Botulinum Toxin Type-A for the Treatment of Excessive Gingival Display on Smiling

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ABSTRACT

Aim and objective: To determine the effect of botulinum toxin type-A (BTX-A) in reducing gummy smile.

Materials and methods: This was an interventional case series conducted at a tertiary care setting in Mangaluru, Karnataka, India. Twenty patients with the gingival display of >3 mm were selected through convenience sampling technique. 2.5 units of BTX-A were injected under sterile conditions on either side of the face. The effect of the injection on gingival display was measured at the interval of 2, 4, 12, and 24 weeks. At the end of the treatment, the patient was asked to smile and was photographed and was compared to pretreatment photo. Repeated measures analysis of variance (ANOVA) was used to detect the change at each interval and intergroup comparisons were performed using *post hoc* Bonferroni test.

Results: The mean gingival exposure reduction from 4.93 to 3.705 mm at week 2. At the end of 24 weeks, the evaluation showed the mean gingival display of 4.755 mm on administration of 2.5 units on either side. The photographs also showed the change in smile at the end of the treatment.

Conclusion: From the study, it was inferred that botulinum toxin was effective in eliminating gummy smile along with noticeable decrease in the nasolabial fold despite for the effect lasting only about 24 weeks.

Clinical significance: A nonsurgical method of correction of gummy smiles when compared to surgical intervention is readily accepted by patients. Botulinum toxin type-A for gummy smiles is an effective, conservative, and satisfactory technique.

Keywords: Botulinum toxin type-A, Experimental study, Gingival display, Gummy smile.

The Journal of Contemporary Dental Practice (2020); 10.5005/jp-journals-10024-2926

INTRODUCTION

The cornerstone of all facial expressions is a smile, can indicate pleasure, joy amusement, or approval. It reflects the inner feelings and is an important aspect of socialization. Esthetics has been an essential goal of orthodontic treatment. The orthodontic treatment demands and appreciates more of esthetic harmony, so along with functionally efficient and balanced occlusion, good esthetics—dynamic smile has become one of the treatment goals of the orthodontist.¹

People who show extreme gingival display in the upper jaw on smiling have been called to have a “gummy smile”.² In case of hyperfunctional muscle where the upper lip raises above than normal smile can lead to increased display of gingiva.³ Normally, a gummy smile is deemed less attractive. Van der Geld et al. found that patient satisfaction with one’s own smile depends on gingival display.⁴ The position of maxillary incisors is known to have a significantly positive correlation with that of the upper lip.⁵ The display of only upper incisors without the exposure of gingival tissue was determined more esthetically pleasing.⁶ The esthetic exposure for the upper incisors is only up to 1 mm.⁷ Gummy smile could be esthetically displeasing, especially in females in whom it is more prevalent.^{8,9}

Botulinum toxin type-A (BTX-A) is a commercially available preparation of neurotoxin.¹ BTX-A is vacuum-dried, sterile, stable powder with good stability that is mixed with normal saline before use.¹⁰

The botulinum toxin is used for the treatment of wrinkles located on the upper third of the face. Also, muscle contractions in head and neck area are treated using botulinum toxin.¹¹ It is now used for hypertrophic masseters, as a treatment option for bruxism as well as a simple therapy to treat gummy smile.¹¹ Botulinum toxin A, when applied correctly, is a safe and effective means of

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How to cite this article: Skaria J, Hegde N, George PP, et al. Botulinum Toxin Type-A for the Treatment of Excessive Gingival Display on Smiling. *J Contemp Dent Pract* 2020;21(9):1018–1021.

Source of support: Nil

Conflict of interest: None

achieving esthetic smile modification, but there are limited data on any demonstrable long-term adverse effects.¹

This study was conducted to determine the effect of botulinum toxin type-A in reducing gummy smile.

MATERIALS AND METHODS

This was an interventional case series conducted at a tertiary care setting in Mangaluru, Karnataka, India. Twenty patients with the gingival display of >3 mm on smiling secondary to hyperfunctional upper lip elevator muscles were selected through convenience sampling technique in the outpatient department at a tertiary care setting. Their ages ranged from 18 to 40 years. Among them, 18 were female patients and 2 were male patients. Patients with amyotrophic

Fig. 1: Schematic representation of gingival display with landmarks

Fig. 3: Administration of BTX-A injection on patient

sclerosis, motor neuropathy, myasthenia gravis, pregnant and breastfeeding females, excessive hypertrophic gingiva, gummy smiles of skeletal and dental origin, allergy to BTX-A or albumin injections or history of BTX-A treatment for the same, participating in another drug or study, using certain medications, such as aminoglycosides and anticholinesterases, other agents interfering with the neuromuscular transmission were excluded from the study.

Patient's medical history was reviewed before conducting the study. Written consent was taken from all patients by informing them the advantages, disadvantages, and side effects. Efforts were taken to obtain standardized, non-posed, spontaneous smile. Cephalometric analysis and periodontal evaluation were performed.

To measure the amount of gingival display, the patient was made to smile and extraoral photographs were taken with the ruler placed along mid-sagittal plane from reference point 1 (RP1) to reference point 2 (RP2). Reference point 1 is the point where the uppermost part of the ruler touched the alar base. Reference point 2 is the point where the ruler touched the lowermost point of the mesial incisal edge of the maxillary central incisor. The gingival exposure was measured using the following points; point A—labrale superioris, point B—lower most point in upper lip

Figs 2A and B: Clinical evaluation of the smile by measuring the change in gingival display: (A) Pretreatment; (B) Four weeks posttreatment

compared with gingival, and point C—superior border of marginal gingiva (Fig. 1).

The distance between points B to C signifies the difference in changes seen in gingival display during smile. The value 2 weeks postadministration of injection signifies the immediate effectiveness of botulinum toxin (Fig. 2). Likewise, the stability of the treatment result is assessed by the measuring variation of points B to C at various time intervals.

One hundred international units (IU) of vacuum-dried Botulinum toxin type A (Botox®; Allergan, Irvine, California, USA) were diluted according to the manufacturer's recommendations by adding 4.0 mL of 0.9% normal saline solution to 100 IU of the toxin to provide 2.5 units/0.1 mL.

Initially, 0.20 units of BTX-A were injected intradermally in forearm for allergy test. Patient was observed for 30 minutes for any allergic reaction. On failure to elicit any allergic reaction under sterile conditions, 2.5 units per side were injected in both sides of the mouth; approximately 1 cm from the corner of the mouth and 3 cm from the commissure of the mouth at a point called "Yonsei point"¹² (Fig. 3).

Aspiration was performed before Botox injection. The patient was advised against exercising, lying down, or massaging the injected area during the first 4 hours after the procedure. The patient was also asked to report back if there are any adverse reactions observed. The effect of Botox on gingival display was measured at the interval of 2, 4, 12, and 24 weeks.

Statistical Analysis

Descriptive analysis was conducted in terms of mean and standard deviation. Multiple comparisons were performed using repeated measures analysis of variance (ANOVA). The *post hoc* Bonferroni test was used to determine the significant difference in intergroup comparisons.

RESULTS

Twenty subjects with excessive gingival display with age ranged from 18 to 40 years were included in this study. Extraoral photograph with ruler was taken to measure the gingival display (Figs 1 and 2).

The measurements at the weeks 0, 2, 4, 6, 8, 12, and 24 were compared for 20 patients (Table 1). The mean gingival display

Table 1: Mean, standard deviation, minimum and maximum value comparisons of gingival display (in N)

Time	N	Mean	Std. deviation	Minimum	Maximum
0 weeks	20	4.93	0.688	4.00	7.00
2 weeks	20	3.705	0.388	3.00	4.30
4 weeks	20	3.705	0.388	3.00	4.30
12 weeks	20	3.630	0.527	2.80	5.00
24 weeks	20	4.755	0.615	4.00	6.50

Test used: repeated measures ANOVA

$F = 25.118$, $p < 0.001$ shows very highly significant

Table 2: Multiple comparisons of gingival display with *post hoc* Bonferroni test

(I) time	(J) time	Mean difference (I-J)	p value
0 weeks	2 weeks	1.225	<0.001 vhs
	4 weeks	1.225	<0.001 vhs
	12 weeks	1.300	<0.001 vhs
	24 weeks	0.1750	1.000
2 weeks	4 weeks	1.225	<0.001 vhs
	12 weeks	1.300	<0.001 vhs
	24 weeks	0.175	1.000
4 weeks	12 weeks	0.075	1.000
	24 weeks	-1.050	<0.001 vhs
12 weeks	24 weeks	-1.125	<0.001 vhs

$p < 0.001$ shows very highly significant

reduced from 4.93 to 3.705 mm at week 2 and 3.630 mm at week 12. At the end of 24 weeks, the evaluation showed the mean gingival display of 4.755 mm. Multiple comparisons *post hoc* Bonferroni test showed the significance in intergroup comparisons ($p < 0.001$). However, no significant difference was seen at week 24 (Table 2).

DISCUSSION

The lips are the main controlling factor in which portions of the teeth, gingiva, and oral cavity will be seen in an individual's smile. The etiology of a "gummy smile" may be gingival, skeletal, or muscular.^{3,13-15} Muscles levator labii superioris alaeque nasi (LLSAN), levator labii superioris (LLS), zygomaticus major (ZMa), risorius and to a less degree, the depressor septi nasi are the muscles that are for upper lip elevation and lateral retraction upon smiling.¹⁶ All of these muscles interact with the orbicularis oris muscle in the production of a smile.^{17,18} The gummy smile is dominated by excessive contraction of the LLS muscles.¹⁹

Several methods to treat gummy smile include surgical procedures, miniscrew, laser but all the above procedures are invasive and had recurrence rate.²⁰⁻²⁵ Hence, nonsurgical method to treat gummy smile is preferred by patients. On administration of BTX-A, muscular contraction is blocked for about 3 to 6 months and also the effect may last longer.²⁶ BTX-A is a simple, easy treatment method to treat gummy smile.

Many previous studies have shown the benefits of BTX-A. In the study performed by Polo, five subjects were administered with two doses of BTX-A. The period between the two administrations was 1 month. The mean reduction of 5.1 mm display was observed.²⁷ In 2008, Polo did the similar study in 30 patients with single dose. Seventeen patients completed the study. The result of the study was a mean gingival decrease of 5.1 mm with 88% compliance rate; it was reported that the average amount of gingival display while smiling

was 5.2 mm before botulinum toxin injection and 0.09 mm 15 days after the injection.²⁸ Previous studies performed by Sandler et al. using Botox to reduce gummy smile gave encouraging results.²⁹ Suber et al. conducted a study on 14 patients and reported that the average amount of gingival display above the central incisors was 4.89 mm before BTX injection and 0.75 mm after BTX injection.³⁰ Mazzuco and Abdalla conducted a study on 16 patients, and they reported a nearly 75.09% decrease in the amount of gingival display as a result of the injection.¹¹

In this study of 20 subjects after follow-up visits at the weeks 2, 4, 12, and 24, the average amount of gingival display above the central incisors was 4.89 mm before BTX-A injection and 0.75 mm after BTX-A injection. The significance in intergroup comparisons ($p < 0.001$) when baseline (mean value of 4.89 mm before BTX-A injection) was compared with gingival display at week 2 (3.705 mm) and at week 12 (3.630 mm). However, no significant difference was seen at week 24 (4.755 mm).

The BTX-A acts on the neuromuscular junction and interrupts the transmission and also denervates the muscles. Due to this, the hyperfunction of the muscles is reduced. This chemodenervation effect persisted only up to week 24. The patients in our study were not followed up further to determine if the chemodenervation persisted >24 weeks. However, the duration of this effect may depend on serotype formulations. The different serotype may impart different efficacy.³¹ In one instance, incobotulinumtoxinA, onabotulinumtoxinA, and abobotulinumtoxinA neurotoxins were compared in the randomized trial for frown lines and incobotulinumtoxinA was found to be the most effective.³² However, none of the studies have compared its efficacy on gingival display.

Even though its noninvasive nature makes the treatment beneficial, it is often known to cause paralysis. The paralytic effects are normally irreversible, especially when the toxin is internalized.²⁹ In this investigation, only 2.5 units were injected at each "Yonsei point", this is significantly less than the previously reported studies like Suber et al.³⁰ where an average of 5.0 units were injected bilaterally at three sites, or other studies by Polo²⁸ and Mazzuco and Abdalla¹¹ wherein 2.5 units were injected at three different sites to denervate the LLS, LLSAN, and ZMi muscles individually. For more desirable effect, the more quantity of neurotoxin at different site is recommended.

The BTX-A reduces the gingival exposure by weakening the contractibility of few upper lip elevator muscles—LLSAN, LLS, and ZMi—and by increasing the length of upper lip. Also, reduction of the nasolabial fold was also a noticeable effect. Polo et al. also observed the reduction of nasolabial fold in eight subjects.²⁸ This effect was caused because of the close proximity of injections to the muscle origins.

Although the results in this study were satisfactory, a possible limitation is variation in individual anatomy that may lead to differences in outcome to treatment.

Another limitation was that the study subjects were not diverse enough in terms of race and geographical location. This makes generalizing the data difficult. Another possible limitation of this study is that a computer software program was not used to aid in the measurements. However, a standardized measuring scale was used and a real-time measurement of each patient's smile was performed. The photographic setup consisted of a SLR camera mounted on tripod (Digitek Tripod DTR550LT). The tripod controlled the stability and the correct height of the camera according to the subject's body height. This ensured the correct horizontal position of the optical axis of the lens. Another element of the setup was flash placed behind the subject. Its function was to light the background and eliminate undesirable shadows. The measurements were made this way because standardized photographs of a spontaneous smile are extremely difficult to obtain. We feel that a photograph captures a smile in a single moment of time, and not necessarily the exact moment of maximal smile. Finally, only one dose of BTX-A was used in our study; hence, the changes seen were limited. Even though BTX-A has its own advantages of being minimally invasive, the changes seen with BTX-A injection is known to be temporary, lasting for only 3–6 months and is considered one of the limitations of the procedure. Future studies must include different doses of BTX-A to know the dose–response relationship.

CONCLUSION

Beauty and trends are subjected to changes over time, but smile is timeless. Depending on the cause and the needs of the patient, this treatment approach could well be used as an alternative procedure for faster and minimally invasive treatment of gummy smile. The drug–dose relationship must be studied in future. Also, future studies must conduct large scale randomized trials to accurately determine the influence of BTX-A on gingival smile.

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