Effect of Botulinum Toxin Type A (Botox) For Neuromuscular Correction of Excessive Gingival Display on Smiling

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Abstract: The display of excessive gingival tissue in the maxilla upon smiling has been called as “gummy smile”. The etiology of gummy smile may be skeletal, gingival, muscular iatrogenic. Many surgical procedures have been described that are invasive and had a recurrence rate. The aim of the study was to reduce the gingival display using botulinum toxin A in selected cases. Ten subjects from both the sexes with age group of 16-27 years, with gummy smile more than 5 mm of gingival exposure on smiling, due to hyperactivity of elevator muscles. Botulinum toxin type A dosage of 1.25 U per muscle site per side was selected as a baseline at the start of the study. Under sterile conditions, 1.25 U per side was injected in both the right and left levatorlabii superioris and levatoralaris superioris alaeque nasi muscles (LLS), and an additional 1.25 U per site at the overlap areas of the levatorlabii superioris and zygomaticus. The effect of botox on gingival display was measured at the interval of 2 weeks, 4 weeks, 8 weeks, 16 weeks, and 24 weeks. Gingival display decreased around 5.1 ± 0.2 mm in all ten subjects. Botox injection is a non-invasive method for treatment of gummy smile. Gingival display reduced to 5.1 ± 0.2 mm on administration of 2.5 units on either side.

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I. Introduction

The display of excessive gingival tissue in the maxilla upon smiling has been called as “gummy smile”, people with excessive gingival display are self-conscious about it, and are psychologically affected. Vander geld et al found that the amount of gingival display is an important characteristic in a person’s own satisfaction with their smile. Esthetic range was up to 1 mm for the upper incisors and 0 mm for the lower incisors. The vertical thickness of the upper lip had a significant positive correlation with the position of the maxillary incisor. Full height of incisor with no gingival tissue was found to be more attractive. The vertical maxillary excess is an osseous developmental alteration, also referred to as long face syndrome. Commonly upper third of the face is normal; the middle third of face has narrow nose and nostril base and the lower third is elongated. There is an increased inter-labial distance, which may or may not be associated with open bite; excessive maxillary anterior teeth display or even complete exposure when lips are in rest position; and excessive exposure of the gingiva during smile. To correct this syndrome, orthognathic surgeries (Le Fort I) with anterior maxillary intrusion are indicated, usually preceded by orthodontic therapy. Delayed passive eruption is characterized by alterations during the passive phase of eruption, allowing the crestal bone to be maintained very close or at the cementoenamel junction level, preventing the gingival tissue to assume its appropriate physiological apical positioning. Marginal gingiva covers most part of dental crown, making it short, and increasing gingival exposure during smile. Conventionally, its treatment involves internally beveled incision or intrasulcular incision followed by osteotomy and osteoplasty, which is limited to the proximity of the crown. Miskinyar used a different surgical technique to treat 27 patients, including 7 who had relapsed after being treated with his new technique. He performed myectomy and partial resection of the levatorlabii superioris muscles; 1 or both of the bellies of the muscles were amputated 1.0 to 2.0 cm at their junction with the orbicularis oris muscle. Ezquerra et al presented a multidisciplinary approach for treating a high smile line with excessive gingival display: either LeFort I osteotomy or gingival and alveolar bone remodeling surgery. Botulinum toxin has been under clinical investigation since the late 1970s for the treatment of several conditions associated with excessive muscle contraction or pain. Botulinum neurotoxin is produced by Clostridium botulinum as a complex of proteins containing the neurotoxin associated with non-toxic components. Botulinum neurotoxin is synthesized as a relatively inactive single-chain polypeptide with a molecular weight of ~150 kDa and becomes activated by selective proteolytic cleavage to yield the heavy and light chains that are linked by a single disulphide bond and non-covalent interactions. There are

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seven botulinium toxin serotypes (A, B, C, D, E, F, and G), all of which inhibit acetylcholine release, although their intracellular target proteins, the characteristics of their actions, and their potencies vary substantially.

Type A toxin has been the most widely studied and has been found to be very successful for therapeutic purposes. Recently, type B became commercially available but its effects are less prolonged and much higher doses are required 100 U of vacuum – dried botulinum type A used (botox or dysport) is used.20

The purpose of that study was to determine whether injecting BTX-A at particular muscle sites could provide an alternative therapy for gummy smiles caused by hyper contractibility or excessive muscle activity.

II. Materials And Methods

10 Patients were selected of both the sexes between age group of 16 - 27 years.

INCLUSION CRITERIA
5mm or more of gingival display on smiling

EXCLUSION CRITERIA:
1. Vertical maxillary excess.
2. Excessive hypertrophic gingiva.
3. Subjects allergic to Botulinum toxin - A or albumin injections or history of previous injections Botulinum toxin - A to the head & neck.
5. Patient using certain medications such as aminoglycosides, anticholinesterases, other agents interfering with the Neuromuscular transmission

Informed consent was taken from the patient, parents or guardians. Patients medical history was reviewed before conducting the study. Lateral Cephalogram was taken & analysed to rule out vertical maxillary excess. Pre-treatment photographs were taken.

III. Method Of Preparation

Botulinum type A was 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 resulted in a 2.5 U/0.1mL dose.

METHODS:
- Cephalometric analysis was performed to rule out whether the gummy smile is Skeletal due to vertical maxillary excess.
- Periodontal evaluation were performed to rule out delayed passive eruption leading to excessive gingival display.
- Extra – oral photographs were taken, including a close – up photograph with ruler placed vertically at the facial midline while the patient is smiling.
- Effort was placed on subjects achieving non posed, spontaneous smiles, as described by Sarver and Ackerman.11

INJECTION SITE:

Approximately 1cm from corner of mouth & 3cm from the commisure of mouth there is the intersection of Upper lip elevator muscles the levatorlabiisuperioris, levatorlabiisuperioris alequenasi, levatorangulirosis, zygomaticusmajor, zygomaticus minor, and the depressor septinasi. It is called “yonsei point”.

The injection sites were additionally determined by muscle animation (smiling) and palpation on contraction to ensure precise muscle location before injection because small anatomical variations in localization sometimes occur. No local anesthesia was administered. No electromyographic guidance were used.

INJECTION METHOD:

A dose of 1.25U per muscle site per side is selected as a baseline to start the study. Under sterile conditions, 1.25 U per side were injected in both the right and left levatorlabiisuperioris and levatorlabii superioris alequenasi muscles (LLS), and an additional 1.25 U per side at the overlap areas of the levatorlabii superioris and zygomaticus Minor muscles (LLS/ZM). Aspiration before BTX-A injection will be done to avoid Involuntary deposition of the toxin into the facial arteries.

The effect of botox on gingival display were measured at the interval of 2 weeks, 4 weeks, 8 weeks, 16 weeks and 24 weeks.
STATISTICAL ANALYSIS:
The Statistical significance was calculated using paired t-test.

IV. Results
Ten subjects with excessive gingival display secondary to hyperfunctional upper lip elevator muscles were enrolled in this study. Their ages ranged from 15 to 25 years. All 10 subjects were evaluated at the week-2, 4, 6, 8, 16 and 24 follow-up visits. Extra-oral photograph & close up photograph with ruler were taken to measure the gingival display.

The gingival exposure was measured using following measurements (called A, B, and C) were recorded:

| Table 1: results depicting the decrease in gummy smile over subsequent weeks. |
|-----------------|-----|-----|-----|-----|-----|
| WEEKS           | A(MM) | B(MM) | C(MM) | ∆A(MM) | ∆C(MM) |
| PREOPERATIVE    | 9     | 8     | 7     | 2      | -5     |
| 2nd WEEK        | 11    | 8     | 5     | 2      | -2     |
| 4th WEEK        | 12    | 8     | 3     | 3      | -3     |
| 6th WEEK        | 12    | 8     | 4     | 3      | -3     |
| 8th WEEK        | 14    | 8     | 2     | 5      | -5     |
| 16th WEEK       | 14    | 8     | 2     | 5      | -5     |
| 24th WEEK       | 14    | 8     | 2     | 5      | -5     |

A: RP1 to superior border of upper lip vermilion.
B: RP1 to inferior border of upper lip vermilion.
C: Inferior border of upper lip vermilion border to junction of the gingiva with the maxillary right central incisor crown along its own midline.

∆A(MM): Difference between successive week and Pre-Operative.
∆C(MM): Difference between successive week and Pre-Operative.

MM- in millimeters,

| Table 2: Statistical analysis showing two tailed and one tailed probability test |
|-------------------------------|-----|-----|-----|-----|
| T TEST ANALYSIS FOR PRE AND POST OPERATIVE VALUES - BASED ON C(MM) | Mean | Variance | T VALUE |
| PREOPERATIVE                 | 6.9 | 1.09 | 9.103 |
| POST OPERATIVE               | 2.1 | 1.69 |       |

STATISTICAL SIGNIFICANCE VALUE
Probability (two-tailed): 0.00001704
Probability (one-tailed): 0.00000852

In this statistical Significance analysis, the computed t-score exceeds the table value of t. Gingival display reduced to 5.1 ± 0.2 mm so we can reject the null hypothesis of no relationship between pre and post-operative values. All ten patients began to show improvement approximately 10 days after the Injection. After 14 days, results were definitely observed. The pre-treatment, 2,4,6,8,16,24th week measurements were recorded and compared for ten patients separately in tabular column. Among the ten patients, In eight patients the gingival display decreased around 5.1mm, for one patient it is decreased to 3mm in lower limit, & in other patient it decreased to 6mm in higher limit.

Graph 1: Decrease in gummy smile over subsequent weeks.
V. Discussion

An esthetically pleasing smile is not only dependent on components such as tooth position, size, shape, and color, but also on the amount of gingival display and the framing of the lips. All of these components form a harmonic and symmetric entity. The lips are the controlling factor in which portions of the teeth, gingival, and oral cavity will be seen in an individual’s smile. The higher the upper lip is elevated when smiling, more visible the teeth and gingiva. The display of excessive gingival tissue in the maxilla upon smiling has been called a “gummy smile.” The etiology may be skeletal, gingival, muscular, iatrogenic, or combination of these. The muscular capacity to raise the upper lip higher than average (hyper functional muscle) can cause excessive gingival display.

Muscles of facial expression responsible for upper lip elevation and lateral retraction upon smiling are LLSAN, LLS, zygomaticus major (ZM), zm, risorius, and, to a lesser degree, the depressor septi nasi muscle.

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.

The canine, or gummy smile is dominated by excessive contraction of the LLS muscles, according to Rubin.

Several methods to treat gummy smile include surgical procedures, miniscrew, laser, but all the above procedures are invasive & had a recurrence rate. A non-surgical alternative for reducing excessive gingival display caused by muscle hyperfunction would be advantageous. Botulinum toxin is under clinical investigation since the late 1970s for the treatment of several conditions associated with excessive muscle contraction or pain.

BTX-A weakens skeletal muscles by cleaving the synaptosome-associated protein SNAP-25, thus blocking the release of acetylcholine from the motor neuron and enabling the repolarization of the postsynaptic terminal. As a result, the muscular contraction is blocked. The production of acetylcholine is not affected by this blockade of the neuromuscular transmission. The effects last 3 to 6 months, although some investigators have reported a longer duration in patients exposed over a prolonged period of time.

Previous studies done by Polo with the use of botulinum toxin A to reduce the gumminess has given encouraging results. In the study done by Polo in 2005 on 5 patients who received 2 doses, with time gap of one month between 2 doses. Follow-up visits were at 2, 4, 8, 12, 16, 20, and 24 weeks post injection. There is a mean gingival decrease of 5.1mm.

In this study, ten subjects (eight female patient & two male patient) with excessive gingival display secondary to hyper functional upper lip elevator muscles were enrolled in the study. Their ages ranged from 15 to 27 years. One dose of 2.5 units was given on either side. Follow-up visits of all 10 subjects were evaluated at the weeks- 2, 4, 6, 8, 16 and 24. Extraoral photographs & close up photographs with a ruler were taken to measure the gingival display.

All ten patients began to show improvement approximately 10 days after the injections. After 14 days, results were definitely observed. The pre-treatment and postoperative 2, 4, 6, 8, 16,24 weekmeasurements were recorded. The mean gingival display decrease was $5.1 \pm 0.2 \text{ mm}$.

The most important for avoiding most unwanted adverse effects are the proper techniques of dilution, storage, and injection, as well as the careful exclusion of Patients with any contraindications. Pain, hematoma, ecchymosis, and bruising can be prevented by cooling the skin before and after Botox injection. Upper lid ptosis may be partly corrected using apraclonidine or phenylephrine eyedrops. If simple rules relating to the indications for and application of botox are followed, this is a safe and effective drug.
VI. Conclusion

The following conclusions were drawn from the present study: Botox-A injection was effective in reducing gummy smile. A mean gingival exposure reduction of 5.1 mm was observed on administration of 2.5 units on either side.

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