

Gummy smile and botulinum toxin: A new approach based on the gingival exposure area

Rosemarie Mazzuco, MD,^a and Dóris Hexsel, MD^b
Carazinho and Porto Alegre, Brazil

Background: Gummy smile (GS) is an aesthetic disorder for some patients, which can be corrected by injection of botulinum toxin.

Objective: We sought to classify GS according to the area of gingival exposure and the respective muscles involved in order to perfect the botulinum toxin injection technique for each patient.

Methods: Sixteen patients with GS were evaluated before receiving botulinum toxin injections. Based on the area of excessive gum displayed and identification of the muscles involved, 4 different types of GS were identified: anterior, posterior, mixed, and asymmetric. AbobotulinumtoxinA (Dysport, Ipsen Biopharm Limited, Wrexham, UK) was injected using a different injection technique for each type of GS, based on the main muscles involved. With the aid of two computer programs, the area of gum exposed was measured before and after the application of abobotulinumtoxinA, to evaluate the level of improvement.

Results: There was a decrease in the degree of gum display in all patients. The general average improvement achieved was 75.09%. Two patients showed slight adverse effects that were easily corrected with additional doses of abobotulinumtoxinA.

Limitations: For this study, there was no sample size calculation and no statistical analysis of the cases.

Conclusion: The authors conclude that it is important to identify the type of GS and therefore the main muscles involved, so that the correct injection technique can be used. AbobotulinumtoxinA was shown to be effective and safe for use in all types of GS in the present sample. (J Am Acad Dermatol 2010;63:1042-51.)

Key words: abobotulinumtoxinA; asymmetric smile; botulinum toxin; Dysport; gingival exposure; gummy smile.

Of all the human facial expressions, the smile is probably the most pleasing and the most complex in terms of meaning. Although it has long been the motive for artistic and philosophical debates, the smile, from an anatomic and physiologic standpoint, is the result of the exposure of the teeth and gums during the contraction of the muscle groups in the middle and lower thirds of the face.

The smile itself and the aesthetics of the smile are influenced by 3 components: teeth, gums, and

Abbreviations used:

BT:	botulinum toxin
DAO:	depressor anguli oris
GS:	gummy smile
LAO:	levator anguli oris
LLSAN:	levator labii superioris alaeque nasi
ZM:	zygomaticus major

lips.^{1,2} An attractive smile depends on the proper proportion and arrangement of these 3 elements.³ The upper lip should symmetrically expose up to 3 mm of the gum and the gum line must follow the contour of the upper lip.¹ The exposure of more than 3 mm of the gum during the smile is known as gingival or gummy smile (GS).

For some patients, GS represents an aesthetic disorder and therefore various correction methods are proposed, including gingivoplasty, orthodontic treatment, orthognathic surgery, and bone resection.¹ As they are highly complex procedures

From Private practice^a and Department of Dermatology, Pontifícia Universidade Católica do Rio Grande do Sul.^b

Funding sources: None.

Conflicts of interest: None declared.

Reprint requests: Rosemarie Mazzuco, MD, Avenida Pátria, 823/302, Carazinho — RS Brazil 99500-000. E-mail: rosemazzuco@hotmail.com.

0190-9622/\$36.00

© 2010 by the American Academy of Dermatology, Inc.

doi:10.1016/j.jaad.2010.02.053

involving moderate to severe morbidity, high cost, and considerable time, they have become less frequently recommended. By contrast, the use of botulinum toxin (BT) represents a simple, fast, and effective method for the aesthetic correction of GS.^{4,5}

This article describes a new classification of GS into anterior, posterior, mixed, or asymmetric, based on the excessive contraction of specific muscle groups (Fig 1), resulting in different areas of excessive gingival display, and a resultant new approach to the treatment of GS with BT.

METHODS

During a period of 20 months, 16 patients with GS were treated with applications of BT at a private practice. After the initial assessment, in which photographs were taken, we identified 4 different types of GS, based on the area of excessive gum displayed and identification of the main muscles involved (Table I):

(1) anterior GS, in which more than 3 mm of gum is exposed in the area between the canine teeth—involving the action of the levator labii superioris alaeque nasi (LLSAN) muscles (3 patients); (2) posterior GS, in which more than 3 mm of gum is exposed posterior to the canines, with normal exposure (<3 mm) in the anterior region—involving the action of the zygomatic muscles (7 patients); (3) mixed GS, with excessive gum exposure in both the anterior and posterior regions—involving the action of a combination of two or more of the above muscles (3 patients); and (4) asymmetric GS, with excessive or more apparent gum exposure on one side—caused by asymmetric contraction of the LLSAN or zygomatic muscles (3 patients).

All patients were referred for treatment with BT and none had contraindications to the use of the BT such as pregnancy, neuromuscular diseases, or use of specific medications.⁶ All the patients had visited dentists and reported not having received any indication for surgical treatment and claimed they were unwilling to undergo such a treatment modality.

The brand of BT used was abobotulinumtoxinA (Dysport, Ipsen Biopharm Limited, Wrexham, UK), 500 IU per vial, diluted in 2 mL of 0.9% sodium chloride solution, immediately before injections, following the recommended guidelines on dilution and

storage.⁷ The dose equivalence adopted by the current authors is 2.5:1 IU between abobotulinumtoxinA and onabotulinumtoxinA (Botox, Allergan, Irvine, CA), which is supported in the literature.⁸ Before the injections, the patients received topical anesthesia with a cream containing lidocaine and prilocaine. For the injections, 0.3 mL syringes were used with a 31-gauge, 8-mm needle, and the abobotulinumtoxinA was injected into the subcutaneous tissue.

The 3 patients with anterior GS (group I) received injections of abobotulinumtoxinA in accordance with the conventional technique, at doses of 2.5 or 5 IU (depending on the degree of gum exposure) on each side of the nasolabial fold, 1 cm lateral and below the nasal ala,⁹ to relax the LLSAN muscle (Fig 2).

The 7 patients with posterior GS (group II) received injections of abobotulinumtoxinA into two points in the malar region, following a lateral and superior path

(corresponding to the path of the zygomaticus major [ZM] and zygomaticus minor muscles, as described below): the first point was located in nasolabial fold, at the point of greatest lateral contraction during the smile and the other point was 2 cm lateral to the first point, at the level of the tragus. At each point, 2.5 IU of abobotulinumtoxinA was injected (Fig 3).

The 3 patients with mixed GS (group III) received injections of abobotulinumtoxinA at all the points described above, but the dose was reduced 50% at the point near the nasal ala (Fig 4).

In the 3 patients with asymmetric GS (group IV), abobotulinumtoxinA was injected, at the same dose, into the two points in the malar region described above, on the side with greater posterior gum exposure. AbobotulinumtoxinA was also injected into the contralateral side, but only at the lowest point (Fig 5). This means that these patients received injections of abobotulinumtoxinA with a different technique and dose on each side of the face.

The patients were advised not to lie down, do exercise, or massage the treated area during the first 4 hours after the procedure.

Twenty to thirty days after receiving the injections, the patients returned for a follow-up visit. The results were analyzed by means of clinical examination and photography. The extent of gum exposure was

CAPSULE SUMMARY

- Gummy smile is an aesthetic disorder that can be corrected by botulinum toxin.
- Usual techniques for its correction have only involved the levator labii superioris alaeque nasi muscle.
- The current authors classify the gummy smile into 4 types and describe the technical details to correct each one based on the muscular involvement.
- They conclude that excessive gingival exposure may be anterior, posterior, mixed, or asymmetric and each one has variable degree of involvement of different muscles.

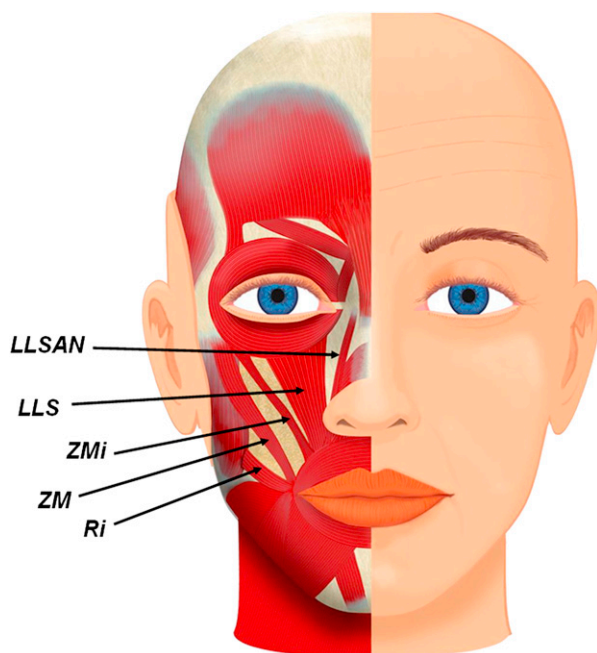


Fig 1. Main muscles involved in gingival exposure: levator labii superioris alaeque nasi (*LLSAN*), levator labii superioris (*LLS*), zygomaticus minor (*ZMi*), zygomaticus major (*ZM*), and risorius (*Ri*).

measured before and after treatment with abobotulinumtoxinA, using two computer programs (AutoCAD, Autodesk Inc, San Rafael, CA; and Mirror, Version 6.1, Canfield, Fairfield, NJ). The distance between the lower edge of the upper lip and the edge of the gum were measured in the following regions: above the central incisors in groups I and III, and above the first premolars in groups II and IV, whereas in the latter, measurements were only taken on the side affected by GS. The difference in the measurements of the above parameters, pretreatment and posttreatment, was expressed as a percentage of improvement in the reduction of gum exposure. To avoid variations in the size or the angle of the photographs, a control measurement of the central incisors and premolar teeth was taken as a parameter in the preprocedure and postprocedure. Measurements of gum exposure were only considered when the control measurement was exactly the same in the before and after photographs (Fig 6).

RESULTS

There was a decrease in the degree of gum display in all patients (Figs 7 to 10). Table II shows the type of GS and the percentage of decrease in gingival exposure before and after application of abobotulinumtoxinA in all patients in this sample. The average improvement achieved in all 16 patients

was 75.09% and the average improvement in each group is shown in Table III. All the patients also had some degree of improvement to the nasolabial fold.

Adverse effects were mild and transient. One patient in group II presented a slightly asymmetric smile that was treated in the follow-up visit with the application of an additional 2.5 IU of abobotulinumtoxinA into the nasolabial fold, on the side where the gum exposure was greatest. Another patient in group II reported difficulty in smiling, and the clinical examination showed slight lowering of the angles of the mouth ("sad smile"), as a result of hyperactivity on the depressor anguli oris (DAO) muscles (Fig 11). This adverse effect was successfully treated by injecting 5 IU of abobotulinumtoxinA into these muscles. No patient in this study reported any other side effects, such as difficulties in moving the lips while speaking or eating.

The duration of the effect of abobotulinumtoxinA varied from 3 to 5 months, and with the exception of the two patients who had adverse effects, the other patients were reasonably satisfied.

DISCUSSION

Since the discovery of the cosmetic use of BT,¹⁰ it has been rapidly incorporated into the arsenal of effective treatments for the improvement of unaesthetic facial conditions. During the more than two decades that BT has been used for cosmetic purposes, several new indications have been found and application techniques are being constantly refined.

In addition to being the first-choice treatment for wrinkles located on the upper third of the face, BT is also widely used in the prevention and correction of changes caused by muscle contraction in the middle and lower thirds of the face and neck,¹¹ including GS.¹²

Goldstein¹³ classified the smile line (consisting of the lower edge of the upper lip during the smile) according to the degree of exposure of the teeth and gums into 3 types: high, medium, or low. The first is characterized by the exposure of more than 3 mm of gum during the smile, which clinically translates as GS. Tjan et al¹⁴ reported gender differences in the smile line. In men, the authors report that the low smile line is predominant (2.5:1), whereas high smile lines are predominant in women (2:1). Perhaps, for this reason, GS is a more common occurrence in women.

Various causes have been described for GS, including lip length, clinical crown length,¹⁵ and mainly altered passive eruption or vertical maxillary excess.¹ On the other hand, the behavior of perioral muscles critically influences the structure of the

Table 1. Classification of gummy smile based on area of gingival exposure

Type of GS	No. of patients	Clinical appearance	Main muscles involved
Anterior	3	Major gum exposure (>3 mm) in area between canine teeth	LLSAN
Posterior	7	Major gum exposure (>3 mm) posterior to canines, with normal exposure (<3 mm) in anterior region	ZM and ZMi
Mixed	3	Excessive gum exposure in both areas (anterior and posterior)	LLSAN, ZM, and ZMi (combination of ≥ 2)
Asymmetric	3	Excessive or more apparent gum exposure on one side only	LLSAN and/or ZM/ZMi ipsilateral

GS, Gummy smile; LLSAN, levator labii superioris alaeque nasi; ZM, zygomaticus major; ZMi, zygomaticus minor.



Fig 2. Patient with anterior gummy smile, showing points and dose used to correct it with botulinum toxin.

smile¹⁶ and, according to Peck et al,¹⁷ patients with GS had at least 20% greater facial muscular capacity to raise the upper lip when smiling. Such cases constitute an indication for treatment with BT, which should be considered during the initial assessment of the patient. Other factors that make BT a first-line therapy for this condition are: the ease and safety of the applications, the use of small affordable doses, and the fast onset of action, low risk, and reversible effect of BT. This last factor is particularly interesting for cases in which orthodontic or surgical procedure are recommended or planned, but for which BT will provide a quick cosmetic benefit to the patient who intends to undergo a later more invasive procedure.

GS has always been regarded as the excessive exposure of the anterior gum, because most authors consider the LLSAN muscle to be mainly responsible for GS.¹⁸⁻²⁰ The LLSAN muscle originates in the frontal process of the maxilla and divides into two fascicles that insert into the cartilage and skin of the nasal ala and upper lip. Its function is to dilate the nostrils and raise the upper lip. The BT-based techniques for the correction of GS published to date

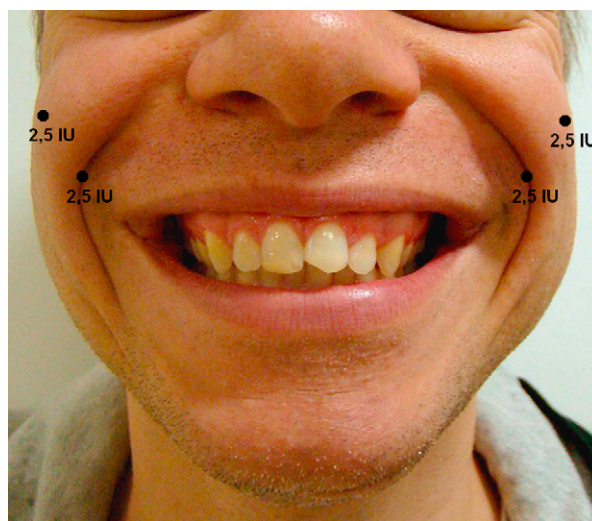


Fig 3. Patient with posterior gummy smile, and newly described points and dose used to correct it.

have only involved the LLSAN muscle. However, all the muscles functionally involved in raising the upper lip have a role in tooth and gum display during smiling: LLSAN, levator labii superioris, ZM, zygomaticus minor, levator anguli oris (LAO), orbicularis oris, and risorius²¹ (Fig 1). A therapeutic approach in which the LLSAN muscle alone is treated with BT may be insufficient when other muscles are involved in the excessive exposure, both anterior and posterior, of the gums. Moreover, in the case of posterior GS, the zygomatic muscles are more functionally involved than the other muscles of the upper lip lift complex, and the conventional application of BT to relax the LLSAN muscle would cause unnecessary lowering of the lip in the medial region, an undesirable result from the aesthetic and functional standpoint.

The ZM muscle originates from the upper lateral surface of the zygomatic bone²² and inserts into the skin at the angle of the corner of the mouth²³ and zygomaticus minor muscle originates from the lower

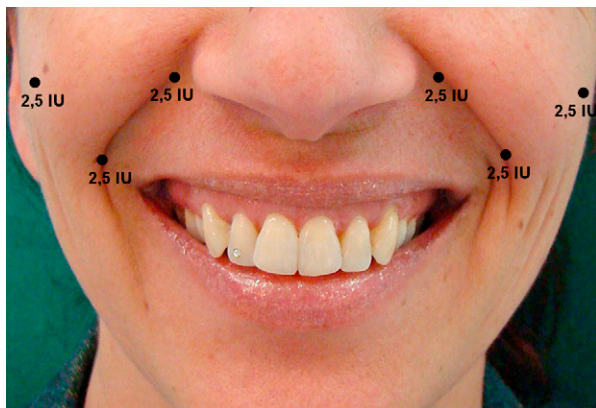


Fig 4. Patient with mixed gummy smile, and respective correction points and dose.

surface of the zygomatic bone and inserts into the lateral part of the upper lip.²⁴ Both follow a path perpendicular in the face. Their contraction causes elevation and lateralization of the lateral portion of the upper lip. This movement is not only essential for the smile, it is also important for speech and chewing and therefore excessive relaxation or paralysis of these muscles has serious cosmetic and functional repercussions. Hence, caution should be taken when injecting these muscles and the doses used should be small.

Other muscles that deserve attention are the LAO and DAO. In normal situations, the effect of the latter (depression of the commissures) antagonizes the effect of the former (elevation of the commissures). The fibers of the LAO muscle, in turn, intersect with those of ZM muscle²⁵ and, for this reason, the LAO muscles also usually become relaxed when BT is injected to fix posterior GS, which can cause a collapse of the commissure, especially in patients with hyperactivity of the DAO muscles. Clinically, this collapse of the commissure gives the mouth a sad appearance when the patient smiles, which was observed in one patient in this sample. When such DAO muscle hyperactivity is apparent before the BT injection for the correction of GS, it can be treated together with the other muscles, during the same treatment session.

Polo²⁶ attempted multiple serial injections into each elevator muscle, with variable doses ranging from 0.625 to 2.5 IU of onabotulinumtoxinA at different phases, under electromyographic guidance. Kane¹⁹ treated excessive gingival display by improving the nasolabial fold, targeting the LLSAN muscle with 5 IU of onabotulinumtoxinA per side. In Kane's¹⁹ article, the initial dose injected was 1 IU, and the subsequent dose was determined according to clinical response during the follow-up visit, 2 to 3

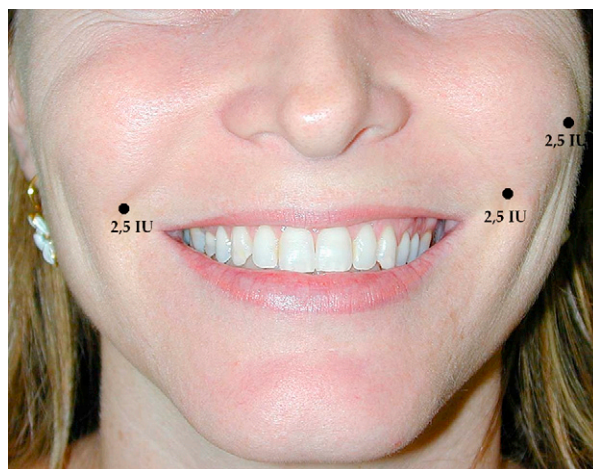


Fig 5. Patient with asymmetric gummy smile and points used to correct it. Note asymmetric dosage.

weeks later. This is a good and cautious approach that helps to prevent undesirable side effects related to excessive doses or excessive potency of the selected dose for a specific patient. Garcia and Fulton²⁰ suggested that 2 to 5 IU of onabotulinumtoxinA was as effective as higher doses. As the injected dose of BT is directly proportional to the intensity and duration of the paralysis, small doses result in slight and partial relaxation of the musculature,¹¹ a desired effect when it comes to the middle third of the face, where all the muscles have an important role in, or relationship with, facial expression.¹⁸ The current authors consider a dose of 2.5 or 5 IU of abobotulinumtoxinA (as was used in the patients in this sample), when applied using the conventional technique, as sufficient to correct anterior GS, without risk of complications. They also suggest that the dose of abobotulinumtoxinA injected into each point should not be greater than 2.5 IU, with a total of two points positioned along the path of the zygomatic muscles, as previously described as safe and effective for correction of posterior GS.

As is well known, all the BT spread in a halo of 1 to 2 cm around the injection point. The diameter of the halo depends mainly on the dilution used and the depth of injection. On the face, where there are several small, operationally sensitive muscles arranged very closely together, the diffusion of BT tends to partially relax the muscles in close proximity to those being treated. Therefore, during the correction of GS, in addition to the muscles listed above, the other muscles of upper lip elevator complex may be relaxed by the BT. In addition, the nasolabial fold may be improved after the injection of BT for the correction of any type of

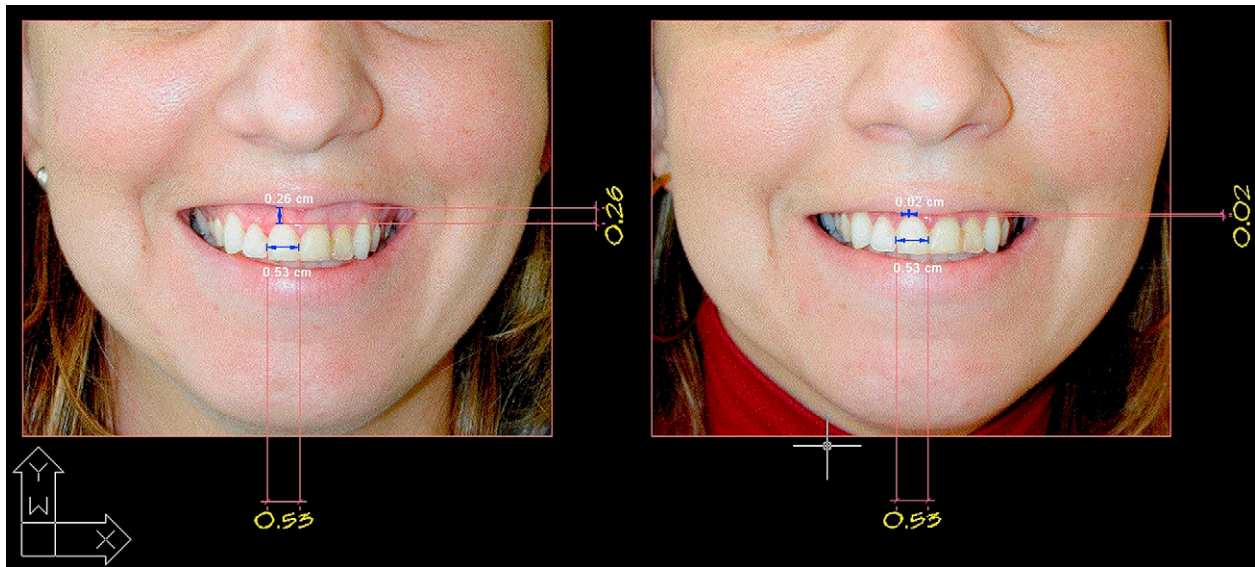


Fig 6. Control measurement of central incisor teeth to ensure that pretreatment and posttreatment photographs were same size and taken from same angle. Horizontal numbers on white are from Mirror program (Canfield, Fairfield, NJ) and on yellow are from AutoCAD program (Autodesk Inc, San Rafael, CA). Vertical yellow numbers are measurements of gingival exposure.

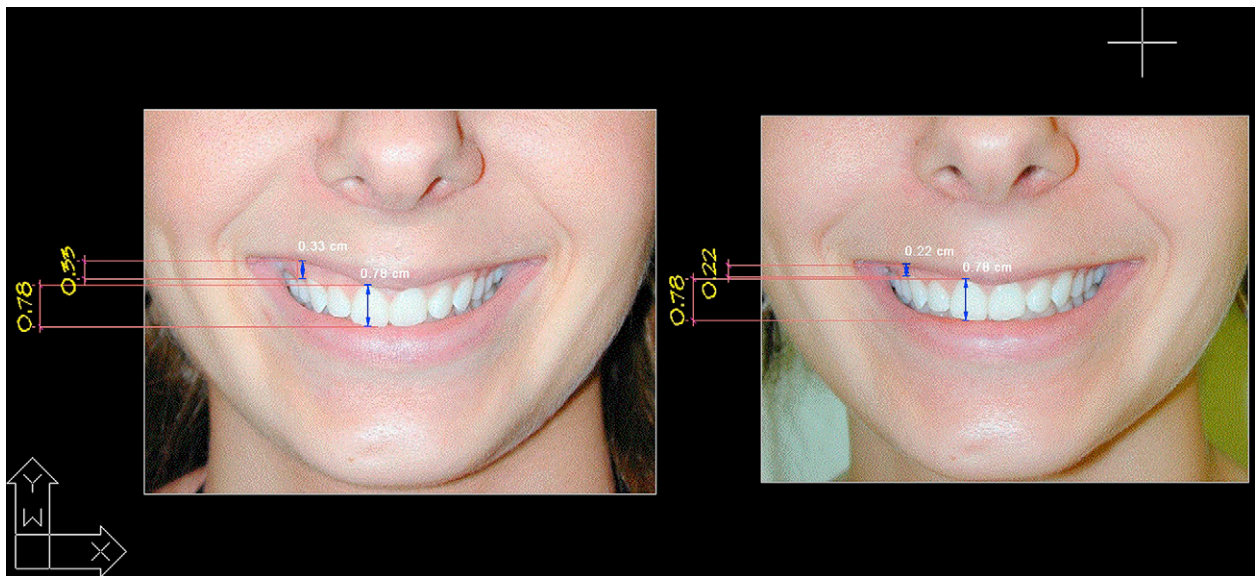


Fig 7. Patient with posterior gummy smile, before and after botulinum toxin treatment.

GS, an effect seen in all of the patients in this sample.

The general rules for the use of BT (eg, contraindications, dilution technique, patient position) remain the same for this indication.^{18,27} However, for many years, lower dilutions have been recommended when there is a need to inject BT into small, functionally sensitive areas of muscle,²⁸ which is a recommendation that is supported by the current authors.

In cases involving asymmetry caused by muscle contraction, bilateral injection of BT is recommended, with a higher dose on the hyperkinetic side. This detail avoids reverse asymmetry with imbalance as a result of muscle contraction on the untreated side. In the correction of asymmetric GS, patients in this sample were injected on both sides, with a small dose of abobotulinumtoxinA being injected into one point on the side with the least gum exposure. An exception to this recommendation should be made



Fig 8. Patient with posterior gummy smile, before and after botulinum toxin treatment.

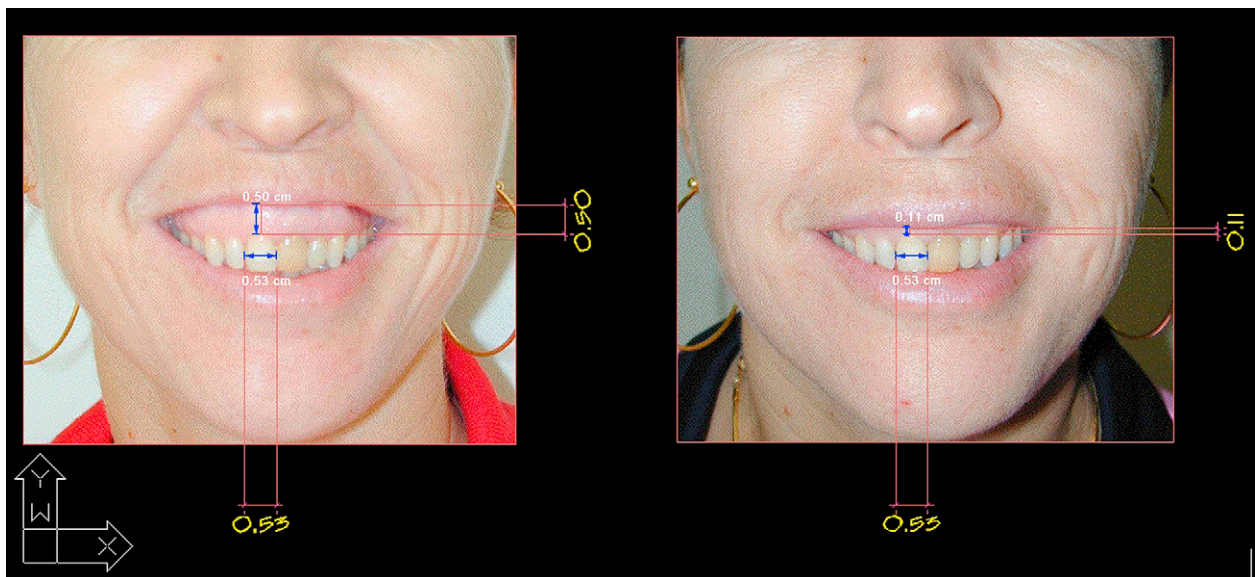


Fig 9. Patient with mixed gummy smile, before and after botulinum toxin treatment.

when the asymmetry of the smile is a result of facial paralysis, in which case it is recommended that BT is injected only into the hyperkinetic side.

When there is a need to treat muscle groups with synergistic effect in relation to the lip movement, the doses injected in each muscle should be lower than those conventionally recommended, because of the risk of an accumulative relaxation effect and the resulting complications. The authors recommend that the doses of BT are reduced by 50% when several synergistic muscles are treated, as described in the technique for the correction of mixed GS.

As a result of muscle weakness, skin flaccidity, and other alterations associated with aging, people older than 60 years may respond disproportionately to the usual doses of BT. It is therefore recommended that all patients receive individualized doses, and if there is any doubt, lower doses should be used, with later retouching being performed if necessary.

In a significant number of patients, there is reduced gum exposure after several applications of BT, even when the effect of this has declined. This fact is explained by the decrease in muscle strength



Fig 10. Patient with asymmetric gummy smile, secondary to facial paralysis, before and after botulinum toxin treatment only in hyperkinetic side.

Table II. Type of gummy smile and improvement of gingival exposure in each patient

Patient	Type of GS	Improvement of gingival exposure (%)
1	Posterior	33.33
2	Anterior	100
3	Asymmetric	100
4	Mixed	78
5	Mixed	92.3
6	Posterior	71
7	Asymmetric	15.8
8	Posterior	57.1
9	Anterior	88
10	Posterior	45.5
11	Posterior	62.8
12	Posterior	75.9
13	Anterior	100
14	Mixed	100
15	Asymmetric	100
16	Posterior	81.8

GS, Gummy smile.

that is likely to occur after several consecutive applications of BT for any indication, which produces long-term muscle relaxation. It is important that the physician identify such cases, in later applications, and reduce the dose to avoid an exaggerated effect.

The adverse events most commonly reported after application of BT to fix GS are ptosis or stretching of the upper lip (“joker-like” smile), asymmetric smile,¹⁸ and difficulty smiling or chewing. These

Table III. Average improvement of gingival exposure in each type of gummy smile

Type of GS	Average improvement (%)
Anterior	96
Posterior	61.06
Mixed	90.1
Asymmetric	71.93

GS, Gummy smile.

effects are usually caused by excessive doses of BT or poor technique, such as injections into the wrong sites.

Some articles suggest there is greater risk of adverse effects when using abobotulinumtoxinA, compared with onabotulinumtoxinA this can be explained by the inadequate dose equivalence suggested and used by some authors.^{29,30} The current authors have accumulated considerable experience with the two BTs mentioned in this article, abobotulinumtoxinA and onabotulinumtoxinA, and have found no evidence of any higher incidence of adverse effects in one or the other. However, they emphasize that the safety of BT used for cosmetic purposes is directly influenced by the choice of the appropriate dose and technique and the correct dose equivalence, which more recent articles suggest to be less than 3:1.^{8,31} In all indications involving the middle and lower thirds of the face, the injection should be made by an experienced physician³² with good anatomic and physiologic knowledge of the facial musculature.³³



Fig 11. “Sad smile,” adverse effect of correction of posterior gummy smile with botulinum toxin (BT). This undesirable effect was treated by injecting BT into depressor anguli oris muscles.

Some patients should undergo orthognathic evaluation, to define the cause and the most suitable type of definitive procedure for the correction of GS,¹⁶ because in some cases, this is a sign of more serious alterations that may have more serious effects with long-term repercussions on the maxillofacial physiology.

Electromyography can be useful, especially when asymmetry occurs after the first application of the toxin and in the treatment of small muscles or abnormal location.^{34,35} The current authors do not routinely use electromyography.

Conclusion

The authors conclude that in the cosmetic correction of GS by BT, it is important to identify the type of smile and therefore the main muscles involved, so that the correct injection technique can be used.

Furthermore, they conclude that the use of BT for the treatment of GS can be considered remedial (when the cause of GS is exclusively muscular), adjuvant (when there is an association of causes and indication of additional treatments such as lip augmentation or orthodontic devices), or palliative (when definitive surgical treatment is recommended).

AbobotulinumtoxinA is effective and safe for use in the middle third of the face when the dose, the correct injection points, and the appropriate dose equivalent to onabotulinumtoxinA is respected. Clinical trials with more patients would be useful to corroborate the results presented in this article.

REFERENCES

- Garber DA, Salama MA. The aesthetic smile: diagnosis and treatment. *Periodontol* 2000 1996;11:18-28.
- Gill DS, Naini FB, Tredwin CJ. Smile aesthetics. *SADJ* 2008; 63(270):272-5.
- Davis NC. Smile design. *Dent Clin North Am* 2007;51:299-318.
- Polo M. Botulinum toxin type A (Botox) for the neuromuscular correction of excessive gingival display on smiling (gummy smile). *Am J Orthod Dentofacial Orthop* 2008;133:195-203.
- Carruthers A, Carruthers J. Cosmetic uses of botulinum A exotoxin. In: Klein AW, editor. *Tissue augmentation in clinical practice: procedures and techniques*. New York: Marcel Dekker; 1998. pp. 207-36.
- Carruthers A, Carruthers JDA. Botulinum toxin in the treatment of glabellar frown lines and other facial wrinkles. In: Jankovic J, Hallett M, editors. *Therapy with botulinum toxin*. New York: Marcel Dekker; 1994. pp. 577-95.
- Klein AW. Dilution and storage of botulinum toxin. *Dermatol Surg* 1998;24:1179-80.
- Karsai S, Raulin C. Current evidence on the unit equivalence of different botulinum neurotoxin A formulations and recommendations for clinical practice in dermatology. *Dermatol Surg* 2009;35:1-8.
- Coscarelli J. Gingival smile. In: Hexsel D, Almeida AT, editors. *Cosmetic use of botulinum toxin*. Porto Alegre (Brazil): AGE; 2002. pp. 199-200.
- Carruthers JDA, Carruthers JA. Treatment of glabellar frown lines with C. botulinum-A exotoxin. *J Dermatol Surg Oncol* 1992;18:17-21.
- Hexsel D, Mazzuco R, Dal'Forno TO, Hexsel CL. Aplicações não-clássicas da toxina botulínica. In: Kede MPV, Sabatovich O, editors. *Dermatologia Estética*. Rio de Janeiro: Atheneu; 2003. pp. 573-80.
- Carruthers J, Carruthers A. Botox treatment for expressive facial lines and wrinkles. *Curr Opin Otolaryngol Head Neck Surg* 2000;8:357-61.
- Goldstein RE, editor. *Esthetics in dentistry*. Philadelphia: JB Lippincott Co; 1976.
- Tjan AH, Miller GD, The JG. Some esthetic factors in a smile. *J Prosthet Dent* 1984;51:24-8.

15. Robbins JW. Differential diagnosis and treatment of excess gingival display. *Pract Periodontics Aesthet Dent* 1999;11:265-72.
16. Hwang WS, Hur MS, Hu KS, Song WC, Koh KS, Baik HS, et al. Surface anatomy of the lip elevator muscles for the treatment of gummy smile using botulinum toxin. *Angle Orthod* 2009;79:70-7.
17. Peck S, Peck L, Kataja M. The gingival smile line. *Angle Orthod* 1992;62:91-100.
18. Carruthers J, Carruthers A. Aesthetic botulinum A toxin in the mid and lower face and neck. *Dermatol Surg* 2003;29:468-76.
19. Kane MA. The effect of botulinum toxin injections on the nasolabial fold. *Plast Reconstr Surg* 2003;112:66S-72S.
20. Garcia A, Fulton JE Jr. Cosmetic denervation of the muscles of facial expression with botulinum toxin: a dose-response study. *Dermatol Surg* 1996;22:39-43.
21. Greenway HT, Breisch EA. Superficial cutaneous anatomy. In: Robinson JK, Arndt KA, LeBoit PE, Wintroub BU, editors. *Atlas of cutaneous surgery*. Philadelphia: WB Saunders; 1996. pp. 5-20.
22. Spiegel JH, DeRosa J. The anatomical relationship between the orbicularis oculi muscle and the levator labii superioris and zygomaticus muscle complexes. *Plast Reconstr Surg* 2005;116:1937-42.
23. Shim KS, Hu KS, Kwak HH, Youn KH, Koh KS, Fontaine C, et al. An anatomical study of the insertion of the zygomaticus major muscle in humans focused on the muscle arrangement at the corner of the mouth. *Plast Reconstr Surg* 2008;121:466-73.
24. Gest TR, Schlesinger J, editors. *MedCharts anatomy*. New York: ILOC Inc; 1995.
25. Ewart CJ, Jaworski NB, Rekito AJ, Gamboa MG. Levator anguli oris: a cadaver study implicating its role in perioral rejuvenation. *Ann Plast Surg* 2005;54:260-3.
26. Polo M. Botulinum toxin type A in the treatment of excessive gingival display. *Am J Orthod Dentofacial Orthop* 2005;127:214-8.
27. Markey AC. Botulinum A exotoxin in cosmetic dermatology. *Clin Exp Dermatol* 2000;25:173-5.
28. Mazzucco R. Perioral wrinkles. In: Hexsel D, Almeida AT, editors. *Cosmetic use of botulinum toxin*. Porto Alegre (Brazil): AGE Editora; 2002. pp. 158-63.
29. Simonetta MM, Cauhepe C, Magues JP, Senard JM. A double-blind, randomized, comparative study of Dysport vs Botox in primary palmar hyperhidrosis. *Br J Dermatol* 2003;149:1041-5.
30. Lew H, Yun YS, Lee SY, Kim SJ. Effect of botulinum toxin A on facial wrinkle lines in Koreans. *Ophthalmologica* 2002;216:50-4.
31. Wohlfarth K, Schwandt I, Wegner F, Jürgens T, Gelbrich G, Wagner A, et al. Biological activity of two botulinum toxin type A complexes (Dysport and Botox) in volunteers: a double-blind, randomized, dose-ranging study. *J Neurol* 2008;255:1932-9.
32. Kane MA. The functional anatomy of the lower face as it applies to rejuvenation via chemodenervation. *Facial Plast Surg* 2005;21:55-64.
33. Gassia V, Beylot C, Béchaux S, Michaud T. Botulinum toxin injection techniques in the lower third and middle of the face, the neck and the décolleté: the "Nefertiti lift." *Ann Dermatol Venereol* 2009;136:S111-8.
34. Khawaja HA, Hernandez-Perez E. Botox in dermatology. *Int J Dermatol* 2001;40:311-7.
35. Klein AW, Mantell A. Electromyographic guidance in injecting botulinum toxin. *Dermatol Surg* 1998;24:1184-6.