Balanced Botox Chemodenervation of the Upper Face: Symmetry in Motion

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ABSTRACT

Cosmetic botulinum toxin type A (Botox, Allergan, Inc., Irvine, CA) has revolutionized minimally invasive treatment of the upper face. Increasingly sophisticated outcomes result in facial symmetry in motion. The face is a three-dimensional moving unit, not an isolated photograph. This is why the advanced injector must hone an astute ability to observe casual microexpressions. Consideration is then given to the patient's age, facial anatomy, facial asymmetry, and dynamic rhytids. The ratio of dosing to agonist and antagonist muscles that allows unopposed action is determined. Nuance in placement and dose combined with adjunct therapy results in natural and appropriate facial emotion and avoids unnatural or bizarre patterns of movement. Asymmetrical scenarios are presented to exemplify this process of analysis and treatment. Many authors have detailed the mechanism of action, history of Botox development, and specific muscle group treatment in the periorbital region. In this discussion, I leave behind rigorous academic analysis and wish to offer my approach, which has evolved through 15 years experience treating the aesthetic patient with Botox. The clinician can read about recommended patterns of injection, and the procedure is quite simple. It is only through skilled observation and understanding of expressive nuance and anatomy that the advanced injector will meet the goal of a natural communicative result with chemodenervation. Experience is accumulated through critical analysis of patient results over time. This discussion first directs attention to why it is important to learn how to look at the face in motion as well as at facial rhytids. A plan is developed for treatment including drug preparation, dosing decisions, precise three-dimensional delivery, and adjunct therapy. Perils may generally be avoided by choosing appropriate dosing and placement. The asymmetrical patient scenario is used to demonstrate nuance in evaluation and treatment.

KEYWORDS: Botox, chemodenervation, symmetry, motion

EVALUATION OF THE PATIENT

Many authors have detailed the mechanism of action, history of Botox development, and specific muscle group treatment in the periorbital region.¹⁻⁹ Nearly all patients have some degree of asymmetrical action of the facial musculature. The injector learns to observe microexpressions and address casual and forced facial actions, habits,

and asymmetries.¹⁰⁻¹⁴ A detailed pattern and dosage of Botox is devised that achieves finesse in treatment for the upper face.

Control and alteration of facial expression can be a powerful tool, which is why it is so important to learn how to observe the face in motion. Psychologist Paul Ekman studied facial expressions beginning in the 1960s

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and identified 3000 expressions, cataloguing the “essential repertoire of human emotion.” Forty-three separate action units were identified, describing every distinct combination of muscular movements the face could make. An action unit is contraction or relaxation of one or more muscles. The Facial Action Coding System was developed by Paul Ekman and Wallace Friesen in 1976 to taxonomize every human facial expression. It is still used by psychologists, interviewers, and animators. Astute observers of facial expression may be able to detect, for example, an insincere smile associated with lying.¹² Orbicularis contraction and palpebral fissure narrowing on genuine smiling is associated with contraction of the zygomaticus major muscle. If the action of a muscle is completely obliterated, it can significantly change emotive ability. This is why it is important to be aware of how we may affect the patient’s perceived expressive communication by weakening any particular muscle. Advanced injectors of Botox evaluate facial asymmetries and dynamic muscle action and artfully deliver the drug to achieve the desired result. Sometimes this means less toxin is used such that motion is preserved, resulting in a natural, pleasant, and communicative appearance in exchange for incomplete wrinkle effacement.

In addition to softening dynamic rhytids, we can use upper facial treatment with Botox to shape the brow and improve of symmetry or position of the head and tail of the brow, lid fold, and palpebral fissure. The eyebrow is manipulated by combining treatment of the brow depressor and brow elevator muscles. The masculine brow generally should be shaped in a more “T” configuration with respect to the nose. A “C” shape with a mild lateral arch generally appears more feminine. Excessive elevation of the head of the brow may induce a surprised look or expose a hollow upper eyelid sulcus. Some patients have a deep upper eyelid sulcus postblepharoplasty from aggressive upper lid fat removal. In this case, it may be desirable to drop the brow position to deemphasize the hollow appearance.

TREATMENT CONSIDERATIONS

A plan for treatment includes preparation of the toxin, balancing the dosage and muscles to be treated, and specific site and depth of muscle injection. Botulinum type A toxin met Food and Drug Administration (FDA) approval for cosmetic glabellar injection in 2002,¹⁵ although I have used it in my practice since 1992. Injection to temporarily weaken any other muscle of facial expression for cosmetic reason is an off-label use of the neurotoxin. For the duration of temporary chemodenervation, the skin has a “rest period” during which the patient’s own collagen remodels the dermis that had been affected by dynamic muscle influence.¹⁶ If Botox is kept in effect routinely every 3 to 5 months, the rhytids are prevented from reforming. Duration of Botox versus

excess muscle weakness must be balanced. A larger-unit dose of toxin will increase the density of weakness and duration of effect. Generally, the lowest dose and volume that will achieve the desired effect is used. If a small dose is used in the orbicularis area to soften the crow’s feet, the area usually reanimates in less than 3 months. Conversely, if a larger dose is administered, undesirable side effects such as decreased blink, widening of the palpebral fissure,¹⁷ or ectropion may occur, but the smile lines will be softened for longer. In the case of partial facial muscle paresis, the muscle may be hypersensitive to chemodenervation, and the duration of effect very prolonged.

Routine intervals of maintenance, even if more widely spaced than 3 months, may avoid fluctuation in appearance and return of full muscular activity. The muscle is kept in a slightly atrophied state. The limited duration of Botox has pros and cons. The expense, time, and discomfort of injection are weighed against the reversibility and the ability to vary and alter doses over time as the face ages.

Volume of reconstitution varies from 1 to 4 mL by personal physician preference and may affect diffusion of the drug, pain from volume injected, precision of units delivered, and wastage of drug. I reconstitute 100 U of Botox from one vial with 1 mL of normal injectable bacteriostatic saline, yielding 10 U of toxin per 0.1 mL of volume. Preserved saline causes less discomfort during injection.¹⁸ I use the BD Ultra-Fine™ II Insulin Syringe, 3/10 mL, 31-gauge needle (BD Consumer Healthcare, Franklin Lakes, NJ).¹⁹ One unit on the insulin syringe then equals 1 U of Botox, allowing microdosing with minimal wastage. The planned dose for each area is drawn up in a separate syringe. The skin is prepped with cleanser.

An understanding of facial anatomy^{20,21} and observation of individual variance is essential. The advanced injector detects the strength and action pattern of the patient’s protagonist and antagonist muscles and decides to weaken or avoid each muscle. The action of a muscle may be potentiated by chemodenervation of its antagonist—and balancing this ratio must be carefully considered. The site, depth, and dose determine the effect on facial structure position in each patient. Depth of injection is important because of layered anatomical musculature and diffusion characteristics. When treating crow’s feet, I inject superficially just subcutaneously, avoiding direct orbicularis muscle and small vessel injection. The subcutaneous delivery allows for more diffusion and less bruising. The frontalis and procerus are injected superficially as well. The corrugator supercilii are injected intramuscularly to penetrate the bulkier muscle, and depressor supercilii are deeper. Touching the periosteum is avoided, as it is sensitive.

Figures 1 through 6 demonstrate patient scenarios that require asymmetrical treatment. This level of nuance may be used to evaluate and treat each “typical” cosmetic patient.

Figure 1 (A) A 53-year-old woman with right facial weakness since 1969 following jaw surgery later developed aberrant regeneration of the seventh cranial nerve. (B) Post-lower eyelid blepharoplasty and 43 U of Botox. Botox (30 U) was placed in the glabella bilaterally, using a lower position and higher dose to the left brow depressors. Botox (13 U) was placed to the frontalis muscle, more inferiorly on the right than the left.

When observing the human face, we are drawn to asymmetry. Botox is used to improve symmetry of the eyelid, brow, and cheek position by altering ratios of dynamic contraction. Attention to precise three-dimensional placement and minute variation in dosing achieves a balanced result: Figures 1 and 2 show two patients with aberrant regeneration of the seventh cranial nerve who manifest periorbital dynamic asymmetry. When cranial nerve VII regenerates, aberrant innervation to the facial muscles may occur, leading to narrowing of the palpebral fissure and eyebrow elevation. To achieve symmetry in motion, the patient is injected bilaterally but asymmetrically²² (Figs. 1A,1B, 2A, and 2B).

UNDESIRABLE EFFECTS

Undesirable aesthetic effects of Botox are most often due to placement and dosage, and they are transient. Inability to emote with the upper face is a telltale sign of Botox. Presumably we would like the patient's appearance to be natural and age appropriate and treatment undetectable. Therefore, leaving some movement and even some lines at rest is desirable. Following are some caveats in treating the periorbital areas: forehead, glabella, crow's feet, and cheek.

Many patients desire eyebrow elevation.²³ Some injectors undertreat the lateral frontalis and overtreat the central frontalis. This technique may drop the head of the eyebrow, giving a heavy glabellar appearance. The

Figure 2 (A) A 55-year-old woman presented for "drooped lid." She developed Bell's palsy in 1978 followed by aberrant regeneration of the seventh cranial nerve, stimulating left palpebral fissure narrowing (not ptosis) upon jaw movements and asymmetry of eyebrows. (B) Left palpebral fissure narrows with jaw movements. (C) Managed with Botox 50 U. Her right frontalis muscle is treated more inferiorly and her left frontalis more superiorly. A higher dose is delivered to her left brow depressors than her right to raise and control the abnormal shape of the left eyebrow. Microdosing to the left pretarsal and lateral orbital orbicularis oculi muscles widen the left palpebral fissure.

Figure 3 (A) Patient was seen post-Botox elsewhere with excessive lateral brow elevation and head of brow separation due to heavy glabellar and medial frontalis muscle treatment and omission of lateral frontalis treatment. Botox (7 U) was added to the lateral frontalis at this visit to drop the lateral brow. (B) Subsequently, the patient underwent upper eyelid blepharoplasty and was managed with 50 U of Botox to the brow depressors and lateral orbicularis without frontalis muscle treatment.

brain increases nerve impulses to the lateral frontalis muscle, which accentuates the tail of the brow elevation. In the extreme, this results in a “Mr. Spock” or sinister appearance (Figs. 3A and 3B). Ekman described this expression in an interview with *New Yorker* magazine (August 5, 2002) in the *Annals of Psychology* column titled “The Naked Face.” The movement that Ekman describes as “action unit two” raises the outer half of the eyebrow (lateral frontalis). Ekman comments that this action is worthless and not part of anything except Kabuki theater. Creating these unnatural or unpleasant expressions with Botox by selectively relaxing a particular combination of facial muscles is to be avoided. If the brow depressors (corrugators, procerus, orbicularis, and depressor supercilii) are treated high above the superior orbital rim, then the inferior frontalis may be affected too. By injecting at this position, the brow can be dropped either inadvertently or intentionally. If the depressors are treated too low and deep, the levator may be weakened by orbital seepage, leading to true eyelid ptosis. Sometimes a drop in the forehead may be perceived by the patient as an eyelid ptosis due to the glabellar heaviness, increased apparent dermatochalasis, and decompensation of habitual frontalis contraction.

A patient with latent myogenic ptosis who has been using the brow to compensate may be dropped to a state of repose and manifest true eyelid ptosis. Until the eyelid ptosis is surgically repaired, treatment of the frontalis should usually be spared.

Aggressive glabellar treatment, although generally well tolerated, may exhibit excessive separation of the head of the two eyebrows. Some patients overrepilate the medial brow hairs. Eyebrow separation becomes more obvious and unattractive following corrugator relaxation.

Microdoses (1 to 2 U) of Botox may intentionally weaken pretarsal upper eyelid orbicularis oculi to temporarily correct minor ptosis for symmetry²⁴ (Figs. 4A and 4B).

The closer the drug is delivered to the lid margin or canthus (pretarsal orbicularis), the greater effect on the palpebral fissure, blink, and lid closure. Care must be taken not to weaken the pretarsal and preseptal orbicularis muscle in patients with lid laxity, lagophthalmos, or dry eye syndrome. Patients with thyroid eye disease, for example, have relative proptosis, lagophthalmos, staring, and lid retraction. Typically they exhibit a widened palpebral fissure and decreased lid support. A high dose in the brow depressor muscles (procerus, corrugator supercilii, depressor supercilii, and superior lateral orbicularis oculi) is tolerated, but smaller doses or omission of treatment to the lateral and inferior lid areas (pretarsal and preseptal orbicularis oculi) is prudent. In a stable thyroid patient without corneal exposure, microdosing can balance minor residual asymmetry following surgery (Figs. 5A and 5B).

The orbicularis oculi muscle is a brow and upper eyelid depressor and cheek and lower eyelid elevator muscle. Heavy treatment of the lateral orbicularis oculi

Figure 4 (A) A 28-year-old woman with mild ptosis presents for Botox of crow's feet. (B) Thirteen days after 20 U of Botox. Botox (16 U) was placed to the lateral orbital orbicularis close to the canthal angle to widen the palpebral fissure and 4 U of Botox injected to the right upper lid pretarsal nasal and lateral orbicularis, which further elevates the right upper eyelid.

Figure 5 (A) A 36-year-old woman with thyroid-related orbitopathy underwent bilateral lower eyelid blepharoplasty and (her) right upper eyelid blepharoplasty with levator recession (elsewhere). She is unhappy with persistent eyelid asymmetry. (B) Managed with Botox 40 U. The nasal right eyelid is raised with 2 U Botox to pretarsal orbicularis. Her left upper lid drops due to Herring's law. Her right lateral orbicularis and right brow depressors are injected with higher doses than the left, and bilateral frontalis muscle is treated. This raises the right eyebrow and balances eyebrow shape.

may smooth the crow's feet in contrast to the lower lid and cheek rhytids that extend inferiorly and laterally. There can be a telltale demarcation line of wrinkle depth. The zygomaticus major contraction may produce more bunching of the skin at the lid and cheek transition,²⁵ or the malar fat pad may drop, leaving a lack of soft tissue along the inferior orbital rim. Treatment in the preseptal orbicularis may allow for an increase in herniated orbital fat, exacerbating the appearance of baggy eyelids.²⁶ Some patients exhibit temporary edema after treatment in the periorbital area, perhaps due to decreased muscular pumping action of the lymphatic drainage. Malar festoons may worsen. Diplopia may occur from lower eyelid injection, presumably from orbital diffusion of toxin to an extraocular muscle.^{27,28}

A seamless transition between cosmetic units of the face is desired. Patients may direct attention to areas like nasalis muscle contraction (bunny lines) previously unnoticed prior to dense treatment of the surrounding areas. Dosing should be tapered between cosmetic areas.

ADJUNCTIVE THERAPIES

Adjunctive use of Botox with other treatments is synergistic. Specific muscles in the face may be relaxed such that fillers can augment the dermal, subcutaneous, or submuscular tissue without dynamic opposition. When

the dermis is immobilized, there is a prolonged duration of the filler.²⁹

Chemodeneration of particular muscles with Botox may be useful in conjunction with surgery and laser resurfacing. For example, prior to brow lifting and fixation, it may be desirable to relax the antagonistic brow depressor muscles, which pull against the recent upward brow repositioning. The immobile phase postoperatively will allow the tissue to adhere at the higher fixated position. Similarly, following periorbital laser resurfacing, inhibition of the dynamic underlying musculature will allow the dermis to be immobile during re-epithelialization and dermal collagen generation.³⁰ Botox may be used in the perioperative period to alter chronic behavior. For example, a patient with unilateral or bilateral eyelid ptosis will contract the frontalis muscle on one or both sides respectively to compensate for the ptosis. The brain perceives the need to clear the visual axis and sends impulses to the frontalis to help elevate the upper eyelid. After ptosis repair, the frontalis muscle may relax automatically, as there is no incentive to raise the eyebrow. In some patients, the frontalis contraction has become habit and continues, with brow and eyelid overelevation. Botox may be injected to relax the brow postoperatively and change the habit. Amblyopia or strabismus may affect the eyelid fold and eyebrow position. Botox may be used to improve periocular symmetry (Figs. 6A and 6B).

Figure 6 (A) A 46-year-old woman referred for left eyelid ptosis. She has left eye amblyopia resulting in a lower left eyebrow and lid fold position, yet normal eyelid margin position. The right eyebrow is higher due to incentive for the brain to stimulate right frontalis muscle contraction, which raises the right eyebrow and lid fold above the normal nonamblyopic eye. (B) Managed with 50 U of Botox, with larger doses to the left brow depressors and left lateral orbicularis muscle. The left eyebrow relaxes upward and raises the left eyelid skin fold.

The vertical integration of Botox in combination with other treatments is a powerful tool for facial shaping. Periorbital surgery can achieve tissue repositioning and reduction of redundant tissue. Dermal fillers soften creases in the skin. Submuscular malar and temporalis fillers augment lost facial volume and mask soft tissue descent. Laser skin resurfacing and photodynamic treatment improve dyspigmentation and actinic damage and build skin collagen. All of these in individualized combinations with Botox will yield the most comprehensive rejuvenation with sustainable results.

SUMMARY

Possible long-term benefits of consistent Botox therapy over time are several. First, behavior modification has been postulated,³¹ which may be partly responsible for cumulative effects of chemodenervation. Dermal creases are remodeled by the patient's own collagen. Prevention of new dermal dynamic rhytids is affected by reducing the repetitive dynamic force of muscle on the skin. Reduction of repetitive force on the soft tissue interconnections with chronic animation may help to reduce descent and involution in the brow and midface. Some patients note increased comfort with relaxation of the glabellar musculature, and studies are ongoing looking into the mechanism of action of Botox for headache relief.^{32,33} Relaxing facial action connoting negative emotion such as anguish may even have biofeedback effects that alter the autonomic nervous system.³⁴⁻³⁷

The influence of chemodenervation on not only structural characteristics at rest but also the expression of emotional dynamics warrants careful evaluation and toxin placement, dosing, and adjunctive therapy planning. The clinician gains experience with patient results and changes technique through critical analysis.

This peer-reviewed publication provides certain information, including off-label uses, not approved by the FDA for Botox (Botulinum Toxin Type A) Purified Neurotoxin Complex, a product of Allergan.

REFERENCES

- Carruthers A, Carruthers J. Botulinum treatment of forehead wrinkles. *Plast Reconstr Surg* 2006;117:1354
- Carruthers A, Carruthers J. Botulinum toxin type A for the treatment of glabellar rhytides. *Dermatol Clin* 2004;22:137-144
- Carruthers A. Botulinum toxin type A: history and current cosmetic use in the upper face. *Dis Mon* 2002;48:299-322
- Carruthers J, Carruthers A. Botulinum toxin below the eyes. *Int Ophthalmol Clin* 2005;45:133-141
- Carruthers J, Fagien S, Matarasso SL. Consensus recommendations on the use of botulinum toxin type A in facial aesthetics. *Plast Reconstr Surg* 2004;114(6 suppl):1S-22S
- Carruthers J, Carruthers A. Botox: beyond wrinkles. *Clin Dermatol* 2004;22:89-93
- Carruthers J, Carruthers A. Botulinum toxin (botox) chemodenervation for facial rejuvenation. *Facial Plast Surg Clin North Am* 2001;9:197-204
- Fagien S. Botulinum toxin type A for facial aesthetic enhancement: role in facial shaping. *Plast Reconstr Surg* 2003;112(suppl):6S-18S
- Fagien S, Brandt FS. Primary and adjunctive use of botulinum toxin type A (Botox) in facial aesthetic surgery: beyond the glabella. *Clin Plast Surg* 2001;28:127-148
- Ekman P. Facial expression and emotion. *Am Psychol* 1993;48:384-392
- Ekman P. Darwin, deception, and facial expression. *Ann N Y Acad Sci* 2003;1000:205-221
- Ekman P, Friesen WV, O'Sullivan M. Smiles when lying. *J Pers Soc Psychol* 1988;54:414-420
- Ekman P. Asymmetry in facial expression. *Science* 1980;209:833-834
- Ekman P, Hager JC, Friesen WV. The symmetry of emotional and deliberate facial actions. *Psychophysiology* 1981;18:101-106
- Package insert Botox (botulinum toxin type A) Purified Neurotoxin complex. 2006; Ref Type: Generic
- Kligman AM, Zheng P, Lavker RM. The anatomy and pathogenesis of wrinkles. *Br J Dermatol* 1985;113:37-42
- Flynn TC, Carruthers JA, Carruthers JA. Botulinum-A toxin treatment of the lower eyelid improves infraorbital rhytides and widens the eye. *Dermatol Surg* 2001;27:703-708
- Alam M, Dover JS, Arndt KA. Pain associated with injection of botulinum A exotoxin reconstituted using isotonic sodium chloride with and without preservative: a double-blind, randomized controlled trial. *Arch Dermatol* 2002;138:510-514
- Flynn TC, Carruthers A, Carruthers J. Surgical pearl: the use of the Ultra-Fine II short needle 0.3-cc insulin syringe for botulinum toxin injections. *J Am Acad Dermatol* 2002;46:931-933
- Knize DM. Muscles that act on glabellar skin: a closer look. *Plast Reconstr Surg* 2000;105:350-361
- Knize DM. An anatomically based study of the mechanism of eyebrow ptosis. *Plast Reconstr Surg* 1996;97:1321-1333
- Putterman AM. Botulinum toxin injections in the treatment of seventh nerve misdirection. *Am J Ophthalmol* 1990;110:205-206
- Balikian RV, Zimble MS. Primary and adjunctive uses of botulinum toxin type A in the periorbital region. *Facial Plast Surg Clin North Am* 2005;13:583-590
- Fagien S. Temporary management of upper lid ptosis, lid malposition, and eyelid fissure asymmetry with botulinum toxin type A. *Plast Reconstr Surg* 2004;114:1892-1902
- Kane MA. Classification of crow's feet patterns among caucasian women: the key to individualizing treatment. *Plast Reconstr Surg* 2003;112(5 suppl):33S-39S
- Paloma V, Samper A. A complication with the aesthetic use of Botox: herniation of the orbital fat. *Plast Reconstr Surg* 2001;107:1315
- Aristodemou P, Watt L, Baldwin C, Hugkustone C. Diplopia associated with the cosmetic use of botulinum toxin a for facial rejuvenation. *Ophthalm Plast Reconstr Surg* 2006;22:134-136
- Wutthiphan S, Kowal L, O'Day J, Jones S, Price J. Diplopia following subcutaneous injections of botulinum A toxin for facial spasms. *J Pediatr Ophthalmol Strabismus* 1997;34:229-234

29. Carruthers J, Carruthers A, Maberley D. Deep resting glabellar rhytides respond to BTX-A and Hylan B. *Dermatol Surg* 2003;29:539–544
30. Carruthers J, Carruthers A. Adjunctive botulinum toxin type A: fillers and light-based therapies. *Int Ophthalmol Clin* 2005;45:143–151
31. Fagien S. Botox for the treatment of dynamic and hyperkinetic facial lines and furrows: adjunctive use in facial aesthetic surgery. *Plast Reconstr Surg* 1999;103:701–713
32. Carruthers A, Langtry JA, Carruthers J, Robinson G. Improvement of tension-type headache when treating wrinkles with botulinum toxin A injections. *Headache* 1999;39:662–665
33. Evers S, Rahmann A, Vollmer-Haase J, Husstedt IW. Treatment of headache with botulinum toxin A—a review according to evidence-based medicine criteria. *Cephalalgia* 2002;22:699–710
34. Levenson RW, Ekman P, Heider K, Friesen WV. Emotion and autonomic nervous system activity in the Minangkabau of west Sumatra. *J Pers Soc Psychol* 1992;62:972–988
35. Levenson RW, Carstensen LL, Friesen WV, Ekman P. Emotion, physiology, and expression in old age. *Psychol Aging* 1991;6:28–35
36. Levenson RW, Ekman P, Friesen WV. Voluntary facial action generates emotion-specific autonomic nervous system activity. *Psychophysiology* 1990;27:363–384
37. Ekman P, Levenson RW, Friesen WV. Autonomic nervous system activity distinguishes among emotions. *Science* 1983; 221:1208–1210