

Original article:

Botulinum toxin type A (Botox) for the neuromuscular correction of excessive gingival display on smiling (gummy smile)

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Abstract:

Introduction: One cause of excessive gingival display is hyperactivity of orofacial muscles related to upper lips. Several surgical procedures have been reported to improve the condition, but surgery always involves risk and is costly. Botulinum toxin type A (BTX-A) (Botox; Allergan, Irvine, Calif) has been studied since the late 1970s for the treatment of several conditions associated with excessive muscle contraction or pain. This clinical pilot study was performed to determine whether BTX-A injections would reduce excessive gingival display.

Material: Six subjects with excessive gingival display due to hyperfunctional upper lip elevator muscles were treated with BTX-A injections.

Results: This treatment modality was effective, producing esthetically acceptable smiles in these patients. The improvements lasted 3 to 6 months.

Conclusions: Injection with BTX-A at preselected sites is a novel, cosmetically effective, minimally invasive alternative for the temporary improvement of gummy smiles caused by hyperfunctional upper lip elevator muscles.

Keywords : Botulinum toxin

INTRODUCTION:

During the last decade, the demand for cosmetic services has increased considerably in many parts of the world. Several medical specialties providing cosmetic services have witnessed increase in procedures that enhance physical traits, reverse the effects of aging, and improve esthetics. Cosmetic surgical procedures, the use of botulinum toxin type A (BTX-A) (Botox; Allergan, Irvine, Calif) and dermal fillers, orthodontic and orthognathic procedures, dental bleaching, and other dental cosmetic procedures are being widely requested by adults. ¹⁻⁴An undeniable psychological benefit of cosmetic procedures is the increase in self-esteem.⁵

In turn, improvement in self-esteem changes the scope of several of these cosmetic procedures to another level: therapeutic. The purpose of this pilot study was to determine whether BTX-A could also be used in patients with hyperfunctional upper lip elevator musculature in conjunction with orthodontic treatment to correct a gummy smile

MATERIAL AND METHODS:

Fifteen female patients undergoing treatment at DEPARTMENT OF ORTHODONTICS AND DENTO-FACIAL ORTHOPEDICS, GOVT .DENTAL COLLEGE AND HOSPITAL, AHMEDABAD, GUJARAT with excessive gingival display were screened, and 6 were selected

for this study. They ranged in age from 18 to 23 years. Cephalometric analysis was performed to determine whether the gummy smile was skeletal (i.e., vertical maxillary excess). Periodontal evaluation was performed to rule out delayed passive eruption leading to excessive gingival display. These patients had a history of fairly good oral hygiene, although mild gingivitis was acceptable. Most of them were receiving active orthodontic treatment. Information about the procedure, its possible benefits, risks, and side effects, and the expected duration of the results, if any, was given in detail to the patients and the parents of the minors verbally and in writing. All agreed to participate. Written informed consent was obtained.

At the beginning of study, extra oral photographs were taken, including a close-up photograph with a ruler placed vertically and horizontally while the patient was smiling for correct measurement of magnification during analysis (Fig-1 of Figure legends). Intramuscular injection for correction of excessive gingival display is given at “Yonsei poing”. (Woo-Sang Hwang).(Fig-3 in Figure legends) Botulinum toxin-A is diluted by adding 4.0 ml of 0.9% normal saline solution without preservatives to 100 U of vacuum-dried *C botulinum* type A neurotoxin complex, according to the manufacturer’s dilution technique. This results in a 2.5 U/0.1 ml dose. After carefully reviewing the literature for small muscle dosage, a dose of 1.25 U per muscle site per side was selected as a baseline to start the study. Aspiration before BTX-A injection was done to avoid involuntary deposition of the toxin into the facial arteries.

The patients were clinically evaluated after 3 days, 7 days, 14 days, 1.5 months, 2.5 months, 4.5 months and 6 months. During the first evaluation, they were asked to report any adverse reactions or

side effects associated with the procedures. During successive follow-up visits, extra-oral photographs were taken in smiling position. Smile analysis was done. Dynamic evaluation tools (videos) in addition to conventional static means (photos) were used to evaluate the data. Photos were obtained by using a Nikon D70s Digital SLR camera with a Nikkor 60-mm micro lens (Nikon, Tokyo, Japan). Videos were captured with a Canon Power Shot S230 Digital Elph camera (Canon, Tokyo, Japan). A group of 11 physicians and dentists, all involved in performing cosmetic procedures, also evaluated the before and after photographic records and rated the results on a 1 to 5 point scale.

SMILE FRAME INCLUDES (As shown in Fig-2 in figure legends)

- A. Upper lip length,subnasale to stomion superius,
- B.Upper lip thickness,
- C.Gingival display at incisor region
- D.Gingival display at canine region,
- E.Inner inter-commissural width
- F.Maxillary incisor display,
- Stomion superius to maxillary incisal edge²⁰

RESULTS:

The results of this pilot study were analyzed both subjectively, by clinical evaluation of the gummy smile, and objectively, with pre- and postoperative photographs. All 6 patients began to show improvement approximately 10 days after the injections. After 14 days, results were definitely observed. The mean reduction in gingival display at 2 weeks for all 6 subjects was 2.66 mm. Gingival display gradually increased from 2 weeks post injection through 4.5 months, but, at 4.5 months, average gingival display still had not returned to baseline values. For this investigation’s analytical purpose, the hypothesized goal for gingival exposure was set at zero. The *t* test, paired 2-sample for means, was used to determine statistical

significance, which occurred at $P < 0.0001$. (see Tables 1-6)

DISCUSSION :

The value of an attractive smile is undeniable. A smile is considered the universal friendly greeting in all cultures. An attractive smile in modern society is often considered an asset in interviews, work settings, social interactions, and even the quest to attract a mate.¹³⁻¹⁴ A pleasing smile involves a harmonious relationship among the teeth, the gingival scaffold, and the lip framework. With the help of orthodontic treatment changes can be made in teeth alignment, and positioning. However sometimes orthodontic treatment alone does not produce satisfactory results in conditions like excessive gingival display during smile due to hyperactivity of orofacial muscles related to upper lips. The mechanism involved is well described in 2 cadaver studies, by Rubin et al¹⁵ and another by Pessa.¹⁶ Both investigations evaluated the origin of the nasolabial fold. Rubin et al concluded that the LLS, the ZM, and the superior fibers of the buccinator muscles under the nasolabial fold are responsible for the production of a full smile. Pessa indicated that the LLSAN was responsible for the formation of the medial portion of the fold and minimally responsible for the elevation of the upper lip and smile formation. He also found that the ZM and the Zm muscles are primarily responsible for the production of the smile.

In another review, Rubin¹⁷ classified smiles into 3 types: the "Mona Lisa" smile, with sharply elevated corners of the mouth, dominated mostly by the action of the ZM; the canine smile, with strong elevation of the upper lip near the midline; and the full denture smile, with significant contracture of all upper lip elevators and lower lip depressors muscles, resulting in a significant

exposure of the maxillary and mandibular dentition. The canine, or gummy, smile is dominated by excessive contraction of the LLS muscles, according to Rubin. BTX-A is the most potent and the most commonly used clinically type. When injected intramuscularly at therapeutic doses, BTX-A produces partial chemical denervation of the muscle, resulting in localized reduction in muscle activity.¹⁸ Botox has been approved by the Food and Drug Administration as a safe and effective therapy for blepharospasm, strabismus, cervical dystonia, and hemifacial spasm since 1989; in 2002, it received approval for the treatment of glabellar lines associated with corrugator and procerus muscle activity, and, in 2004, approval was obtained for the treatment of primary axillary hyperhidrosis. The National Institutes of Health Consensus Conference of 1990 also included it as a safe and effective therapy for other nonlabeled uses.¹⁹

All patients were pleased with the results. No side effects (infection, bruising, edema, or loss of muscle strength) were reported or observed. One patient reported mild pain during the injection procedure. The effect began to be noticeable approximately 7 days after injection, with the maximum noticeable effect about 14 days after injection. This effect was reported to be progressive. Some reduction in gingival display was retained at the end of study. Reduction in gummy smile was noted both in incisal as well as canine region. Some degree of reduction in incisal display also was retained at the end of study. A group of physicians, dentists and persons directly involved with lay persons, evaluated and rated the pre injection and 2-weeks post injection facial photos. These evaluators included 2 from each of the following fields: maxillofacial surgery, orthodontics, cosmetic dentistry and 1 each from periodontics, plastic

surgery and general physician. One police –officer and one lawyer also evaluated and rated the photos. Their mean rating of the result of the BTX-A injections was 3.64.

Although surgical techniques have been reported in the literature, they are not routinely used to treat hyperfunctional upper lip elevator muscles resulting in a short upper lip and a concomitant gummy smile. Most of the surgical correction currently used seems to be LeFort I maxillary osteotomies with impaction for skeletal vertical maxillary excess and gingivectomies for delayed passive dental eruption with excessive gingival display. Simply by injecting botulinm toxin excellent correction of gummy smile was noted in this study with no major side-effects.

CONCLUSION

BTX-A injections (1.25 units in both right and left sides) for the neuromuscular correction of excessive gingival display (gummy smile) caused by hyperfunctional upper lip elevator muscles was effective and statistically superior to baseline smiles ($P<.00001$), although the effect was transitory some effect was also retained at the end of study. In severe cases of gummy smile, dose of botulinm toxin can be increased. The mean gingival exposure reduction was 2.66 mm. gingival display gradually increased from 2 weeks postinjection through 24 weeks, but, at 24 weeks, average gingival display still had not returned to baseline values. Botox had no effect in statics of smile (ex. lip length), but only on dynamics of smile.(muscle activity on smile) The results were extremely satisfactory to both the subjects in this study and the physicians and dentists serving as evaluators.

Table 1- MEAN READINGS OF ALL PARAMETERS MEASURED IN STUDY

Parameter Days	14 days	1.5 month	4.5 month
Gingival display	2.66	2.16	1
Lip length	1.83	1.16	0
Inner commissural width	1	3	2.16
Gingival display at canine	2.16	2.08	0.66
Incisal display	2.5	1.83	1

Table-2.GINGIVAL DISPLAY (in mm)

Paired Samples Statistics(a)					
		Mean	N	Std Deviation	Std.ErrorMean
Pair 1	DAY_0	3.67	6	1.033	0.422
	DAY_15	1.00	6	1.549	0.632
Pair 2	DAY_0	3.67	6	1.033	0.422
	MONTH_1.5	1.50	6	1.378	0.563
Pair 3	DAY_0	3.67	6	1.033	0.422
	MONTH_4.5	2.67	6	1.633	0.667

Pair 4	DAY_15	1.00	6	1.549	0.632
	MONTH_1.5	1.50	6	1.378	0.563
Pair 5	DAY_15	1.00	6	1.549	0.632
	MONTH_4.5	2.67	6	1.633	0.667
Pair 6	MONTH_1.5	1.50	6	1.378	0.563
	MONTH_4.5	2.67	6	1.633	0.667

Table-3.Gingival display at canine (in mm)

Paired Samples Statistics(a)					
		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	DAY_0	4.00	6	1.581	0.645
	DAY_15	1.83	6	2.160	0.882
Pair 2	DAY_0	4.00	6	1.581	0.645
	MONTH_1.5	1.92	6	1.594	0.651
Pair 3	DAY_0	4.00	6	1.581	0.645
	MONTH_4.5	3.33	6	1.472	0.601
Pair 4	DAY_15	1.83	6	2.160	0.882
	MONTH_1.5	1.92	6	1.594	0.651
Pair 5	DAY_15	1.83	6	2.160	0.882
	MONTH_4.5	3.33	6	1.472	0.601
Pair 6	MONTH_1.5	1.92	6	1.594	0.651
	MONTH_4.5	3.33	6	1.472	0.601

Table-4..Incisal Display (in mm)

Paired Samples Statistics(a)					
		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	DAY_0	16.67	6	1.506	0.615
	DAY_15	14.17	6	1.472	0.601
Pair 2	DAY_0	16.67	6	1.506	0.615
	MONTH_1.5	14.83	6	1.472	0.601
Pair 3	DAY_0	16.67	6	1.506	0.615
	MONTH_4.5	15.67	6	1.633	0.667
Pair 4	DAY_15	14.17	6	1.472	0.601
	MONTH_1.5	14.83	6	1.472	0.601
Pair 5	DAY_15	14.17	6	1.472	0.601
	MONTH_4.5	15.67	6	1.633	0.667
Pair 6	MONTH_1.5	14.83	6	1.472	0.601
	MONTH_4.5	15.67	6	1.633	0.667

Table-5 .Inner inter-commisural width(in mm)

Paired Samples Statistics(a)					
		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	DAY_0	54.33	6	3.445	1.406
	DAY_15	53.33	6	3.724	1.520
Pair 2	DAY_0	54.33	6	3.445	1.406
	MONTH_1.5	51.33	6	4.457	1.820
Pair 3	DAY_0	54.33	6	3.445	1.406
	MONTH_4.5	52.17	6	3.656	1.493
Pair 4	DAY_15	53.33	6	3.724	1.520
	MONTH_1.5	51.33	6	4.457	1.820
Pair 5	DAY_15	53.33	6	3.724	1.520
	MONTH_4.5	52.17	6	3.656	1.493
Pair 6	MONTH_1.5	51.33	6	4.457	1.820
	MONTH_4.5	52.17	6	3.656	1.493

Table-6..Lip length(in mm)

Paired Samples Statistics(b)					
		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	DAY_0	10.00	6	1.789	0.730
	DAY_15	11.83	6	2.137	0.872
Pair 2	DAY_0	10.00	6	1.789	0.730
	MONTH_1.5	11.33	6	1.366	0.558
Pair 3	DAY_0	10.00	6	1.789	0.730
	MONTH_4.5	10.00	6	1.789	0.730
Pair 4	DAY_15	11.83	6	2.137	0.872
	MONTH_1.5	11.33	6	1.366	0.558
Pair 5	DAY_15	11.83	6	2.137	0.872
	MONTH_4.5	10.00	6	1.789	0.730
Pair 6	MONTH_1.5	11.33	6	1.366	0.558
	MONTH_4.5	10.00	6	1.789	0.730

Fig-1 Close-up photograph with a ruler placed vertically and horizontally for correct measurement of magnification during analysis



Fig-2(Smile Frame)

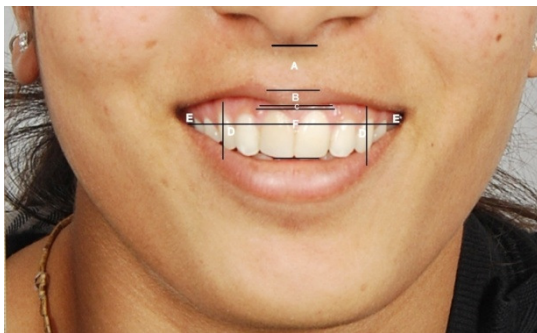


Fig-3(Location of YONSEI POINT)

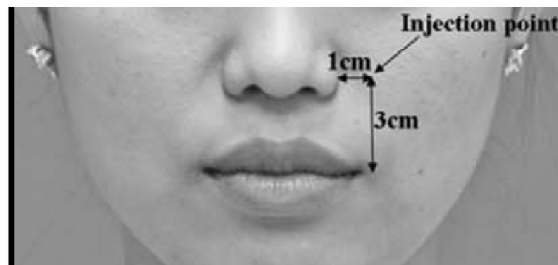
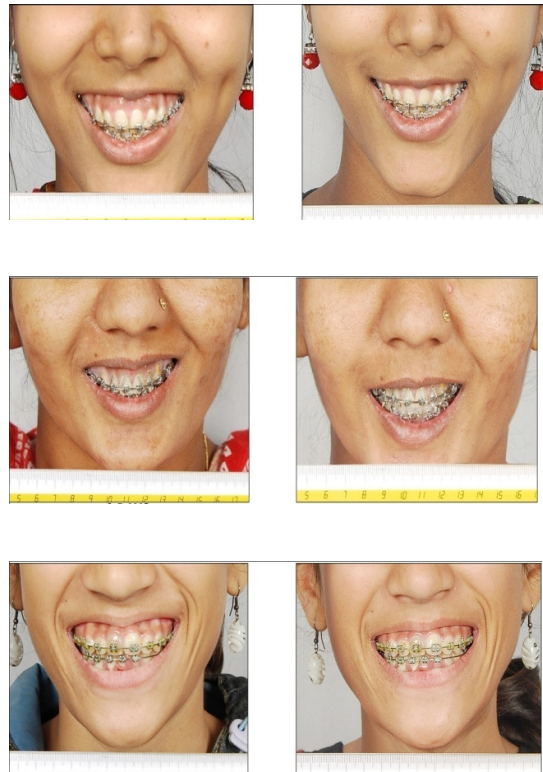
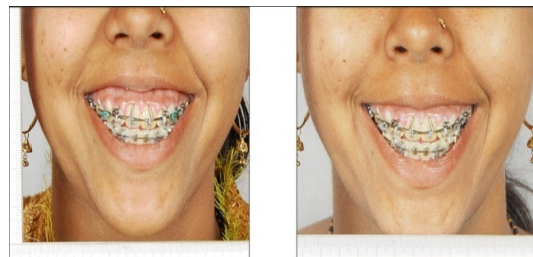


Fig 4 Pre-injection and Post-Injection Photographs (After 14 days) in selected samples



Case-6

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