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NEW ANATOMICAL INSIGHTS INTO PREVENTING BROW PTOSIS WITH BOTULINUM TOXIN-A USE

INTRODUCTION

Botulinum toxin-A (BTX-A) injections were the most commonly performed non-surgical procedure in 2020 according to the Aesthetic Plastic Surgery National Databank Statistics.[1] Between 2019 and 2020, the number of neurotoxin injections performed in the United States has risen 1.5 fold from 1,712,994 to 2,643,366.[1,2] When utilizing BTX-A in the upper face, the incidence of eyebrow ptosis varies widely and has been quoted in the literature at upwards of 20%.[3-6] This adverse event is not exclusively seen post-treatment of the frontalis muscle but can also occur through inadvertent diffusion of the neurotoxin when treating the glabellar complex.[6] Over the past year, new anatomic considerations to help injectors optimize results and reduce the risk of eyebrow ptosis with frontalis and glabellar BTX-A injections have been published.[7-9] This paper aims to summarize three such publications which may help to positively impact injectable outcomes in the clinician's day-to-day practice.

THE LINE OF CONVERGENCE

The frontalis muscle acts as the sole elevator of the eyebrows, thereby making injectors proceed with caution when treating this area with BTX-A for fear of eyebrow ptosis. To minimize this risk, it is recommended to focus treatment on the upper portion of the frontalis despite a lack of evidence for why this produces a more desirable clinical outcome.[7-10]

In 2020, Cotofana et al. helped shed light on this clinical phenomenon by introducing the concept of the Line of Convergence (C-line).[7] Twenty-seven healthy volunteers (11 men and 16 women) with a mean age of 37.5 ± 13.7 years (range, 22 to 73 years) and of diverse ethnicity (14 Caucasians, four African Americans, three Asians, and six of Middle Eastern descent) had the pattern of their forehead movement during eyebrow

elevation analyzed. The mean forehead height was found to be 65 ± 8.1 mm and 53.4 ± 9.2 mm for men and women, respectively. The median number of horizontal forehead rhytids independent of sex was four.[7]

The investigators found that all patients had a bimodal movement of forehead skin with elevation of the eyebrows and depression of the hairline. The C-line was the name given to the stable horizontal forehead line. The position of the C-line was found at approximately 60% of the total forehead height when moving superiorly from the eyebrows. This location also corresponded to the second forehead line when counting in the inferior direction from the hairline **(Figure 1)**. Interestingly, there were no statistically significant variations between sexes or ethnicities.[7]

This paper helped to elucidate the role of the frontalis muscle and its bidirectional movement. The lower ~60% appears to act as an eyebrow elevator, whereas the upper ~40% depresses the hairline. Clinically, the concept of the C-line can help injectors reduce the risk of eyebrow ptosis by using a lower dosage in the lower 60% of the forehead when appropriate.

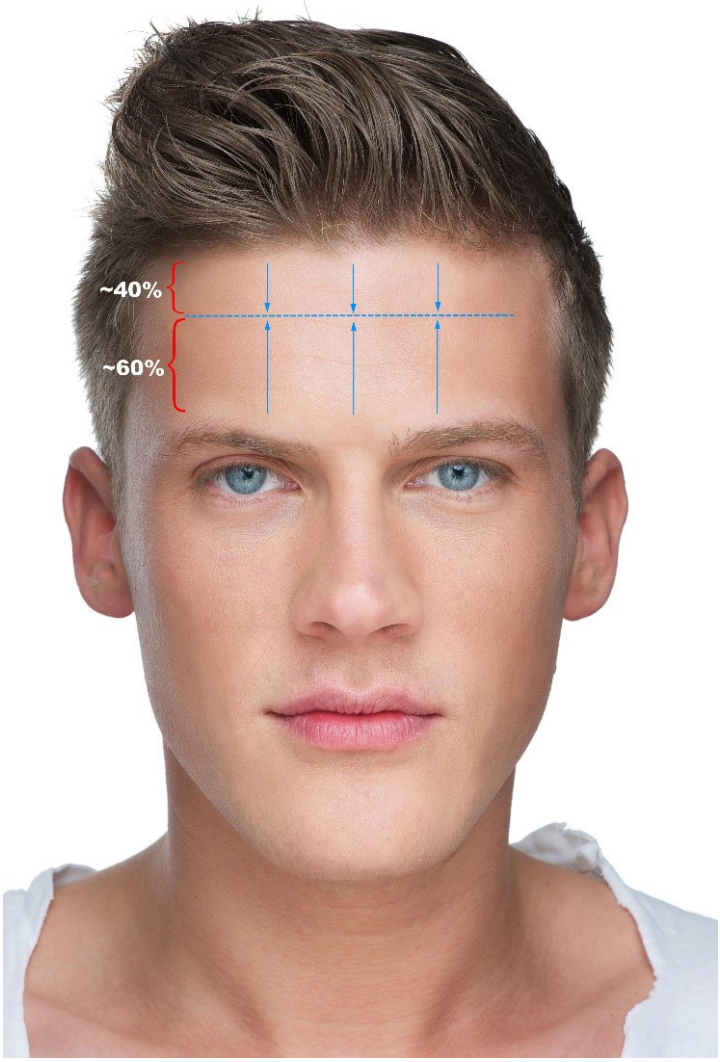

Figure 1: The approximate location and movement of the Line of Convergence; courtesy of Matthew Sandre, MD

DEPTH OF INJECTION WHEN TREATING THE FRONTALIS

Similarly, clinicians must also consider the depth of injection when treating the forehead to minimize the risk of brow ptosis. Superficial/dermal injections of BTX-A on the forehead have been previously shown to result in a lower number of eyebrow ptoses when compared to deeper/intramuscular injections.[8,11,12]A recently- published , prospective interventional, split-face study assessed the depth of BTX-A injections in the treatment outcomes of horizontal forehead lines.[8] The results demonstrated how a blended-depth injection technique is supported by the forehead's fascial anatomy and may lead to a more optimal aesthetic result.[8]

Fourteen patients with a mean age of 35.71 (7.8) years and mean body mass index of 21.9 (3.0) kg/m^2 had their foreheads treated with abo-BTX-A. There were 8 injection points per frontalis (4 per side) which were landmarked as mirror images of each other. The dose injected varied between patients based on their frontalis muscle activity with a mean value of 25.73 international units of abo-BTX-A. One side was treated with superficial injections in order to place product superficial to the frontalis muscle. This was accomplished placing the needle at a 45° angle and producing a bleb with product injection. The contralateral side was treated with deep injections perpendicular to the skin surface, placing product in the supraperiosteal plane. This depth was confirmed by the injectors hearing a 'click' to indicate that they pierced the subfrontalis fascia.[8]

The treatment outcome was rated by the physician and by two independent observers according to a forehead line severity scale (0-4) at 14 and at 30 days. The results found that the deep injections produced a superior outcome in reducing horizontal forehead line severity at days 14 and 30 compared to the contralateral side that received more superficial BTX-A injections.[8] No eyebrow or eyelid ptoses were observed with either injection technique.

Injections above the C-line (in the upper 40% of the forehead), can be injected deep in order to help maximize neurotoxin effect on the frontalis muscle. Comparatively, BTX-A injections below the C-line, or in areas where one wishes to have less effect on the frontalis muscle activity, can be placed more superficial to reduce the possibility of eyebrow ptosis.[8]

A recently-published paper demonstrated the clinical utility of a 3-point glabellar injection technique to reduce the possibility of medial eyebrow ptosis and excessive lateral eyebrow lifting/"Spocking". The approach centers on understanding the detailed anatomy of the procerus and corrugator supercilii muscles and targeting their bony origin, reducing the frequency of indirectly affecting the lower frontalis.[9]

Box. 1 New Potential Strategies to Prevent Eyebrow Ptosis with BTX-A Injections

- When injecting the frontalis:
  - » Consider placing the majority of the units above the C-line
  - » Injections below the C-line can be placed more superficial to lessen the effect on frontalis muscle activity
  - » Injections above the C-line can be placed deep on bone to maximize effect on frontalis muscle activity
- When injecting the glabella:
  - » Inject deep on bone at the origin of the procerus and corrugator supercilii
  - » Avoid injections above the level of the hairy eyebrow

Anatomically, the superficial injection places BTX-A above the suprafrontalis fascia which acts as a partial barrier between the product and the frontalis muscle.[8,13] In contrast, the perpendicular deep injections not only place the product deep to the subfrontalis fascia but also create a vertical channel for the BTX-A to travel retrograde along and therefore come in direct contact with the frontalis muscle.[8] Davidovic et al. highlighted that this retrograde travel of fluids has also been documented previously using fillers with different viscoelastic properties.[14-16]

3-POINT GLABELLAR INJECTION TECHNIQUE

Glabellar injection techniques frequently differ between practitioners depending on variables such as injector preference, the patient's desired outcomes, and glabellar contraction patterns.[9,17-20] Many injection techniques target both the medial and lateral corrugator supercilii muscle, and the placement of these injection points can occasionally allow product to diffuse to the lower frontalis muscle fibers increasing the risk of an eyebrow ptosis.[9,17,18]

A total of 105 patients (27 males and 78 females) with a mean age of 40.90 ± 9.2 years were included between the different participating centres. A standardized 2D and 3D injection technique was used but injectors were allowed to vary the number of units between patients and select the type of BTX-A used. Injection of the procerus was completed using a midline injection point at a vertical height of a line connecting the medial canthal ligaments. The needle was inserted perpendicular to the skin and product was injected deep on bone. The corrugator supercilii injection was also deep on bone at the medial inferior eyebrow. The needle was inserted at a 45°

angle to both the midline and frontal bone. No injection points were above the line of the hairy eyebrow.[9] **(Figure 2)**

eyebrow ptosis, eyelid ptosis, or "Spocking" of the lateral eyebrow. An increase in medial eyebrow height of 1.21 ± 2.8 mm was also observed.[9]

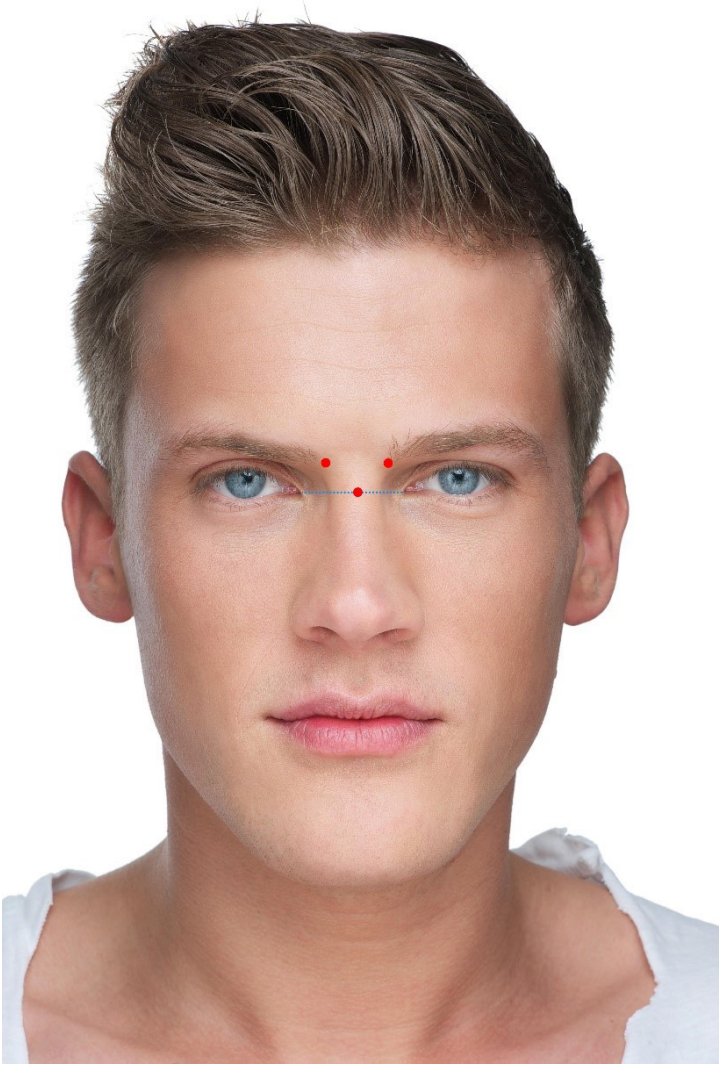

Figure 2: The three-point glabellar complex injection technique; courtesy of Matthew Sandre, MD.

The procerus muscle was injected with an average of 5.23 ± 2.5 units of ona-/inco-BTX-A or 12.90 ± 6.3 units of abo-BTX-A. Each corrugator supercilii muscle was injected with an average of 13.27 ± 5.7 units ona-/inco-BTX-A or 33.17 ± 14.2 abo-BTX-A. A statistically significant reduction in median glabellar wrinkle score was seen with this injection technique (median score before treatment = 3; median score at 14 days = 0). There were no cases of

Clinically, this newly-proposed 3-point technique appears to have the potential to reduce the risk of eyebrow ptosis while still achieving desirable glabellar wrinkle reduction. Furthermore, less injection sites also reduce patient discomfort and the risk of bruising, making it appealing for injectors and patients alike.

CONCLUSION/DISCUSSION

The demand for non-surgical aesthetic procedures continues to rise in dermatology practices and BTX-A injections may offer patients an effective treatment option for many commonly encountered facial aesthetic concerns. Although facial BTX-A injections carry a relatively low rate of complications, expert injectors are continuously looking for new ways to optimize patient outcomes and minimize risk. This paper highlights three recent publications that aim to expand our anatomic knowledge of the forehead and glabellar complex and how it relates to BTX-A injection techniques. However, it is critical that clinicians remain cognizant of variations in patients' anatomy and aesthetic goals which are essential to consider during every patient encounter.

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