terenzi et al19. The reference structures (dental crown width) were measured with the digital ruler of the digital smile design (DSD) program, using millimeters as the unit of measurement (Fig 3). First, the digital ruler was calibrated to a real measurement using an initial photograph of the teeth with a millimeter probe in each case. The dental crown width of two teeth (superior central incisors) in the initial photograph (baseline – preoperative) was obtained. In the same way, the widths of the same teeth were measured in the immediate postoperative and 3- and 12-month follow-up photographs. An average of the two measure-

**Postsurgical follow-up**

Table 1  Dental crown height mean length (millimeters) obtained in each case at baseline, immediate postoperative, 3 months, and 12 months

<table>
<thead>
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<th>Baseline</th>
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<th>12 months</th>
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<tr>
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<tr>
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<tr>
<td>Final mean</td>
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<td>8.0</td>
<td>7.7</td>
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</table>

The distortion ratio was calculated by dividing the average width obtained in the final photograph (immediately postoperative, 3 months or 12 months) by the width obtained in the initial photograph (baseline).

Table 2  Dental crown height mean length (millimeters) obtained in each case at immediate postoperative and 12 months

<table>
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<tr>
<td>Final mean</td>
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<td>8.8</td>
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</table>

The distortion ratio was calculated by dividing the average width obtained in the photograph at 12 months by the width obtained in the photograph at 3 months.
ments was obtained for each photograph. A distortion ratio was calculated by dividing the mean width obtained in the final photograph (immediate postoperative, 3 or 12 months) by the width obtained in the initial photograph (baseline). This distortion ratio was used to normalize the measurements of crown length utilized to compare the crown length after immediate postoperative, 3 and 12 months, with the crown length obtained from the baseline photograph (Table 1). Moreover, a distortion ratio was also calculated by dividing the mean width obtained in the 12-month photograph by the width obtained in the immediate postoperative photograph. This distortion ratio was used to compare the crown length obtained in the immediate postoperative photograph with that obtained in the 12-month one (Table 2).

The smile photographs 1 year after the crown lengthening procedure (Fig 4) show a reduction in the gingival smile and a correction of the gingival zenith. Table 1 shows a 1.2 mm increase in the average crown length after the surgical procedure (difference between immediate postoperative and baseline). After 12 months, the average crown length remained 1.6 mm higher than at baseline (difference between 12 months...
Fig 5 Lip repositioning procedure (case 6). (a to c) Measurement of keratinized gingiva. (d and e) Elliptical incision demarcation using a marking pencil. (f to i) Single partial-thickness elliptical incision. (j) Simple interrupted suture in the medium, canine, and molar regions. (k) Immediate postoperative, final aspect.
postoperative and baseline). Moreover, Table 2 shows a minimal difference (0.3 mm) between the average crown length in the immediate postoperative measurement and 12 months after the procedure; in other words, the gingiva rebound 12 months after the surgical procedure was only 0.3 mm, indicating gingival margin stability after 12 months of follow-up.

Lip repositioning technique

One patient (case 6) was dissatisfied with the degree of gingival exposure during smile even after the crown lengthening procedure. In this case, the EGD occurred due to the combination of APE with a hyperactive upper lip. Therefore, lip repositioning was performed according to the technique proposed by Rosenblatt and Simon to complement the gummy smile treatment. The preoperative protocol described above was followed. The location of the mucogingival junction and the keratinized gingiva size were determined using a periodontal probe (Fig 5a to c). A marking pencil was used to outline the borders of the elliptical incision (Fig 5d and e). The lower incision coincided with the mucogingival line in order to avoid any loss of attached gingiva, and was extended from the mesial aspect of the first premolars bilaterally. The distance between the superior and inferior borders was 1.5 mm, which was the length of the repositioning desired in the patient’s smile as determined by the preoperative measurement.

A single partial-thickness elliptical incision was created with a No. 15 C blade, removing the epithelium but keeping the underlying connective tissue intact (Fig 5f and l). Care was taken to avoid damage to the minor salivary glands in the submucosa. The area of frenectomy was approximated with a simple interrupted suture (polyglycolic resorbable 5/0 suture, Vicryl; Ethicon/Johnson & Johnson) to ensure symmetry and proper midline placement. Other key sutures were made bilaterally in the canine and molar regions (Fig 5j). Then, multiple interrupted sutures were made between the initial key suture placement areas to complete the wound closure (Fig 5k). The same postoperative protocol described above was followed, and the patient was instructed to minimize lip movements when smiling or talking for 2 weeks after the surgery. The sutures were removed at the 2-week follow-up appointment. Postoperative healing was uneventful. A minor scar formed on the suture lines but remained invisible during smiling. The 3-month follow-up showed a reduction of gingival display, and the patient was satisfied with the final treatment result (Fig 6).

Discussion

A careful diagnosis and treatment plan are essential to indicate the most predictable APE treatment protocol. The most common diagnostic method is TP, which is used to detect the CEJ subgingivally and to calculate the real clinical crown dimension.
The soft tissue height is measured with a periodontal probe down to the BC, and this dimension can also be used to guide the amount of osseous resection to be fulfilled. Studies comparing TP with direct bone-level measurements immediately after flap reflection suggest that TP is an accurate method of determining BC levels. However, although transgingival bone probing measurements seem to be very close to the histometric bone level, the use of cone beam computed tomography (CBCT) has also been proposed, which allows for the three-dimensional (3D) visualization of the alveolar bone/soft tissue as well as accurate and precise measurements. A retrospective study by Batista et al showed that CBCT enabled a precise diagnostic of the reduced distance between the CEJ and the BC as well as the precise determination of the anatomical crown length, a key reference for APE surgical treatment. However, TP alone was used to diagnose and select all APE type 1B cases treated in this case series due to the unavailability of the patients to undergo CBCT scanning during the surgical planning period.

In this case series, Chu’s Aesthetic Gauges were successfully used to guide the excess gingival tissue removal and correct the tooth size proportion. These measurement tips include Chu’s Proportion Gauge, which represents an objective mathematic appraisal of tooth size ranges. Additionally, a full-thickness flap was performed to access the BC and restore the biologic width, assuring the stability of the long-term clinical results. Ribeiro et al suggested another method to treat APE, ie, a minimally invasive flapless esthetic crown lengthening procedure using micro chisels, via incision without flap elevation. However, in their randomized controlled trial, the esthetic crown lengthening, with or without flap elevation, showed similar and stable clinical results for up to 12 months.

Clinical studies evaluating the esthetic crown lengthening procedure have shown that less soft tissue rebound occurs when the postoperative gingival margin is positioned 3 mm coronal to the surgically reduced BC, compared with flaps repositioned at or below it. In these case reports, the BC was placed 2 mm apical to the CEJ, and the flap 1 mm coronally, to allow for a proper biologic width and to ensure the stability of crown height gained over time. In these case reports, a clinically insignificant gingival rebound of 0.01 mm was observed between 3 and 12 months. On the other hand, according to a review by Marzadori et al, a buccal ostectomy should be performed after choosing the guiding tooth, following the esthetic proportion parameters. Thus, for these authors, the bone reduction could be considered complete when the flap was precisely adapted over the underlying bone. The tissue biotype might also significantly influence the gingival tissue rebound, as previous studies have shown that the mean tissue regrowth in patients with a thick biotype was significantly greater than those with a thin one. Therefore, the identification of tissue biotype is necessary before crown lengthening surgery, since the presence of a thick biotype will require greater bone reduction to avoid tissue rebound.

The photographic analysis performed in the present case series suggests that the crown lengthening procedure described in this article was successful in increasing the clinical crown length and maintaining it for 12 months (average crown length 1.6 mm higher than at baseline). The average crown length values observed in these case reports was 6.8 mm (baseline), 8.0 mm (immediate postoperative), 7.7 mm (3-month follow-up), and 8.4 mm (12-month follow-up) (Table 1). Using the same surgical protocol, Silva et al observed values of 8.5 mm (baseline), 10.3 mm (immediate postoperative) and
9.9 mm (6-month follow-up). Cairo et al. also observed average crown length values of 8.5 mm (baseline), 10.2 mm (immediate postoperative), and 10.1 mm (6-month follow-up). Moreover, certain clinical studies have shown some gingival rebound ranging from 0.1 to 0.2 mm over the time period. However, in these case reports, a clinically insignificant gingival rebound of 0.3 mm was observed between the immediate postoperative measurement and the one taken at 12 months (Table 2).

The case 6 patient was dissatisfied with the degree of gingival exposure during smile even after the crown lengthening procedure. In this case, the EGD occurred due to the combination of the APE with a hyperactive upper lip. The less-invasive options for hyperactive upper lip treatment are botulinum toxin injection or lip repositioning. Injecting overactive muscles with measured quantities of botulinum toxin results in a reduction of muscle activity, a relaxing of the lip muscles, and a decrease of the upward pull on the lip. Although the botulinum toxin injection is the least-invasive treatment, the results are temporary and only last for a period of 3 to 6 months before slowly fading. Due to this, lip repositioning was successfully indicated for the hyperactive upper lip treatment. A recent systematic review published by Tawfik et al. showed that lip repositioning successfully reduced the EGD by 3.4 mm. Faus-Matoses et al. showed in three case reports that lip repositioning can produce stable results 1 year after the procedure. Thus, lip repositioning is indicated for patients with minor discrepancies as well as for those who desire a treatment that is less invasive than orthognathic surgery but which has a more immediate (and long-term) result compared with orthodontics or botulinum toxin injection treatment. However, this technique is contraindicated in the presence of a minimal zone of attached gingiva as well as in cases of several vertical maxillary excesses, where an interdisciplinary approach is recommended.

In a modified lip repositioning technique, the maxillary labial frenulum is maintained, and two mucosal strips (one at each side of the frenulum) are removed. In this modification, the frenulum helps to maintain the position of the labial midline and prevents changes in lip symmetry. However, the frenulum maintenance can limit the correction of the EGD in the region of the maxillary central incisors during lip repositioning. A recent clinical study showed that the modified lip repositioning technique shows less relapse after surgery as well as excellent cosmesis. Moreover, compared with the conventional technique, it shows greater sustainability after 6 months. In case 6 in the present case series, the frenulum was removed during the crown lengthening procedure due to its insertion near to the gingival margin. For this reason, in this case the conventional lip repositioning technique was utilized.

The methodological limitations of the present case series include a relatively low number of participants and the absence of any clinical analysis of the periodontal parameters to confirm the photographic analysis described in this article. Therefore, additional controlled clinical studies are necessary to evaluate the long-term outcomes of the procedure here described with a larger sample size.

In conclusion, the surgical protocol including gingivectomy and apically positioned flap plus osseous resective surgery could be considered a predictable protocol for the reduction of EGD associated with APE.

Disclaimer

The authors declare that there are no conflicts of interest.