
A stepwise approach to the correction of excessive gingival display: an integrative review of the literature

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Background: Excessive gingival display is an aesthetic concern for patients and a challenge for clinicians. An accurate diagnosis is essential in order to provide effective treatment.

Aim: The aim of the present article is to fill a gap in the current literature by providing clinicians with an overview and a stepwise approach to assessing gingival excess, as well as reviewing possible treatment.

Method: Published articles related to smile aesthetics and excessive gingival display over the last 40 years were identified and analysed through an electronic search.

Results: An examination should be initiated extra-orally to distinguish contributing skeletal factors. The relationships of four aesthetic parameters (LIPG): lip length (L), incisal lines (I), tooth proportions (P), and gingival lines (G), should be examined individually to determine other possible causes of gingival excess. Contributing factors may include a short or hypermobile upper lip, dentoalveolar extrusion, or altered passive eruption. Further investigation to identify patients who might benefit from orthognathic surgery, orthodontic treatment alone, lip repositioning or botulinum injection, or aesthetic crown lengthening procedures, should be conducted to reconfirm a diagnosis and provide the optimal treatment.

Conclusion: Clinicians can have a dental blueprint for anterior tooth reconstruction and are able to provide comprehensive treatment in co-operation with other disciplines. By understanding the principles of an aesthetic smile line, the aetiology of an excessive gingival display and treatment concepts, clinicians may provide alternative treatments to avoid extensive surgical procedures while achieving acceptable outcomes.

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Introduction

Many parameters constitute an aesthetic smile. Three main tissue structures – the lip framework, gingival scaffold, and the teeth – complement each other to produce a patient's smile.¹ As early as 1970, Hulsey assessed lip-tooth relationships and concluded that having the upper lip at the level of the gingival margin of the maxillary central incisors was rated as the most attractive smile.² Tjan divided the smile into three

types: low, average and a high smile.³ A medium or low smile line with little or no gingival display is considered the most appealing, while a high smile displaying greater than 2–3 mm of maxillary gingiva is considered unpleasant.^{4–7} Patients with a 'gummy' smile may have a poor psychological status, reflected by low self-confidence. The perception of an excessive gingival display is, however, subjective. Greater than 2 mm of gingival exposure is regarded as unattractive by orthodontists, whereas greater than 4 mm of gingival

display is considered unpleasant by lay people.⁸ The prevalence of an excessive gingival display is reported in 7% of men and 14% of women.⁹ Prevalence rates that differ from the reported data may indicate that a clinician's diagnostic technique is faulty.¹⁰

Factors including symmetry, colour, shape and the long axis of the teeth, as well as the gingival scallop and papillae, are important considerations in regard to smile aesthetics.¹ There are too many factors for clinicians to evaluate within a short visit, and evidence from randomised controlled clinical studies has not been reported to date.¹¹ Therefore, the objectives of the present article are to review the current literature regarding the aetiology and treatment modalities of gingival excess and to provide simple guidelines for a stepwise management approach.

Aetiology

An excessive gingival display is mainly attributed to three components: (1) bone, (2) lips, and (3) teeth. A skeletal problem relates to a vertical maxillary excess, which is an overgrowth of the maxilla in a vertical direction. A short upper lip or hypermobile lip is affected by the elevator muscles that lift the lip to a higher position. Related dental problems include incisal overeruption (anterior dentoalveolar extrusion), compensatory incisal eruption (incisal wear), and altered passive eruption. Drug-induced or plaque-induced gingival hyperplasia are confounding factors that are beyond the scope of this article. A step-by-step approach to analysing the three components is introduced in the following section.

Extra-oral smile analysis

It is imperative for periodontists to comprehensively examine patients rather than directly focus on gingival issues. Facial asymmetry or disproportionate dimensions between the upper, middle, and lower thirds of the face in the frontal view are features of concern. A convex profile, incompetent lips, and a retrusive mandible can subsequently strengthen an impression. A longer lower third of the face and with accompanying facial features immediately provide clues that skeletal factors may be involved in gingival excess.^{12,13} If the lower facial third is equal to the other thirds, skeletal factors can be excluded.¹⁴ A cephalometric radiograph is required to exclude vertical maxillary excess but if a patient is diagnosed

with a vertical dysplasia, orthognathic surgery may be the best treatment to restore normal inter-jaw relationships and reduce associated gingival excess (Figure 1).

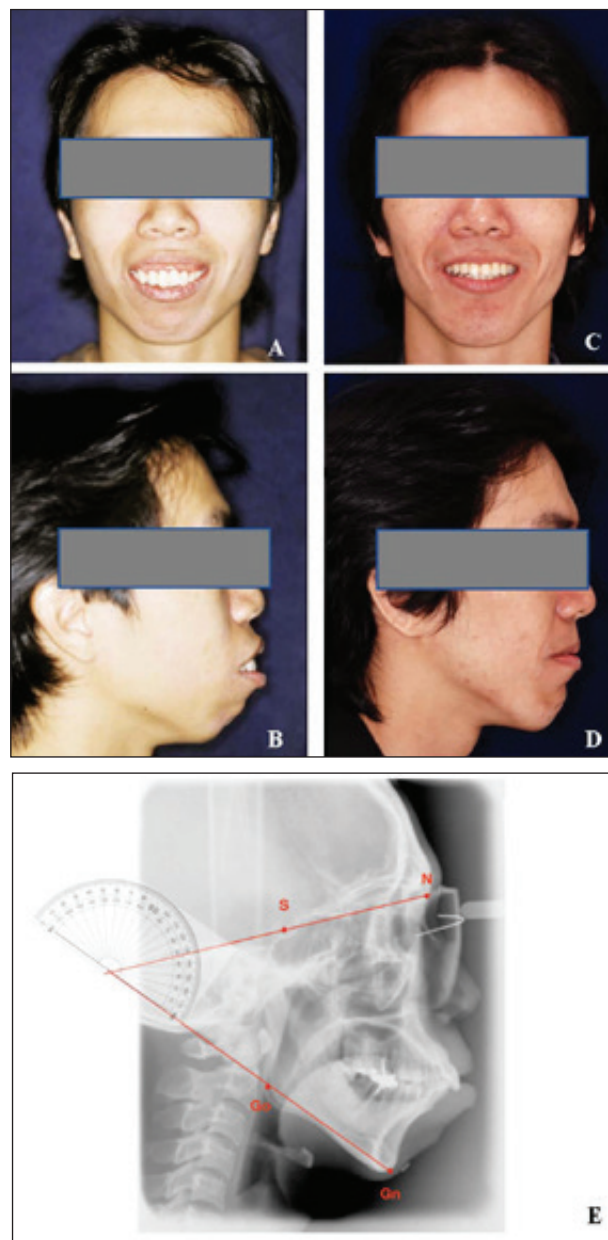


Figure 1. (A, B) The initial gummy smile resulted from vertical maxillary excess. His convex profile, longer lower thirds of face, and lip incompetence provide a clue of bone problems during extra-oral examination. (E) Cephalometric radiography is required and may reveal a steep mandibular plane and large SNGoGn degrees, which indicates that skeletal growth mainly occurs vertically. Normal SNGoGn ranges from 27 to 37 degrees. (C, D) Great improvement in skeletal relationships and gingival display are noted after orthodontic and orthognathic surgery.

Intraoral smile analysis

Part 1: LIPG checklist (Fig. 2)

L: Lip length measurement

Lip length is measured from subnasale to the most inferior border of the upper lip. The average upper lip length at rest is 22–24 mm in young adult males and 20–22 mm in young adult females, with a mean upper lip length of 22.3 mm.^{5,14} An upper lip that is less than 15 mm is regarded as short.^{12,16} Lip length on full smile is measured according to the extent of upper lip movement calculated as lip length at rest minus lip length during a full smile. The mobility of the maxillary lip generally ranges between 6 to 8 mm from repose to a full smile. Greater than 8 mm of lip mobility¹⁷ or 1.5- to 2-fold increased translation¹⁸ defines a hypermobile upper lip, which is related to muscular hyperfunction (Figure 3).¹⁴

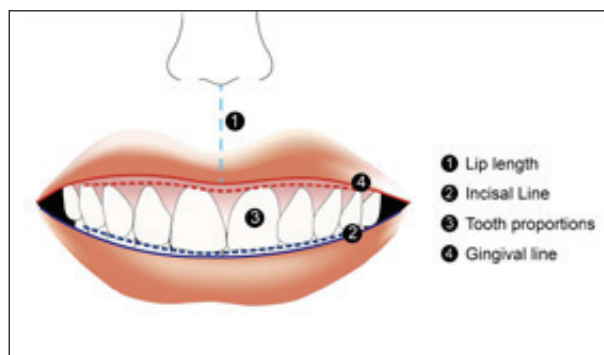


Figure 2. The LIPG principle is recommended for intraoral step-by-step analysis of a gummy smile. Lip lengths at rest and during full smile are measured first to determine whether the upper lip is short or hyperactive. Secondly, an incisal line is determined based on the curvature of the lower lip and the amount of tooth displayed at rest. Third, each tooth length is decided by the average figures provided in the literature. Finally, the gingival level of each tooth can subsequently be decided after consideration of the relationship of the position of the incisal edge and tooth length. In general, the gingival level is parallel to the inferior border of the upper lip.



Figure 3. (A, C) The patient presented with a chief complaint of excessive gingival display. Lip length is measured from the subnasale to the inferior border of the upper lip. The mobility of the upper lip can be determined by assessing the difference in the upper lip length between the smile at rest and full smile. She was diagnosed with hypermobility of the upper lip and decided to receive a lip repositioning procedure. (B) The purpose of lip repositioning is to limit the labial retraction of the elevator smile muscles in order to reduce gingival display by means of shortening the vestibular depth. (E, F) The amount of excised alveolar mucosa should double the amount of gingival display, which can be marked with colour transfer applicators. (G, H) A partial thickness flap procedure was performed to remove the mucosa tissue, and suturing was performed from the midline and halfway between the two sutures. (D) Great reduction of excessive gingival display was noted after lip repositioning. The thickness of the upper lip increased. Stable results still remained after the one-year visit.

I: Incisal line determination

An optimal incisal plane should be parallel to the curvature of the lower lip.^{2,7,16,19} On average, 2–3 mm and 3–4 mm of tooth should be displayed in repose in young men and young women, respectively, and these values may decrease with age.^{12,20,21,22} An incisal line that is not in harmony with the lower lip curvature, and reveals more or less tooth at rest, indicates malpositioned teeth or incisal wear. Orthodontic intervention to distalise and intrude teeth using miniscrews or miniplates for overerupted anterior teeth, or prosthodontic involvement for severe attrition teeth, can re-establish ideal incisal positions and reduce associated gingival exposure (Figure 4).

P: Proportions of teeth establishment

Short clinical crowns may be caused by either altered passive eruption or incisal wear. Average values of clinical crown length, width or ratios may serve as guides to identify these problems. The golden proportion (1.618) is widely present in Greek architecture and was once applied to the teeth. However, the maxillary arch may become abnormally narrow when using the golden proportion, and specific width-to-length ratios of each tooth should be explored.^{23–25} Individual tooth proportions of maxillary anterior teeth range from 72 to 80%.²⁶ Sterett et al. analysed tooth size on male and female casts. The average proportions of the central incisors,

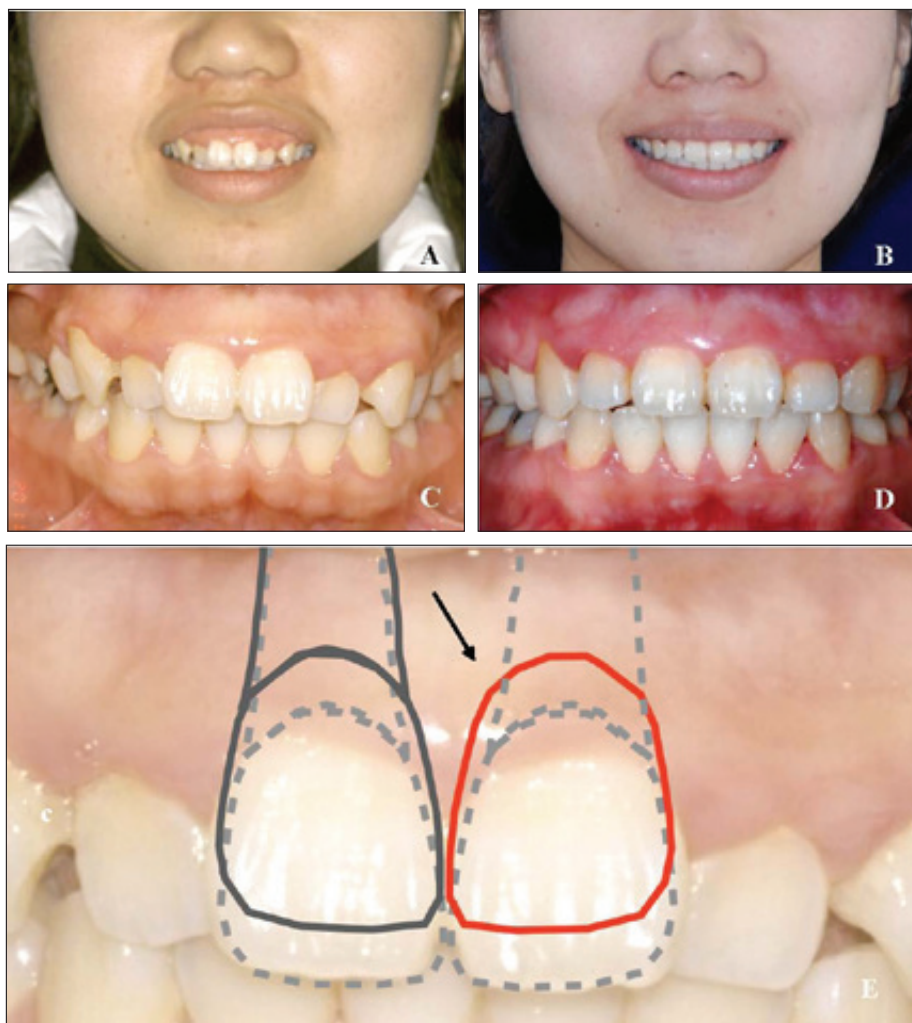


Figure 4. (A, C) The patient complained of a gummy smile, and the incisal edges of the anterior teeth were positioned more coronally. Incisal line is the second parameter of an intraoral smile analysis. An ideal incisal line should be in harmony with the lower lip. Inharmonious incisal lines and excessive tooth display at rest suggest the necessity of orthodontic treatment. (B, D) The patient underwent orthodontic treatment, including intrusion of the upper teeth and retraction of the upper and lower dentition. She had a harmonious smile after orthodontic treatment. (E) In such a case, orthodontic treatment to intrude the teeth is better than incisal edge reduction in combination with surgical crown lengthening to restore the normal length of the anterior teeth. One reason is that orthodontic treatment can preserve tooth structure. Secondly, the intruded anterior teeth maintain their normal emergence profile, whereas surgical crown lengthening may expose the root portion, leading to narrower mesiodistal dimensions and most likely resulting in overhanging prostheses.

lateral incisors, and canines are documented as 85%, 76% and 79%, respectively, on male casts and 86%, 79%, and 81%, respectively, on female casts.²⁷ Several studies have provided average values of tooth width and length as a general reference. Chu suggested the average width of the anterior teeth should be 8.5 mm, 6.5 mm and 7.5 mm for the central incisors, lateral incisors and canines, respectively. These numbers are evident in 34% of subjects and can be correct in 82% of subjects when the values are altered by ± 0.5 mm.²⁸ Tooth dimensions exhibit gender differences typified by the canines among the anterior tooth groups.^{28,24,27} Tooth width is 0.5 mm greater than the mean in men, whereas 0.5 mm smaller than the mean in women.²⁸ Wheeler reported mean lengths of 10.5 mm, 9.0 mm, and 10.0 mm for central incisors, lateral incisors and canines, respectively, by measuring extracted teeth.²⁹

Tooth width generally remains constant, whereas tooth length could be altered by aging, attrition and soft tissue conditions.²⁴ In most cases, the use of mean values or calculations enables the re-establishment of ideal crown length, especially for teeth affected by incisal wear or altered passive eruption. The average ratio and width should be used to calculate ideal clinical crown length.²⁸ For example, in the case of altered passive eruption or worn incisors with a width of 8.5 mm for central incisors, the ideal tooth length would be $8.5 \text{ mm} / 0.85 = 10 \text{ mm}$.²⁷ For teeth with extreme mesiodistal dimensions, average ratios are recommended for the re-establishment of proportionate crown length.

G: Gingival level confirmation

The gingival level may be determined by established incisal lines and tooth length. The optimal position of the marginal gingiva of the central incisors and canines is at the same level. The gingival margin of a lateral incisor is 1–2 mm more occlusal than the adjacent teeth.^{10,30–32} The gingival zenith, which is the most apical part of gingival scallop, of the central incisors and canines should be at the distofacial line angle, whereas the zenith of the lateral incisors should be at the mesiodistal centre. The zenith determines the axis of each tooth group, and the ideal gingival level generally follows the curvature of the upper lip.¹⁹ The upper lip should rest at the midfacial gingival margin of the anterior teeth during an extensive full smile.¹² If the gingival margin is not a continuous curved line, the teeth may have gingival recession or altered passive

eruption. The addition of tissues by soft tissue grafting or the resection of tissues by crown lengthening procedures may resolve these problems (Figure 5).

Part 2: Further investigation before procedures

Candidates for orthognathic surgery (OGS)

Features such as a convex profile, lip incompetence, a longer lower facial third, and relatively low occlusal planes that cause the maxillary canines and premolars to be covered by the lower lip, are all clues indicating the involvement of a skeletal component in an excessive gingival display. If a ‘gummy’ smile occurs with coincident incisal and occlusal planes, an overdeveloped maxilla is highly suspected.^{12,19} A cephalometric radiograph is mandatory to confirm a vertical maxillary excess (VME). A high SNGoGn angle, which represents the inclination of the mandibular plane to the anterior base of the cranium, indicates that the skeletal growth pattern is mainly vertical (Figure 1).^{6,33} In addition, the distance between the palatal plane and the upper incisal edges is approximately 2 mm greater than average values in patients presenting with a VME, unlike in patients without a VME.⁶ Most of the subjects with an excessive gingival display have a tendency to exhibit a skeletal Class II malocclusion, while a skeletal Class III malocclusion is less likely.¹³ The severity of the gingival display and related bone problems determine treatment options. For patients with a type III VME, which is characterised by ≥ 8 mm gingival display, a LeFort I maxillary osteotomy with impaction can correct the bone and related gingival display. The mandible may rotate upwards and forwards into occlusion, but a mandibular osteotomy may be required in certain cases to establish a stable occlusion.¹⁸ However, OGS is associated with high morbidity. In addition, a high cost is expected because the procedure should be implemented in a hospital setting.³⁴ Garber and Salama introduced a classification of VME and offered treatment modalities based on its severity. Orthodontic treatment or lip repositioning procedures represent alternatives to manage a ‘gummy’ smile for type I or type II VME based on reduced trauma compared with OGS.¹

Candidates for orthodontic treatment

When the incisal line is not coincident with the curvature of the lower lip, the entire occlusal plane

should be examined. If a difference between the anterior and posterior dentition exists, dentoalveolar extrusion may be the diagnosis. Conversely, if no difference is noted, a vertical maxillary excess may be the cause of excessive gingival and tooth display.¹² Dentoalveolar extrusion results from the lack of a stable occlusion. Thus, anterior maxillary teeth may overerupt, and in company, the gingiva and alveolar bone subsequently move occlusally. The incisal edges of the anterior teeth may be covered by the lower lip at full smile.³⁵ An imaginary line drawn from the maxillary canine to canine or a piece of dental floss can be used to identify any discrepancies between anterior and posterior alignment.¹⁸

In patients with a diagnosis of dentoalveolar extrusion, orthodontic treatment is preferred rather than crown lengthening procedures to correct a 'gummy' smile. The former is a non-invasive procedure and can bring the entire attachment apparatus into a more apical region. Crown lengthening is an invasive treatment that combines prosthetics to realign the incisal lines and restore tooth proportions. Moreover, it is challenging to restore ideal dimensions given that the neck of the tooth becomes narrower after surgical procedures (Figure 4). The gingival margin should be deeper in the sulcus, so that the tooth's emergence profile can be developed from a deeper region to wider contact point areas. Otherwise, the restoration may cause an overhang, which is difficult for healthy oral hygiene maintenance.^{1,36} Therefore, the crown-root ratio and the discrepancy of the mesiodistal dimensions between the crown and the root should be taken into consideration when selecting orthodontic treatment or surgical management. Regardless of the chosen procedure, it is imperative to establish an occlusal stop to ensure long-term stability.¹⁸

Candidates for lip repositioning or botulinum injection

A short or hypermobile upper lip may benefit from lip repositioning or a botulinum injection. The lip repositioning procedure was first introduced in 1973³⁷ and mechanically involves limiting the retraction of the smile elevator muscles and the range of motion of the upper lip by reducing the vestibular depth. An adequate amount of mucosal tissue, which is double the amount of gingival display, should be excised.¹⁴ The borders of the remaining tissues may then be approximated to alter the vestibular depth. The

facial midline and dental midlines should be marked before local anaesthesia to ensure bilateral symmetry postsurgically (Figure 3).³⁸ Another method involves modified lip repositioning by retaining the midline maxillary labial frenum.¹⁷ Suturing should be initiated at the midline and midway between the two sutures to ensure bilateral symmetry post-operatively.¹⁴ To prevent potential relapse within one year post-operation, lip movement should be minimised for at least one month. Some authors suggest an overcorrection during surgery by placing the lip slightly below the zenith, in anticipation of a small amount of rebound after complete healing. The mean reduction of the gingival display by lip repositioning averaged 6.4 mm.³⁹ Other modified techniques, such as myectomy or a combined approach of myotomy of the levator labii superioris muscle, are rarely used given the lack of a significant reduction by this relatively invasive procedure.^{40,41} Mucocele formation due to severing minor salivary glands is the most severe complication and may resolve on its own without any intervention.⁴² Lip repositioning is an invasive treatment with scar contraction but is a reversible surgical procedure. After two to three years of follow-up, cases have exhibited stable and satisfying outcomes.^{17,39} A recent case report of identical twins with type III VME and hypermobile upper lips demonstrated remarkable aesthetic enhancement of the smile after two years.³⁴ However, patients with minimally attached gingiva are contraindicated given the difficulty in flap design and suturing leading to an increased risk of relapse. In addition, the shallow vestibular depth and narrow attached gingiva may compromise oral hygiene measures.^{17,38,42,43}

The muscles involved in facial expression for upper lip elevation and lateral retraction include the levator labii superioris (LLS), levator labii superioris alaeque nasii (LLSAN), zygomaticus minor (ZMi), zygomaticus major and depressor septi. All of these muscles interact with the orbicularis oris muscle to develop a smile.⁴⁴ Polo conducted a pilot study using botulinum injection as a nonsurgical treatment modality to manage excessive gingival display of muscular origin.⁴⁵ Mechanically, botulinum causes temporary muscle atrophy by inhibiting acetylcholine release and therefore muscle contraction.⁴⁶ Injections are administered intramuscularly on an empirical basis or under electromyographic guidance (EMG). EMG is useful in accurately locating active muscles, in treating small, weak, and deep muscles or those cases with a



Figure 5. (A, G) Gingival levels of anterior maxillary sextant are determined after appropriate tooth lengths are decided. The patient presented with squat and short clinical crowns with a chief complaint of a gummy smile. Altered passive eruption was diagnosed by thorough examination, including bone sounding and identification of CEJ positions. (C) A diagnostic mock-up is suggested for communication with patients before surgery. The morphology of the mock-up can be adjusted after aesthetic assessment and used as a guide during surgery. (D) For patients with altered passive eruption, periapical films should be obtained to observe whether the CEJ position is consistent with clinical findings. (E, F) An osseous resective procedure should be performed to create 2–3 mm distance between CEJ and the alveolar crest for the development of supracrestal attachment. Osteotomy should be extended to the line angle of the tooth as it is the part most commonly neglected by operators (arrow). (B, H) Aesthetic crown lengthening was performed, and the patient was satisfied with the treatment outcome.

history of poor response to botulinum toxin.⁴⁷ The six smile muscles are the most commonly injected sites although the LLSAN is the main target in most of the reported studies. However, the dose of toxins and the adopted techniques vary between the studies.^{44,48} Hwang et al. investigated the surface anatomy of the lip elevator muscles in 25 adult cadavers and noted a triangular region through which three muscles (LLS, LLSAN, and ZMi) pass. The centre of the triangular region was named the “Yonsei Point” and is located 1 cm horizontally from the ala and 3 cm above the lip, on average.⁴⁹ This injection point is recommended because the three muscles are easily targeted with a single injection.^{44,50,51} The dose of botulinum varies

depending on the muscle volume and severity of the ‘gummy’ smile. Males with more muscle volume may require more botulinum than female patients to achieve similar results. Polo proposed an injection protocol based on the amount of gingival exposure. For greater than 8.5 mm of gingival exposure, a total amount of 10 units of botulinum is recommended. It was also strongly suggested to avoid injecting the orbicularis oris muscle given its function when pursing the lips.⁴⁴ However, a recent case report mentioned no noticeable improvement until the orbicularis oris muscle was injected and up to 20 units of botulinum was utilised in total.⁵⁰ No conclusions can be drawn regarding total dosing amounts. Most authors

advocate the initial use of low doses, and supplemental doses can be added in a second stage.^{45,48,52} The effect is apparent one to two weeks later, and the effect duration is four to six months depending on muscle thickness and activity.⁴⁶ Despite its short-term effect, botulinum administration costs less and is a nonsurgical procedure. Some authors have noted that the effect duration may be prolonged because muscles may atrophy after several botulinum injections.⁴⁸ The most severe complications of botulinum injection are an asymmetric smile, a sad appearance, lengthening of the upper lip, drooling and difficulty in functioning.⁴⁸ Most adverse reactions are caused by limited clinician experience and poor injection techniques.⁴⁴ Patients who have neuromuscular disorders, are pregnant or lactating, taking calcium channel blockers, cyclosporine, and aminoglycosides, or have a history of hypersensitivity to botulinum, should not be treated in this manner.⁴⁶

Candidates for esthetic crown lengthening

When altered passive eruption is suspected in patients with short clinical crowns, greater assessment is required. There are four types of altered passive eruption circumstances advocated by Coslet: 1A, 1B, 2A, and 2B.⁵³ The first step in diagnosing altered passive eruption is to subgingivally identify the cemento-enamel junction (CEJ). If the CEJ is not detectable, altered passive eruption (subgroup B) is noted.³⁵ If the CEJ can be identified (subgroup A), the bone sounding after local anaesthesia should be probed to determine the relationship between the osseous level and CEJ position. Finally, standardised preoperative periapical X-rays are necessary to reconfirm the CEJ and osseous levels.^{54,55} Zucchelli suggested using a gutta-percha cone to identify the gingival margin in a periapical radiograph and subsequently compare clinical and radiographic crown length. Altered passive eruption can be confirmed if a ≥ 3 mm difference is noted between clinical and radiographic crown length measurements.⁵⁶ In certain situations, the anatomic crown should be fully exposed, making the clinical crown the same as the anatomical crown, for maximum aesthetic appeal.¹⁰

Treatment varies for each of the four types of altered passive eruption. For type 1 patients, a traditional gingivectomy can be performed given that adequate keratinised gingiva is present. At least 3 mm of keratinised gingiva (2 mm attached, 1 mm non-attached) should remain after surgery. For type 2

patients, an apically positioned flap is recommended due to insufficient keratinised tissues. Osseous surgery is not needed for subtype A patients because an adequate distance is present between the CEJ and alveolar crest. However, an osseous resective procedure is necessary for subtype B patients because the alveolar bone is almost at the level of CEJ, and no space is available for the formation of a supracrestal attachment.⁵³ Gargiulo et al. introduced the concept of a dentogingival complex, which comprises the average values of sulcus depth (0.69 mm), epithelial attachment (0.97 mm) and connective tissue attachment (1.07 mm). A minimum of 3 mm from the alveolar crest to the free gingival margin is therefore required for the insertion of the attachment apparatus.^{31,57} The 3 mm distance is especially important for teeth with subgingival restorations to allow the formation of biologic width, thus keeping tissues away from food and bacterial insults.⁵⁸ However, some authors recommended measuring individual biologic width given that high variability in the epithelial attachment exists.^{59,60} A distance of 2 mm between the CEJ and alveolar crest for thin phenotypes and 3 mm for thick phenotypes has been suggested because patients with thick phenotypes exhibit increased risk of soft tissue regrowth.^{36,61,62} If the space is not provided, tissue could rebound or recede in thick or thin phenotypes, respectively.³¹ Additionally, the region of expected connective tissue attachment should not be instrumented during surgery. Otherwise, unpredictable bone or attachment loss may occur during the formation of a new connective tissue attachment.⁵⁵

The CEJ is an important landmark during crown lengthening procedures. However, if the CEJ is not identifiable, the position of the incisal edge and average tooth dimensions remain useful parameters to decide a newly created final gingival level,^{31,63} which can be either at the level^{35,64} or slightly coronal to the CEJ position.^{18,54}

Clinicians may either choose an open flap or flapless gingival surgical technique with sufficient tactile sensation based on experiences and preferences. For type 1 cases, similar results were reported for up to 12 months. A flapless crown lengthening procedure is contraindicated in type 2 cases of altered passive eruption and cases with insufficient keratinised gingiva.^{55,64} Regardless of the various techniques, leaving the interdental papilla intact and avoiding

Table I. Management of gingival excess.

Aetiologies	Features	Treatments
Vertical maxillary excess	-Longer lower third -Lip incompetence at rest position -Steep mandibular plane	Degree I (2~4 mm gingival display): - Orthodontic treatment - Botulin - Lip repositioning
		Degree II (4~8 mm gingival display): - Lip repositioning - OGS
		Degree III (>8 mm gingival display): - OGS
Short upper lip	Lip length <15 mm	Lip repositioning
Hypermobility of upper lip	Lip mobility > 8 mm; 1.5~2x of translation	- Botulin - Lip repositioning - Myectomy or myotomy
Altered passive eruption	- Short-looking teeth - ≥ 3 mm difference between clinical and radiographic crown length	Esthetic crown lengthening procedure
Altered active eruption	Short-looking teeth with incisal wear	Orthodontic intrusion or esthetic crown lengthening procedure with prostheses

The length of upper lip: the distance between the subnasale to the lower border of the upper lip

lip mobility = Upper lip length at rest – upper lip length at full smile

the raising of a palatal flap are principles to reduce recession of the interdental tissues by maintaining vascularity.⁶² Bone recontouring should extend to the tooth line angles, as insufficient recontouring is a common cause of relapse.³⁶ Mock-ups before the procedure and surgical guides during the operation should be utilised (Figure 5).¹² A final prosthesis may be fabricated after six months given that minimal vertical soft tissue changes are reported.⁶⁵

Treatment sequence

A 'gummy' smile is typically a characteristic of more than one factor.^{1,12,18} An accurate diagnosis is essential in order to provide effective treatment options (Table I), and the treatment sequence should be carefully considered. For example, in a case with both vertical maxillary excess and altered passive eruption, orthodontic treatment should be performed before periodontal surgery given that extrusion or intrusion of the teeth may alter the gingival level.¹⁹ Furthermore, aesthetic crown lengthening procedures should be performed prior to orthognathic surgery to establish a baseline reference for deciding how much gingival display requires surgical correction by impacting the maxilla.^{1,18,35} The basic principle is to display 2 mm of the incisal edge of the teeth at rest after orthognathic

surgery. Aesthetic crown lengthening procedures can be re-performed if a minimal amount of tissue rebounds.¹

Age is also a factor that should be considered before treatment. Children often exhibit crowns that appear short because the process of tissue migration apically is not yet complete. Maxillary anterior teeth complete their gingival migration by the age of 12, whereas lateral incisors complete their gingival migration by the age of 16.⁶⁶ Further studies have demonstrated that teenagers should wait until 18–20 years of age before any irreversible treatments are performed.^{53,67} Nevertheless, Robbins stated that altered passive eruption should be diagnosed when growth is complete.¹⁸ Moreover, muscles exhibit atrophy and elevator muscle activity decreases with increasing age.^{16,21} This phenomenon was substantiated in the study by Desai et al., which showed that no individuals older than 50 years exhibited high smiles and no subjects under the age of 19 exhibited low smiles. The maxillary incisor display upon smiling decreased and muscle ability to raise the upper lip was reduced by approximately 2 mm by 40 years of age.²¹ Considering this phenomenon, clinicians may treatment plan patients to exhibit 1–2 mm of gingiva upon a full dynamic smile as a youthful characteristic during the rehabilitation of smile aesthetics.

Conclusions

An excessive gingival display is a common aesthetic concern for many patients and a multifactorial problem for clinicians. The condition not only increases the difficulty of treatment but also increases the risk of an unacceptable aesthetic outcome. Potential causes may include lip length, incisal line, the proportions of the teeth, and the gingival level. The present article has reviewed the current literature and provides a simple guideline to analyse excessive gingival display. An extra-oral examination is the first important step to exclude skeletal deformity. An intraoral examination, including an assessment of lip length, incisal lines, tooth proportions and gingival lines, should be individually performed to identify the origin of a 'gummy' smile.

Combined therapies may be required in certain cases and may include orthognathic surgery, orthodontic treatment, lip repositioning, botulinum injection, and aesthetic crown lengthening. The treatment options as well as the treatment sequence require full consideration. A thorough investigation prior to treatment is highly desirable as maxillofacial surgeons, periodontists, orthodontists, prosthodontists, and aesthetic dentists need to integrate and work together as a multidisciplinary team. Using the proposed stepwise analysis, clinicians can picture possible aesthetic outcomes and make patients comprehend the benefits and side effects of each procedure in advance. Alternative treatments may be considered to optimise treatment outcomes and enhance patient comfort and satisfaction.

Conflict of interest

The authors report no professional or financial conflict of interest in relation to this paper. Patients provided permission for the publication of clinical data and photographs.

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