

Optimized Aesthetic Outcomes When Treating Glabellar Lines with Botulinum Toxin Type A: GLO 3 + 2: A Precise Technique Based on Anatomy

Nowell Solish, MD*
 Michael A.C. Kane, MD†
 Jessica Brown, PharmD‡
 Conor J. Gallagher, PhD‡

Summary: Good patient outcomes after treatment of the glabellar complex with botulinum toxin type A entail elimination of glabellar lines and maintenance of a natural eyebrow position. A precise injection technique that accurately targets the muscles that influence eyebrow position is required to reduce the risk of adverse aesthetic outcomes or unmasking an underlying eyelid ptosis. Here, we describe the glabellar lines optimization (GLO 3 + 2) injection anatomy technique, a precise five-point injection pattern that is based on current understanding of facial functional anatomy and which aims to minimize the risk of affecting nontargeted muscles. Injection sites above the brow or that do not target the precise location of the muscles in the glabellar complex are likely to inadvertently expose the frontalis to botulinum toxin type A and result in undesirable aesthetic outcomes. Because the frontalis is a strong determinant of aesthetic outcomes, it is important to consider the overall effects of the interactions between the eyebrow depressors and the opposing forces of the frontalis on brow outcomes in both the resting brow position and during dynamic brow movement. (*Plast Reconstr Surg Glob Open* 2024; 12:e5650; doi: 10.1097/GOX.0000000000005650; Published online 4 March 2024.)

INTRODUCTION

Achievement of optimal outcomes after glabellar complex treatment with botulinum toxin type A (BoNTA) entails elimination of glabellar lines and maintenance of natural or pleasing eyebrow positions and shapes.^{1,2} Eyebrow outcomes typically perceived to be unappealing or unnatural have excessive elevation of the lateral brow relative to the medial brow, causing “quizzical” brow shapes at rest or on animation, or cause the brow to drop, resulting in tired or depressed appearances, and which may be overly masculinizing. Although facial anatomy varies between patients, the anatomical principles that affect the relative dominance of facial muscles on eyebrow symmetry and position are relatively consistent.^{1,3} In particular, the medial and lateral frontalis regions contribute to maintenance of eyebrow shape at rest and to aesthetically pleasing outcomes at maximum forehead

lift.³ Hence, injection techniques that avoid the frontalis and precisely target the glabellar muscles that influence eyebrow position are as important as dosing for good patient outcomes.^{2,4}

The conventional five-point injection pattern for glabellar treatment with BoNTA aims to target the procerus, the medial and lateral aspects of the corrugator supercilii, and the horizontal fibers of the superior orbicularis. Treatment guidelines recommend an individualized approach and avoiding the lower frontalis to minimize adverse brow effects.² In practice and, in part, because of outdated/incorrect anatomical images, practitioners may attempt to lower the risk of eyelid ptosis by administering BoNTA 1–2 cm above the upper brow.^{2,5–8} New insights into facial functional anatomy suggest this approach does not target the anatomical location of the key muscles that cause glabellar lines to form and increases the risk of the frontalis being exposed to BoNTA.^{3,4,9} Thus, a more precise injection pattern that requires accurate location and targeting of the procerus and corrugator supercilii muscles is needed. Here, we describe the glabellar lines optimization (GLO 3 + 2) injection anatomy technique, a precise

From the *Division of Dermatology, University of Toronto, Toronto, Ontario, Canada; †Department of Plastic Surgery, Manhattan Eye, Ear, and Throat Hospital, New York, N. Y.; and ‡Revance Therapeutics, Inc., Newark, Calif.

Received for publication July 14, 2023; accepted January 16, 2024.

Copyright © 2024 The Authors. Published by Wolters Kluwer Health, Inc. on behalf of The American Society of Plastic Surgeons. This is an open-access article distributed under the terms of the [Creative Commons Attribution-Non Commercial-No Derivatives License 4.0 \(CCBY-NC-ND\)](https://creativecommons.org/licenses/by-nc-nd/4.0/), where it is permissible to download and share the work provided it is properly cited. The work cannot be changed in any way or used commercially without permission from the journal.

DOI: 10.1097/GOX.0000000000005650

Disclosure statements are at the end of this article, following the correspondence information.

Related Digital Media are available in the full-text version of the article on www.PRSGlobalOpen.com.

five-point injection pattern for glabellar line treatment with BoNTA that is based on current understanding of facial functional anatomy and which aims to minimize the risk of affecting nontargeted muscles.^{3,10}

FACIAL FUNCTIONAL ANATOMY RELEVANT TO GLABELLAR LINE TREATMENT

Evidence from cadaver and in vivo imaging studies show that corrugator muscles extend horizontally from below the superciliary arch along the natural hairy brow line, rarely extending above the hairy eyebrow margin (Fig. 1).^{3,6,7} The frontalis, the only muscle that suspends the eyebrows, originates from the galea and extends caudally, remaining superficial, and interdigitates with the corrugator and procerus muscles at the upper brow margin.³ Because eyebrow position is a balance between the downward forces of the depressor complex and the upward forces of the frontalis, any weakening of the lower frontalis by BoNTA exposure will unbalance these forces, potentially resulting in adverse brow outcomes. Conventional teaching has encouraged practitioners to place corrugator injection points 1–2 cm above the brow, to minimize gravity-driven spread of BoNTA into the superior orbit and to prevent exposure of the levator palpebrae superioris to BoNTA.⁵ However, whether injecting the medial or lateral corrugator regions,

Takeaways

Question: How to accurately target the muscles in the glabellar complex and avoid adverse eyebrow outcomes and eyelid ptosis when treating glabellar lines with botulinum toxin type A.

Findings: A precise and accurate injection technique that targets the muscles that influence eyebrow position is as important as dosing to ensure good patient outcomes when treating the glabellar complex with botulinum toxin type A.

Meaning: Avoiding adverse outcomes with glabellar line treatment requires accurate identification of the true anatomic location of the procerus and the medial and lateral corrugator regions, considerations for assessment of frontalis activity and underlying eyelid ptosis, and a precise injection technique.

injections above the brow and those that do not target the precise location of the glabellar muscles are likely to inadvertently expose the frontalis to BoNTA, resulting in undesirable aesthetic outcomes.⁴ These unwanted effects can occur by several mechanisms, depending on where the lower frontalis is weakened. Inactivation of the lower medial frontalis through inadvertent BoNTA exposure

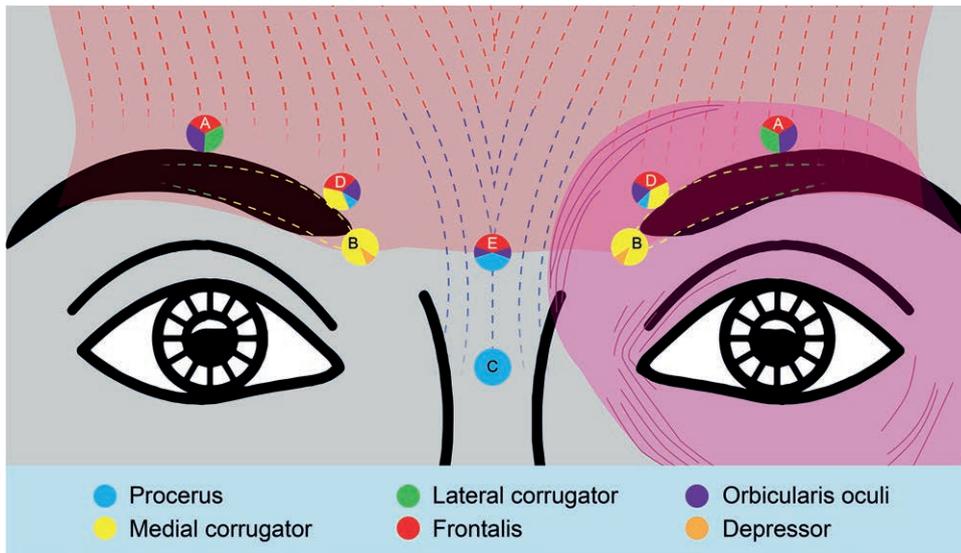


Fig. 1. Illustration of glabellar injection sites with botulinum toxin type A when treating upper facial lines. Colored circles and segments represent the locations of the facial muscles in most patients. Yellow and green dashed lines denote the medial and lateral corrugator supercillii, respectively; red dashed lines and shading denote the frontalis muscle; blue dashed lines denote the procerus; and pink lines and shading denote the orbicularis oculi. The recommended technique includes superficial injections to the lateral corrugator (A), which overlies the frontalis; deep injections to the inferior medial corrugator (B), which underlies the frontalis and where the bulk of medial corrugator mass is located for most patients; and deep injections to the lower procerus (C), where the bulk of the muscle mass is located. Injection sites more likely to be at risk of exposing the central frontalis to botulinum toxin type A include the superior medial corrugator (D), which may also include the frontalis and procerus, irrespective of injection depth, and the superior procerus (E), which may also include the frontalis and orbicularis oculi. Reproduced with permission of Oxford University Press from Bertucci V, Green JB, Fezza JP, et al. Impact of glabellar injection technique with DaxibotulinumtoxinA for Injection on brow position. *Aesthet Surg J.* 2023;43(Suppl 1);S10–S18.

can result in medial brow drop (which may be perceived as lateral brow elevation), resulting in a “Spock” eyebrow shape, whereas weakening of the lower medial and lateral frontalis regions can result in a brow drop across all regions. Unbalanced changes in medial and lateral brow position may be evident at rest and will be intensified upon dynamic brow movement.⁴ The supplemental video shows how to accurately identify the true anatomic location of the corrugators and procerus in patients before glabellar line treatment and considerations for assessment of frontalis activity. [See **Video (online)**, which displays (1) how to accurately locate target muscles for glabellar line treatment (24 seconds), (2) considerations for frontalis activity and preexisting eyelid and baseline eyebrow ptosis (1 minute, 39 seconds), (3) identification of target muscles in patients during the pretreatment assessment, and (4) the GLO 3 + 2 injection anatomy technique (3 minutes, 9 seconds)].

GLO 3 + 2 INJECTION ANATOMY TECHNIQUE

The GLO 3+2 injection anatomy technique was identified after an analysis of the effects of subtle differences in a five-point glabellar injection technique with daxibotulinumtoxinA-lanm for injection (Revance Therapeutics, Inc., Nashville, Tenn.) on resting brow position among four clinical trial investigators.⁴ Brow position was measured quantitatively using vertical and horizontal brow displacement. An injection technique that precisely targeted the true anatomic location of the corrugators and procerus did not result in negative eyebrow outcomes, whereas techniques that did not precisely target the true location of these muscles (ie, medial corrugator injections above the brow, lateral corrugator injections deeply or toward the medial third of the brow, procerus injections above the inferomedial

brow) were associated with suboptimal outcomes.⁴ [See **figure, Supplemental Digital Content 1**, which displays eyebrow outcomes after glabellar line treatment with botulinum toxin A in (A) a 54-year-old woman who received the GLO 3 + 2 injection technique that precisely targeted the true anatomic location of the corrugators and procerus and (B) a 36-year-old woman who did not receive the GLO 3 + 2 technique. In patient B, injection points to the medial regions of the corrugators were accurately targeting the medial region, but injections to the lateral regions of the corrugators and the procerus exposed the lower frontalis to botulinum toxin A. Adapted with permission from Bertucci V, Jean D Carruthers JD, Sherman DD, et al. Integrative Assessment for Optimizing Aesthetic Outcomes When Treating Glabellar Lines With Botulinum Toxin Type A: An Appreciation of the Role of the Frontalis. *Aesthet Surg J.* 2023;43(Suppl 1);S19–S31. <http://links.lww.com/PRSGO/D94>]. Although a direct comparison was not conducted, the anatomical specificity of this technique should be applicable to the treatment of glabellar lines with other neuromodulators.

Video 1 demonstrates the GLO 3 + 2 injection anatomy technique. Medial corrugator injections are full-dose and placed medially, deep into the muscle bulk, inferomedial to the natural hairy brow (Fig. 2).⁴ Lateral corrugator injections are placed at or just medial to the midpupillary line; superficially; and, as low as possible, slightly above the upper margin of the natural hairy brow to minimize exposure of the frontalis to BoNTA.^{3,4,10} Procerus injections are placed deep into the greatest muscle bulk, close to its origin, in the midline, and generally horizontally aligned with the medial canthi regions.⁴

Selection of BoNTA injection patterns and doses for glabellar line treatment typically involve facial assessments that are centered on glabellar complex activation. Because of individual differences in the location, size, and activity

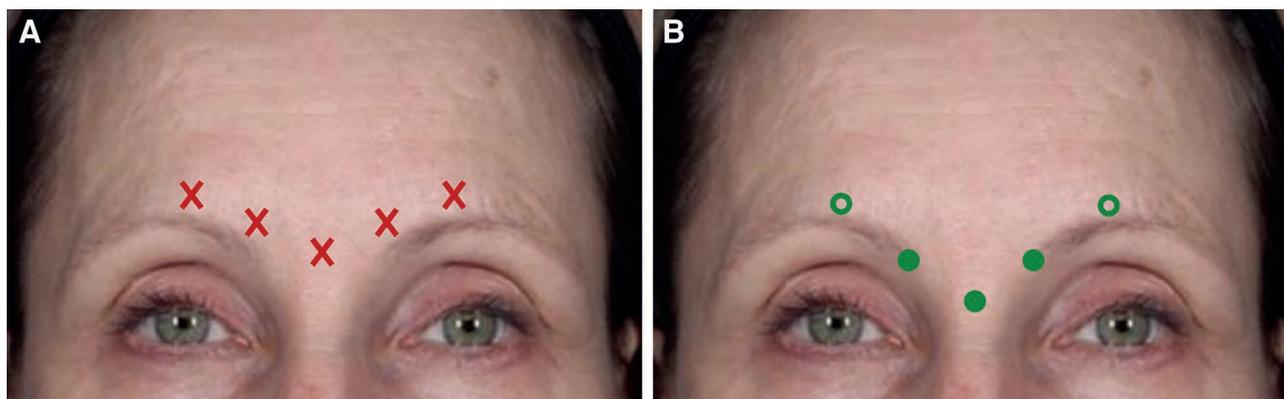


Fig. 2. Recommended five-point injection pattern for treatment of the glabellar complex with botulinum toxin type A. A, As shown on the left, medial corrugator injection sites above the medial brow, lateral corrugator injection sites administered deeply or more medially toward the medial third of the brow, and procerus injection sites superior to the horizontal line connecting the inferior region of the medial brows are not recommended. B, The recommended five-point injection pattern is shown on the right and comprises deep injections into the inferomedial aspect of the natural hair-bearing eyebrow, near the origin of the corrugator supercilia; superficial injections into the lateral corrugator, between the midpupillary and lateral limbal lines and within 1 mm of the natural hair-bearing eyebrow; and a deep midline injection to the procerus, at or below the horizontal line connecting the inferior region of the medial brows. Representative images are shown for a 54-year-old woman. Reproduced with permission of Oxford University Press from Bertucci V, Green JB, Fezza JP, et al. Impact of glabellar injection technique with DaxibotulinumtoxinA for Injection on brow position. *Aesthet Surg J.* 2023;43(Suppl 1);S10–S18.

of facial muscles, and because the frontalis is such a strong determinant of aesthetic outcomes, it is critical to include a broader and more detailed assessment that considers the overall effects of the interactions between the eyebrow depressors and the opposing forces of the frontalis on brow outcomes in the resting brow position and during dynamic brow movement.⁹ For patients with a compensated eyelid ptosis, inadvertent exposure of the lower frontalis to BoNTA may weaken involuntary frontalis activity, unmasking the ptosis. Patients with “wavy” forehead lines, which usually indicates a central aponeurosis, have limited medial frontalis activity and less latitude for weakening before the frontalis is overwhelmed by the downward forces of the depressor complex.³ These patients are at a greater risk of medial brow drop with injection sites that are more cranial, resulting in adverse outcomes.⁹ For patients with existing eyebrow ptosis, inadvertent exposure of the lower frontalis to BoNTA is likely to worsen the ptosis. For these patients, it is particularly important to precisely identify the location of, and precisely inject, the lateral corrugator region to ensure minimal impact on the frontalis.

CONCLUSIONS

Practitioners need to be aware of the implications of imprecise injection techniques on patient outcomes when treating glabellar lines, irrespective of neuromodulator type. Although seemingly easy, optimal glabellar line treatment requires individualized approaches based on an up-to-date understanding of facial functional anatomy and the interplay of the frontalis with the depressor complex, to inform the pretreatment assessment and selection of treatment patterns and dosing.⁹ The GLO 3 + 2 Injection technique minimizes exposure of the frontalis to BoNTA during glabellar injection by precisely targeting the glabellar muscles. However, individual treatment responses can vary and, as with any injection technique, it is important to conduct a posttreatment assessment to determine whether adjustments are necessary.²

Jessica Brown, PharmD

Medical Affairs, Revance Therapeutics
7555 Gateway Blvd
Newark, CA 94560

E-mail: jbrown@revance.com

DISCLOSURES

This analysis was supported by Revance Therapeutics, Inc. (Nashville, Tenn.), manufacturer of DAXXIFY (daxibotulinumtoxinA-lanm for injection). Writing and

editorial assistance was provided to the authors by Serina Stretton PhD, CMPP, of Envision Pharma Group and was funded by Revance Therapeutics, Inc. The authors did not receive honoraria or payments for authorship.

Nowell Solish is a clinical investigator and consultant for Allergan Aesthetics, an AbbVie Company (Dublin, Ireland), Croma-Pharma (Leobendorf, Austria), Galderma (Lausanne, Switzerland), Merz Aesthetics (Frankfurt, Germany), and Revance Therapeutics, Inc. (Nashville, Tenn.); and is a speaker for Allergan Aesthetics and Galderma.

Michael A.C. Kane has been a consultant and investigator for Galderma, Merz Aesthetics, and Revance Therapeutics, Inc. He is a consultant for Allergan Aesthetics, Alphaeon Corporation (Irvine, Calif.), Premier Pharm (Moscow, Russia), Teoxane (Geneva, Switzerland), and Valeant (Laval, Quebec, Canada).

Jessica Brown and Conor J. Gallagher are employees of Revance Therapeutics, Inc.

REFERENCES

1. Anido J, Arenas D, Arruabarrena C, et al. Tailored botulinum toxin type A injections in aesthetic medicine: consensus panel recommendations for treating the forehead based on individual facial anatomy and muscle tone. *Clin Cosmet Investig Dermatol*. 2017;10:413–421.
2. Kaminer MS, Cox SE, Fagien S, et al. Re-examining the optimal use of neuromodulators and the changing landscape: a consensus panel update. *J Drugs Dermatol*. 2020;19:s5–s15.
3. Cotofana S, Solish N, Gallagher C, et al. The anatomy behind eyebrow positioning: a clinical guide based on current anatomic concepts. *Plast Reconstr Surg*. 2022;149:869–879.
4. Bertucci V, Green JB, Fezza JP, et al. Impact of glabellar injection technique with daxibotulinumtoxinA for injection on brow position. *Aesthet Surg J*. 2023;43(Suppl 1):S10–S18.
5. Cohn JE, Greco TM. Advanced techniques for the use of neurotoxins in non-surgical facial rejuvenation. *Aesthetic Plast Surg*. 2020;44:1788–1799.
6. Lee H-J, Lee KW, Tansatit T, et al. Three-dimensional territory and depth of the corrugator supercilii: application to botulinum neurotoxin injection. *Clin Anat*. 2020;33:795–803.
7. Benedetto AV, Lahti JG. Measurement of the anatomic position of the corrugator supercilii. *Dermatol Surg*. 2005;31:923–927.
8. Macdonald MR, Spiegel JH, Raven RB, et al. An anatomical approach to glabellar rhytids. *Arch Otolaryngol Head Neck Surg*. 1998;124:1315–1320.
9. Bertucci V, Carruthers JD, Sherman DD, et al. Integrative assessment for optimizing aesthetic outcomes when treating glabellar lines with botulinum toxin type A: an appreciation of the role of the frontalis. *Aesthet Surg J*. 2023;43(Suppl 1):S19–S31.
10. Lorenc ZP, Smith S, Nestor M, et al. Understanding the functional anatomy of the frontalis and glabellar complex for optimal aesthetic botulinum toxin type A therapy. *Aesthetic Plast Surg*. 2013;37:975–983.