J. Maxillofac. Oral Surg. (Jan–Mar 2022) 21(1):51–57
https://doi.org/10.1007/s12663-021-01541-0

CLINICAL PAPER

Botulinum Toxin-A in the Treatment of Excessive Gingival Display: A Clinical Study

B. Anton Tyrone Soris[1] · K. Vandana Shenoy[1] · Ashok Ramadorai[1] · C. S. C. Satish Kumar[1] · Laavanya Marimuthu[1]

Received: 13 June 2020 / Accepted: 23 February 2021 / Published online: 15 March 2021
© The Association of Oral and Maxillofacial Surgeons of India 2021

Abstract
Purpose The aim of this study was to elucidate the efficiency of BTX-A injections as an alternative approach in patients with excessive gingival display and to observe the patient's satisfaction in order to obtain cosmetically promising results.
Materials and Methods Fifteen patients of whom ten female and five male with different types of gummy smiles such as anterior (53%), posterior (7%) and mixed (40%) reported to the Department of Oral and Maxillofacial Surgery at Thai Moogambigai Dental College and Hospital, Chennai, Tamil Nadu from December 2018 to October 2019 those who were willing to undergo corrections using Botulinum Toxin Type A (BTX-A) were selected for the present study using various inclusion and exclusion criteria. The patients were injected with BTX-A on Yonsei triangle accordingly. The clinical evaluation and patient satisfaction evaluation were carried out.
Results A significant decrease in the gingival exposure of about 3.5 ± 1 mm at 2 weeks after injection was observed and it lasted for 4 months. It was also noted that there was no difference in the measurement of gingival display on maximum smile for postinjection during 5th and 6th month when compared with preinjection measurements. This study confirms that the efficacy of BTX A injection lasted for 4 months and then gradually reduced resulting in reversal of gingival display during maximum smile.
Conclusion The authors conclude that in the cosmetic correction of gummy smile by BTX-A, it is important to identify the type of smile and the main muscles involved, so that the correct injection technique can be used. It also confirms that BTX-A is a novel, competent, risk-free and minimally invasive nonsurgical therapy that can extensively improve smile aesthetics.

Keywords BTX-A · Gummy smile · Yonsei triangle · Nonsurgical therapy

Introduction

Smiles are a well-recognized facial signature that plays a crucial role in expression of joy and positive emotion of a person. Smile is regarded as a significant part of any facial aesthetic surgeries. Excessive gingival display, generally known as 'gummy smile' or 'high smile line', is a condition distinguished by the exposure of gingiva in excess during smile. In recent times, this has received increased prominence in the cosmetic literature. As a result, people with excessive gingival display will be self-conscious or embarrassed regarding the same. They get psychologically affected and thus seek treatment [1].

The management of gummy smile includes Lefort I osteotomy, crown lengthening procedures, maxillary incisor intrusions, microimplants, headgears, self-curing

✉ B. Anton Tyrone Soris
tyron93anton@gmail.com

K. Vandana Shenoy
drvandanashenoy@yahoo.com

Ashok Ramadorai
ashokramadorai@gmail.com

C. S. C. Satish Kumar
cscdentalcare@gmail.com

Laavanya Marimuthu
dr.m.laavanyaomfs@gmail.com

[1] Department of Oral and Maxillofacial Surgery, Thai Moogambigai Dental College and Hospital, Chennai, Tamil Nadu, India

silicone implant with myectomy and partial resection of levator labii superioris with muscle repositioning have been described using a wide range of surgical and non-surgical approaches. Nonetheless, these techniques do not assist the reduction of muscle hyperactivity permanently as it has more tendency to relapse and hence, nonsurgical alternative treatment may be a desirable choice [2].

Botulinum toxin is the first bacterial toxin used in the treatment of excessive muscle contraction or pain since three decades. The anaerobic bacterium, *Clostridium botulinum*, is responsible for its production. The scientific applications of botulinum toxin are increasing for both cosmetic and therapeutic uses as it has become a versatile drug in various medical fields over three decades. Botulinum Type A (BTX-A) is the most powerful and frequently used clinically among the 8 different serotypes of Botulinum toxins that exist. BTX-A has been used and showed promising results in the treatment of strabismus, cervical dystonia, blepharospasm and hemifacial spasm, hyperfunctional larynx, juvenile cerebral palsy, spasticity, pain and headache, occupational dystonia and writer's cramp, temporomandibular disorders, myofacial pain, and oromandibular dystonia and bruxism. In recent times, BTX-A has emerged as an efficient, minimally invasive tool to combat gummy smile for patients with hyperfunctional upper lip [3].

With this view point, the aim of this study was to determine the efficacy of BTX-A injections as an alternative approach in patients with excessive gingival display and to observe the patient's satisfaction in order to obtain cosmetically promising results.

Materials and Methods

Case

Fifteen patients with excessive gingival display reported to the Department of Oral and Maxillofacial Surgery at Thai Moogambigai Dental College and Hospital, Chennai, Tamil Nadu from December 2018 to October 2019 who were willing to undergo corrections using Botulinum Toxin Type A (BTX-A) were selected and explained about the procedure, the possible complications and adverse effects for the study using the following inclusion and exclusion criteria:

Inclusion Criteria

Patients aged between 18–40 years, patients with hyperactive lip elevating muscle and gingival exposure more than 2 mm**,** patients with either anterior, posterior or mixed gummy smile, patient undergoing orthodontic treatment for vertical maxillary excess, hyperactive lip with gummy smile, patients who are not willing for orthoganthic surgery or any surgical corrections and patients who agreed to comply with the requirements of the study.

Exclusion Criteria

Patients who were allergic to the composition of BTX-A, previous history of Botox® injections in head and neck region, patients with short upper lip, neuromuscular disorders, on medications like aminoglycosides, quinine, penicillamine and calcium channel blockers that would interfere with the neuromuscular function, pregnant and lactating mothers, psychologically unstable patients or those who had unrealistic goal and expectations.

The armamentarium used for the study is sterile patient's gown, sterile masks and head caps, sterile gloves, EMLA cream, marker, 1 mL insulin syringes(40 IU) with 30 gauge fine needles, normal saline or distilled water, Botulinum toxin Type-A (Botox® Allergan) and digital reflex camera.

As this study involved human subjects, the guidelines laid down in the declaration of Helsinki were adhered to. This study was approved by Institutional Review Board, Thai Moogambigai Dental College and Hospital, Chennai and a signed an informed consent was obtained from all patients. In order to avoid bias, the same surgeon performed the procedure (Ref: Dr. MGRDU/TMDCH/2017-18/0112201702).

Composition and Preparation of BTX-A Injections

The main composition of Botox® 100 units vial used in this study includes *Clostridium botulinum* type A neurotoxin, 0.5 mg of Human Albumin and 0.9 mg of sodium chloride. This was diluted with 2.5 ml of 0.9% sodium chloride solution, therefore each 0.1 ml of Botox injection has 4 units**.**

Methods of Injecting BTX-A

An anesthetic cream was applied half an hour prior to injections. The sites of injection were prepared with betadine antiseptic solution followed by local application of ice. The marking was done to locate the hyperactive muscle that produces gummy smile such as, the Levator labii superioris alaque nasi, the zygomaticus minor and zygomaticus major muscles. The site of injection was marked with an ordinary eye pencil. Three points were marked, Point 1—Lateral point of ala of nose; Point 2—Midpoints of nasolabial fold between ala and commissure and Point 3—Maxillary point located at one-quarter distance between ala and tragus. Circles with a radius of 1 cm

from each point and from the center of the triangle (Yonsei point) (Fig. 1) were drawn and it represent effective range of Botulinum toxin [13]. The frequency of overlapping with each muscle vector and the circular area from each landmark were counted under the assumption that a single injection of Botox® at that point should affect all three muscles. Direct injection technique was used in our study to inject Botox®, in which the needle was inserted perpendicular to the skin. The BTX-A was injected into the target muscle. In the present study, for anterior gummy smile and mixed gummy smile cases, total three injection sites, two injections were given bilaterally on the Yonsei triangle and one injection on philtrum of upper lip were selected. For posterior gummy smile, the injection site is 1 cm lateral to Yonsei triangle. Patients were injected 4 units on Yonsei triangle on either side followed by 2 units of Botox® injected into the philtrum of upper lip.

Method of Evaluation and Its Criteria

The evaluation was performed in two parts, namely *Clinical evaluation*: using maximal gingival display on the standardized photographs taken during different time intervals like 3rd, 7th and 15th day, 1st, 2nd, 3rd, 4th, 5th and 6th month follow-up period and *Patient Satisfaction Evaluation* using questionnaire answered by the patients involved in the study after 30 days post-injection.

Clinical evaluation was done by assessing and classifying the patients as anterior gummy smile, posterior gummy smile, mixed gummy smile and asymmetrical gummy smile. Before injections all the patients underwent a standardized photographic session, photos were obtained using CANON 1300D 18MP, 18–55 mm ISII Lens Digital SLR camera. Facial photos and close-up perioral photos were taken at a distance of 4 feet from the subject prior to injection and postinjection on 3rd, 7th, 15th day and every month till 6 months period as a follow-up. Preinjection gingival display on maximal smile of the patients were measured from the crest of the gingiva to the lower most border of the upper lip (Fig. 2).



Fig. 1 Points forming Yonsei triangle

Statistical Analysis

For this investigation's analytical purpose, paired student's t test was used with the "Software Statistical Package for Social Sciences, IBM Corporation, SPSS Inc., Chicago, IL, USA version 20" software package (SPSS).

Results

In the present study, clinical evaluation using maximal gingival display and patient satisfaction evaluation using a questionnaire after 30 days post-injection were done (Fig. 3). Fifteen patients of whom ten female and five male with different types of gummy smiles such as anterior (53%), posterior (7%) and mixed (40%) were selected (Fig. 4a). The measurement of gingival display during maximum smile at the time of preinjection and postinjection at regular intervals on 3rd, 7th, 15th day, 1st month and reviewed for 6 months.

In this study, the mean value of gingival display on maximum smile prior to injection was 7.07 ± 1.280 mm, while the mean value for the 3rd day postinjection was 6.20 ± 1.320 mm. The mean difference between these two groups was 0.867 mm which was not statistically significant ($p = 0.000$).On day 7 and 15 postinjection the mean value was 5.07 ± 0.961 mm and 3.40 ± 1.056 mm, respectively. A significant mean difference between these groups was 2 mm and 3.667 mm was observe ($p = 0.000$). The mean value for the 1st and 2nd month postinjection was 3.07 ± 1.033 mm with a significant difference of 4 mm between them ($p = 0.000$). 3rd month postinjection

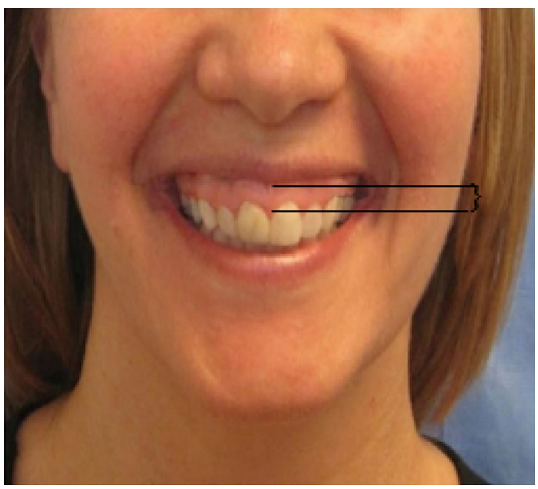


Fig. 2 The measurement made from the crest of the gingiva to the lower most border of the upper lip

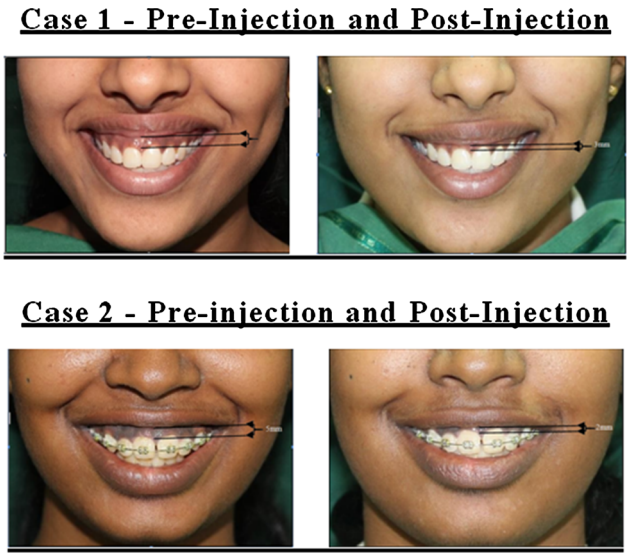


Fig. 3 Case photos

mean value was recorded as 3.47 ± 1.457 mm with the mean significant difference of 3.6 mm ($p = 0.00$). 5.00 ± 1.069 mm mean value with a difference of 2.067 mm was noted during the 4th month which was statistically insignificant ($p = 0.000$). 5th month postinjection revealed a mean value of 6.67 ± 1.291 mm with a difference of 0.400 mm which was statistically insignificant ($p = 0.28$). For the 6th month, 6.93 ± 1.280 mm was recorded as the mean value with a difference of 0.133 mm which was insignificant ($p = 0.164$) (Fig. 4b) (Table 1).

The preoperative and postoperative measurements were recorded and compared. A significant decrease in the gingival exposure of about 3.5 ± 1 mm at 2 weeks after injection was observed and it lasted for 4 months. It was also noted that there was no difference in the measurement of gingival display on maximum smile for postinjection during 5th and 6th month when compared with preinjection measurements. This study confirms that the efficacy of BTX A injection lasted for 4 months and then gradually reduced resulting in reversal of gingival display during maximum smile.

Regarding patient's satisfaction, based on the questionnaire, 67% patient has reported that the treatment seems to be very satisfied and another 27% reported as satisfied after one month of postinjection (Fig. 5). Moreover, all of them expressed their willingness to repeat the treatment.

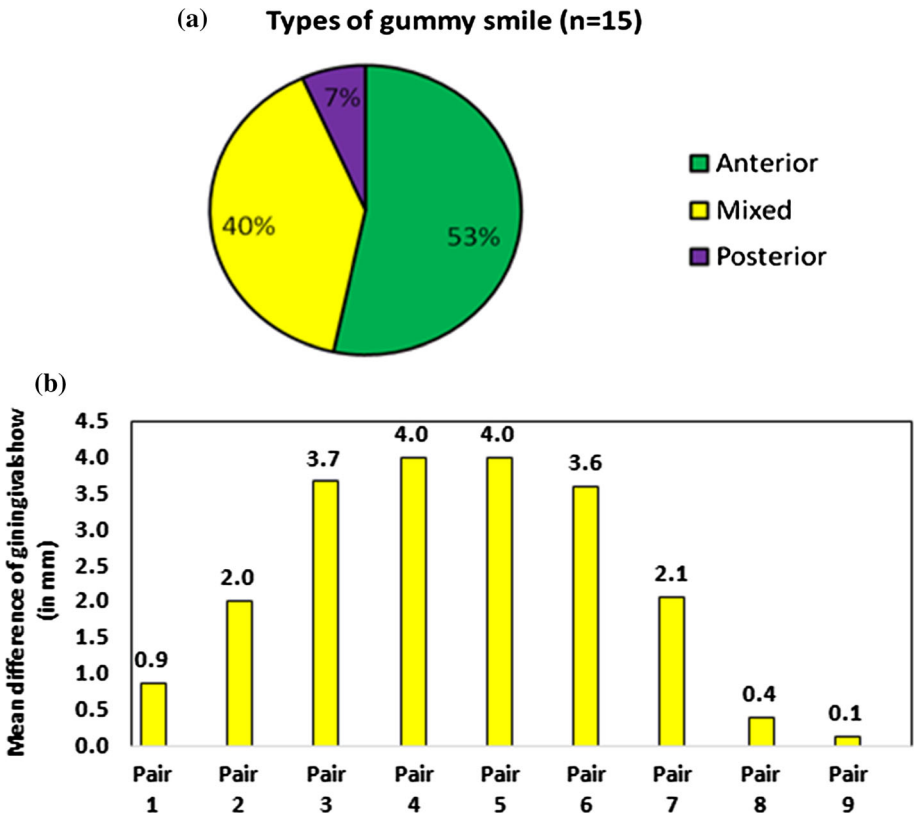


Fig. 4 **a** Pie chart showing distribution of different types of gummy smile. **b** Mean difference of preinjection gingival display on maximum smile measurements with post-injection measurements at each posttreatment visits

Table 1 Comparison of the preinjection gingival display on maximum smile measurements with post-injection measurements at each post-treatment visits using paired student's *t* test

		Mean	SD	Std. error mean	Mean difference	'*t*' statistics	*df*	Sig. (2-tailed)
Pair 1	Pre op	7.07	1.280	0.330	0.867	6.500	14	0.000
	3rd_day	6.20	1.320	0.341				
Pair 2	Pre op	7.07	1.280	0.330	2.000	10.247	14	0.000
	7th_day	5.07	0.961	0.248				
Pair 3	Pre op	7.07	1.280	0.330	3.667	12.084	14	0.000
	15_day	3.40	1.056	0.273				
Pair 4	Pre op	7.07	1.280	0.330	4.000	14.491	14	0.000
	1st_month	3.07	1.033	0.267				
Pair 5	Pre op	7.07	1.280	0.330	4.000	14.491	14	0.000
	2nd_month	3.07	1.033	0.267				
Pair 6	Pre op	7.07	1.280	0.330	3.600	9.930	14	0.000
	3rd_month	3.47	1.457	0.376				
Pair 7	Pre op	7.07	1.280	0.330	2.067	9.057	14	0.000
	4th_month	5.00	1.069	0.276				
Pair 8	Pre op	7.07	1.280	0.330	0.400	2.449	14	0.028
	5th_month	6.67	1.291	0.333				
Pair 9	Pre op	7.07	1.280	0.330	0.133	1.468	14	0.164
	6th_month	6.93	1.280	0.330				

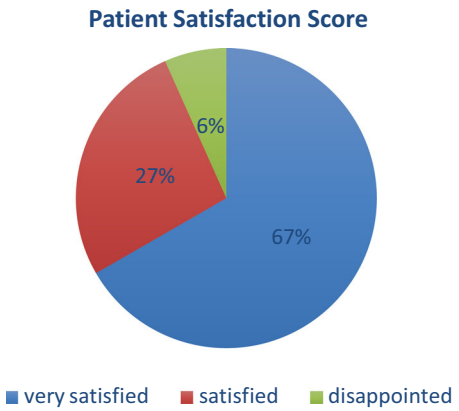


Fig. 5 Percentage of patient satisfaction towards based on the treatment

Discussion

The harmony between teeth, lips and gingival scaffold involves in creating aesthetic appearance of a smile [4]. The activity of diverse facial muscles, such as Levator labii superioris, Levator labii superioris alaque nasi, Zygomaticus major and Zygomaticus minor helps to determine the lip framework. These muscles play a vital role in lifting the upper lip and pulling it toward sides when smiling and create smile through interaction with depressor septi nasi, Risorius and Orbicularis oris muscles. Goldstein [5] classified the smile line into three types based on the degree of exposure of the teeth and gums namely high, medium, or low. It is distinguished by the exposure of gum more than 3 mm during a smile. Gummy smile can be diagnosed by facial examinations with frontal and lateral views of facial symmetry, upper lip length, display of maxillary central incisors at rest, amount of gingival display on smile.

Literature review reports many surgical procedures to correct gingival smile caused by muscular hyperactivity or short upper lip. However, surgical techniques may lead to a relapse and undesirable side effects like contraction of the scar tissue [13]. The use of Botulinum toxin injections was proposed by Polo [3] as a new nonsurgical method to treat excessive gingival display. The toxin decreases the elevating muscle activity, aimed in particular at the levator labii superioris muscle, levator labii superioris alaque nasi, zygomaticus minor muscle. The benefits of BTX-A in 5 patients with gummy smiles were previously reported by Polo [6]. The use of BTX-A for various cosmetic procedures has been described extensively in earlier reports. Botox blocks the neuromuscular transmission by binding to acceptor sites on motor or sympathetic nerve terminals, thereby, inhibiting the release of acetylcholine. This inhibition occurs as Botox cleaves the synaptosomal—associated protein (SNAP-25). Therefore, when injected intramuscularly at therapeutic doses, it produces partial chemical denervation of the muscle resulting in localized reduction in muscle activity [7].

In the present study, out of fifteen patients 10 female and 5 male patients were selected. The fact that majority subject of gummy smile treatment was women which is in consonance with the earlier reports [8–11]. This confirms that women are more interested in aesthetics compared to men and high smile is more dominant in women while low smile is more dominant in men.

In this study, the measuring method for preinjection and postinjection follow-up were done with the reference point in photographs from crest of gingiva in relation to central incisors to the lower border of upper lip for anterior gummy smile and crest of gingiva in relation to premolar tooth to lower border of upper lip in posterior gummy smile which was similar in earlier reports [3, 12].

We had three points of injection target, first point 1 cm away from ala of the nose and 3 cm from the corner of the mouth superiorly at the Yonsei point targeting Zygomaticus minor, Levator labii superioris, Levator Labii Superioris Alaque Nasi for anterior gummy smile. This is in good agreement with the earlier reports [3, 12–14]. For posterior gummy smile, one point target bilaterally 2 cm away from the ala of nose targeting Zygomaticus major muscle which was similar to study done by Mazzuco and Hexsel [12]. The lip elevator muscles without electromyogram were targeted and injected manually which was also done similar to the previous reports [13, 14]. 4units Botox® per injection point was used and it was found to be effective for four months in the present study which was in consonance with the reports of Polo [3, 6] and Suber [11].

By injecting at the predestined sites, BTX-A brings about decrease in gingival exposure by declining the contractility of the upper lip elevator muscles and also, a marked effacement of the nasolabial fold [6]. Partial to complete upper lip drooping, due to hypotony or atony of the central elevators may lead to excessive upper lateral pulling of the zygomaticus major and as a consequence, a 'joker smile' may result [15]. Even though the outcome began to reverse by the 4th month, the exposure, however, never returned to the original values [6].

Our study found that the effect of botulinum toxin was temporary and the gingival display gradually increased after the 12 weeks, but in lip reposition (the surgery procedure), the lip reverted back to its original position with almost complete relapse after 6 months of surgical procedure.

We noticed highest level of satisfaction after two months in the patients who were injected with BTX-A. However, the satisfaction dropped after four months and the same result was noticed in the patient who were treated by surgery [10]. Hence, treatment with BTX-A injection is better than surgical treatment.

Vartanian et al. [16] reported the possible risks and complications after receiving Botox injection. The injection site pain, edema, ecchymosis, headaches, dry mouth, and flu-like mild malaise can occur after Botox injections with altering frequencies which may be technique-dependent; they should not be considered complications. Usage of fresh 30-gauge needles, intradermal injection, topical application of anesthetics like EMLA cream and applying an ice pack to the injection site immediately prior to injection is a simple, safe and cost-effective method that can lessen the pain in injection site. Tendency of bruising at higher rate may be noted in patients who are on aspirin, anticoagulant medications (such as warfarin); nonsteroidal anti-inflammatory drugs. Reports on temporary hypesthesia in injection site are meager, but do exist and may be due to localized edema and trauma. Skin dryness and flakiness were experienced by the patients who received Botox for upper face rejuvenation [17]. Good injection technique, precise understanding of underlying facial anatomy, and suitable site-specific dosage of Botox may minimize these complications and moreover, they are almost reversible and impermanent. The impact of complications can be minimized by well-timed patient instruction, psychological support, and medical intrusion. None of these complications, however, were experienced by any of the patients in our current study.

Conclusion

There is an emergence of new technologies to improve and enhance the physical appearance in this era of passion to beautify ourselves. Use of this BTX-A is a novel, efficient, harmless and minimally invasive nonsurgical therapy that can extensively improve smile aesthetics.

Funding Self-funded.

Declarations

Conflict of interest The authors declare that they have no conflicts of interest.

Informed consent Written and informed consent was obtained from the patient's for participation in the study and its publication with accompanying clinical photographs and radiographic images.

References

1. Flanary C (1992) The psychology of appearance and the psychological impact of surgical alteration of the face. In: Bell WH (ed) Orthognathic and reconstructive surgery, vol 1, 1st edn. WB Saunders, Philadelphia, pp 2–21
2. Sandler PJ, Alsayer F, Davies SJ (2007) Botox: a possible new treatment for gummy smile. Virt J Orthod 20:30–34

3. Polo M (2005) Botulinum toxin type a in the treatment of excessive gingival display. Am J Orthod Dentofac Orthop 127:214–218
4. Garber DA, Salama MA (1996) The aesthetic smile: diagnosis and treatment. J Periodontol 11:18–28
5. Goldstein RE (1976) Esthetics in dentistry. JB Lippincott Co, Philadelphia
6. Polo M (2008) Botulinum toxin type A (Botox) for the neuromuscular correction of excessive gingival display on smiling (gummy smile). Am J Orthod Dentofac Orthop 133:195–203
7. Indra AS, Biswas PP, Vineet VT, Yeshaswini T (2011) Botox as an adjunct to orthognathic surgery for a case of severe vertical maxillary excess. J Maxillofac Oral Surg 10:266–270
8. Tjan AH, Miller GD (1984) Some esthetic factors in a smile. J Prosthet Dent 51:24–28
9. Niamtu J (1999) Aesthetic uses of botulinum toxin A. J Oral Maxillofac Surg 57:1228–1233
10. Gracco A, Tracey S (2010) Botox and the gummy smile. J Orthod 11:76–82
11. Suber JS, Dinh TP, Prince MD, Smith PD (2014) OnabotulinumtoxinA for the treatment of a "gummy smile." Aesthet Surg J 34:432–437
12. Mazzuco R, Hexsel D (2010) Gummy smile and botulinum toxin: a new approach based on the gingival exposure area. J Am Acad Dermatol 63:1042–1051
13. Hwang WS, Hur MS, Hu KS, Song WC, Koh KS, Baik HS, Kim ST, Kim HJ, Lee KJ (2009) Surface anatomy of the lip elevator muscles for the treatment of gummy smile using botulinum toxin. J Angle Orthod 79:70–77
14. Dinker S, Anitha A, Kumar K (2014) Management of gummy smile with Botulinum toxin type A: a case report. J Int Oral Health 6:111–115
15. De Maio M, Rzany B (2007) The most common indications, 5.7–6 complications. Botulinum toxin in aesthetic medicine. Springer, Berlin, p 69
16. Vartanian AJ, Dayan SH (2005) Complications of botulinum toxin A use in facial rejuvenation. Facial Plast Surg Clin 13:1–10
17. Bulstrode NW, Grobelaar AO (2002) Long-term prospective follow-up of botulinum toxin treatment for facial rhytids. Aesthet Plast Surg 26:356–359

Publisher's Note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.