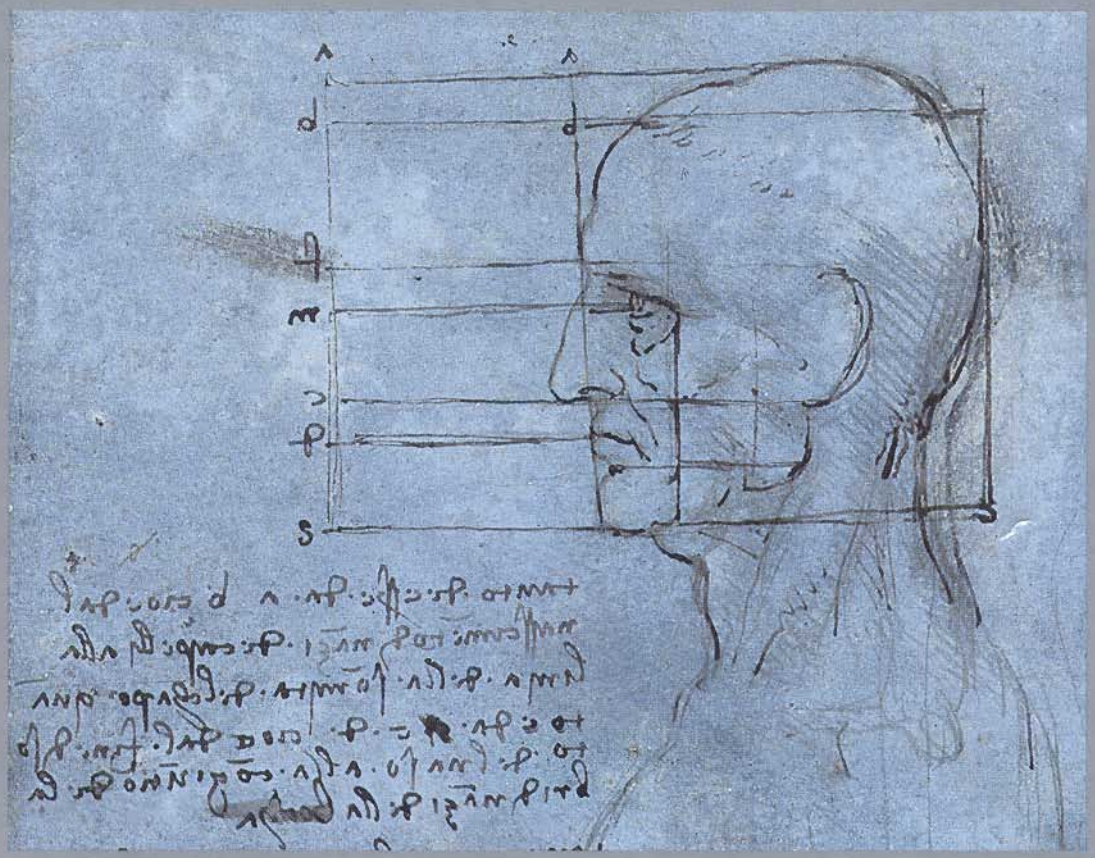
Facial Plastic and Reconstructive Surgery

second edition



Ira D. Papel

John Frodel
G. Richard Holt
Wayne F. Larrabee
Nathan Nachlas
Stephen S. Park
Jonathan M. Sykes
Dean Toriumi

Thieme

Chapter 23

Botulinum Exotoxin A (Botox) for Facial Wrinkles

Andrew Blitzer, William J. Binder, and Mitchell F. Brin

Botulinum exotoxin A (Botox), produced by the bacterium *Clostridia botulinum*, is a potent neurotoxin that exerts its effect at the neuromuscular junction, inhibiting the release of acetylcholine. The effect of the toxin is a muscular weakness or flaccid paralysis.[1] Botox has been safely and effectively used in the treatment of patients with facial dystonia, hemifacial spasms, or facial tics. In treating these patients we noticed a cosmetic benefit. Often patients who were receiving unilateral Botox injections for dystonia or hemifacial spasm would return asking to have their contralateral side injected to give them a more youthful appearance.[2]

Botox improves the cosmetic appearance by decreasing or eliminating the hyperfunctional facial lines caused by skin pleating due to the contraction of the underlying muscles.[3] The loss of facial hyperfunctional lines with resultant smooth skin surface is seen in conditions that cause facial muscle weakness, such as facial nerve injury, Bell's palsy, or stroke. Botox does not address skin lines unrelated to muscular hyperfunction, such as actinic damage, loss of dermal elastic fibers, or skin atrophy. These may be best managed with chemical peels, laser resurfacing, or injection of filler materials.

In 1989, Botox was approved by the FDA as safe and effective therapy for blepharospasm, strabismus, and hemifacial spasm. Spasticity was added to the label in 1998. The National Institutes of Health (NIH) Consensus Conference of 1990 also included a number of "off-label" indications, including adductor spasmodic dysphonia, oromandibular dystonia, and torticollis. Many other off-label uses are becoming the standard of therapy. We have used Botox for more than 12 years and reported it for the correction of hyperfunctional lines of the face, including glabellar lines, horizontal forehead lines, lateral orbital lines ("crow's feet"), platysmal bands, and hyperactive mentalis muscles.[4] Carruthers and Carruthers[5] simultaneously reported similar results of Botox injections for the correction of hyperfunctional facial lines.

Botox treatments require use of a standard freezer that will keep toxin at −15°C to −20°C, sterile nonpreserved saline, syringes, and small-gauge or hollow-bore monopolar electromyography (EMG) needles. Botox (Allergan, Inc., Irvine, CA) is shipped on dry ice, and each vial contains 100 units of freeze-dried, lyophilized botulinum toxin A. The frozen toxin is reconstituted with nonpreserved saline before treatment. We usually add 4 cm^3 of saline yielding 25 units/cm^3 (2.5 units in 0.1 cm^3); 2.5 cm^3 of saline yielding 40 units/cm^3 (4 units in 0.1 cm^3); or 2 cm^3 of saline yielding 50 units/cm^3 (5 units in 0.1 cm^3).

The patient's facial lines are photographed for medical-legal reasons and for the purpose of comparison after treatment (Figs. 23–1 to 23–3). The photographs should show the patient's face at rest and with the activity that exaggerates the facial lines. A detailed analysis of the facial lines should decipher which lines are functional, which are caused by changes in the properties of the skin (e.g., actinic or age-related changes), which are the result of underlying structural deformity, and which are scar-related. A careful medical history is taken, with particular attention to prior cosmetic surgery and facial treatments, prior trauma, bleeding tendency, current medications, sensitivity to drugs, propensity to scarring, or hypo- or hyperpigmentation. We use a pre- and posttreatment rating scale of the functional lines that is used at rest and during activity. The rating is performed both by the patient and by the physician during each visit. A 0–3 rating scale has been developed for evaluation (0 = no facial lines; 1 = mild facial lines; 2 = moderate facial lines; 3 = severe facial lines).[3,6]

Despite the paucity of data, patients who are pregnant or lactating should not be injected because the effects of the toxin

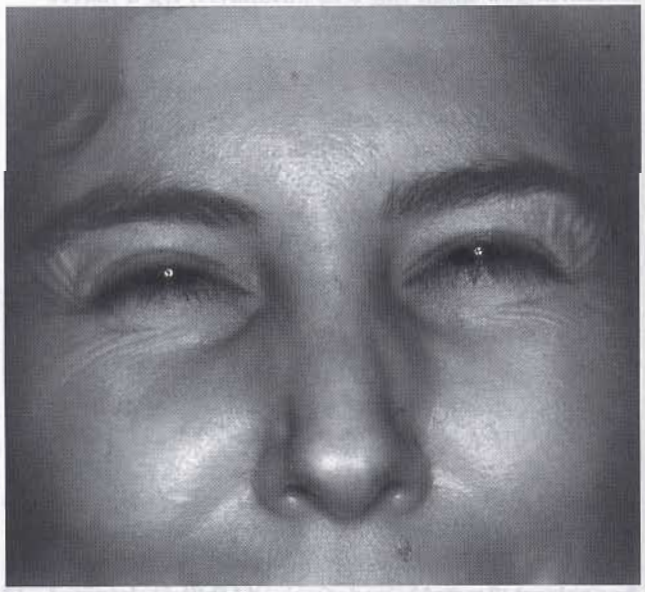


Figure 23–1 Patient before injection with excessive squint lines (crow's feet) around the lateral and inferior orbital area.

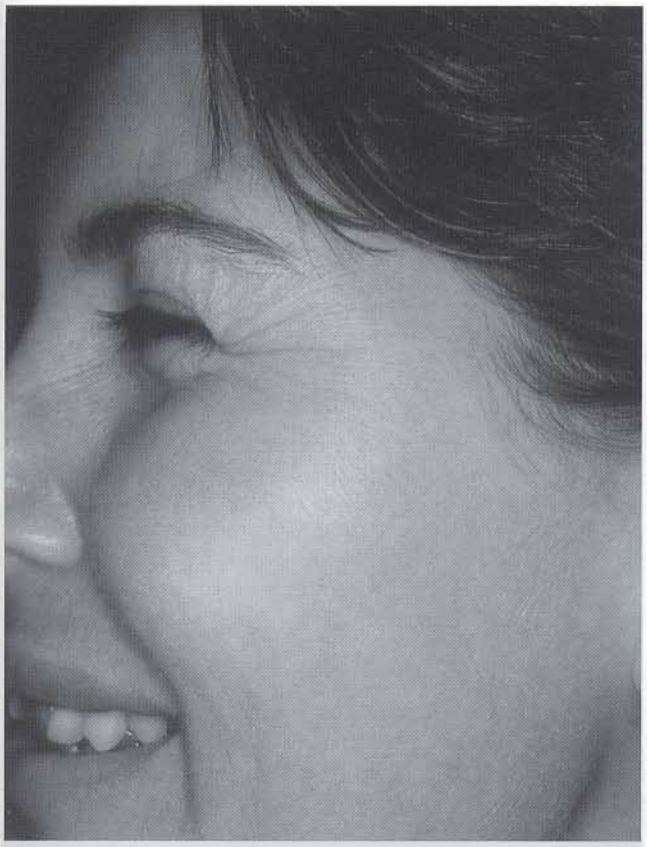


Figure 23–2 Lateral view of the excessive squint lines prior to injection.

on the fetus are unknown. We recommend treating with caution patients with underlying neuromuscular disease, such as Eaton-Lambert syndrome, myasthenia gravis, and motor neuron disease. Aminoglycoside antibiotics may interfere with neuromuscular transmission and potentiate the effect of a given dose of Botox; therefore, we do not recommend prescribing Botox for a patient undergoing aminoglycoside treatment.[6]

TECHNIQUE

An informed consent should be obtained from each patient following explanation of the injection procedure, the reason for injection, and the potential complications. The patient should be informed that Botox injections were approved by the FDA in 1989 as safe and effective therapy on label for blepharospasm, strabismus, and hemifacial spasm. In 1990, the NIH Consensus Conference on the Clinical Uses of Botulinum Toxin included the treatment of spasmodic dysphonia, oromandibular dystonia, facial dystonia, occupational writer's cramp, and torticollis. In 1998, spasticity was added to the on-label use. Other off-label uses included management of tremor, juvenile cerebral palsy, hyperhidrosis, sphincter dysfunction, and hyperfunctional facial lines.[7]

After consent is obtained, ratings performed, and pictures taken, the patient's face is marked with a pen for all of the areas of maximum muscle pull causing the bothersome hyperfunctional lines. The site of each injection is marked to

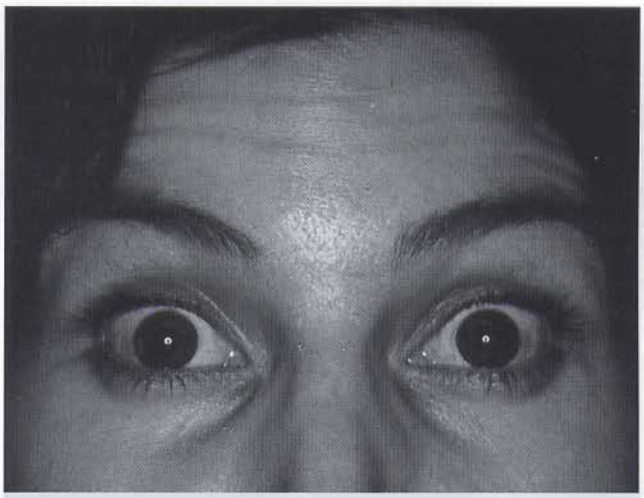


Figure 23–3 Patient demonstrating hyperfunctional frontal lines prior to injection.

treat each of the muscles causing hyperfunction. Circles are drawn around each injection, allowing 1 to 1.5 cm for diffusion of the toxin from each injection point. The confluence of circles should totally cover the area of excess muscle function without infringing on other adjacent muscles (see Figs. 23–4 to 23–6). A photograph or diagram of the injection sites and the dose at each site should be made and kept as part of the patient record to allow for postinjection assessment of the efficacy of a given treatment session and provide a "road map" for future injections. Depending on the patient's response, the placement of injections and the dose can be adjusted and recorded for future injections.

When the marking is complete, the area to be injected can be iced or treated with EMLA to decrease the discomfort associated with skin penetration by needle. The toxin is then drawn up in a tuberculin syringe with a 27-gauge, hollow-bore, Teflon-coated monopolar EMG needle. This needle is hooked up to the EMG machine, and ground and reference leads are placed on the face. The needle is placed through the overlying skin to impale the muscle previously marked for injection. The patient is instructed to accentuate the specific facial expression, such as frowning, squinting, or elevating the brow. If the needle is in an active part of the muscle, a loud burst of activity will be heard on the speaker of the EMG machine. If a distant signal is obtained, the needle should be moved until it is in a maximal position and then the toxin is injected. This is repeated at each mark for injection. The EMG technique increases the accuracy of the delivery and therefore decreases the doses necessary for a given desired response. If a larger dose is needed in a given area, either a larger volume or an increased concentration in the same volume can be given. Increasing the volume may lead to diffusion of toxin to adjacent muscles, causing unwanted weakness. To avoid this, increase the concentration of toxin in the same volume that will increase the degree of weakness without increasing the area of diffusion. Injections around the eye for orbicularis oculi weakening can be done with a tuberculin syringe and a 30-gauge 0.5-in. needle. Similarly, patients with very prominent muscles, or those who have been previously

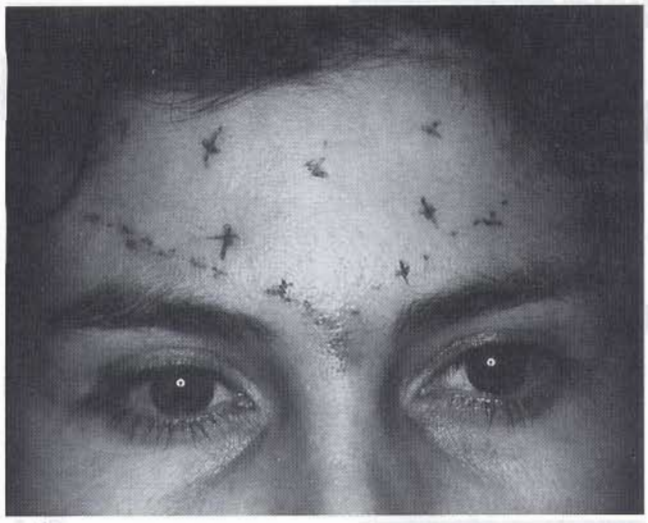


Figure 23–4 We mark all patients for location of injection sites. To maximize the effect and minimize the unwanted areas of weakness that can occur in forehead injections, I put one mark between the medial aspect of the brows. Marks are then made 1 cm above the brow at the midpupillary line. A triangle is then drawn. The toxin injections are all given above these lines, allowing for elevation of the lateral brow, continued mimetic function of the lateral brow, and no migration of the toxin to the levator muscle. Marks are then made about 1.5 cm apart across the forehead lines to encompass all of the area within the triangle.

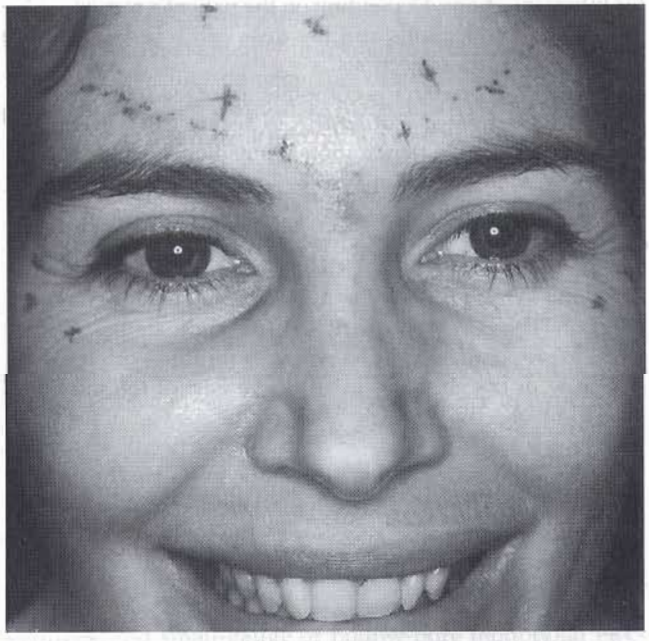


Figure 23–5 The crow's feet lines are marked while the patient is smiling. The first mark is made 1 cm lateral to the lateral canthal ligment and on the plane of the lateral canthus. If there are lines above this area, a second mark is made above. A third or fourth mark is made over the inferior wrinkles following the orbital rim. These are marked bilaterally and then injected.

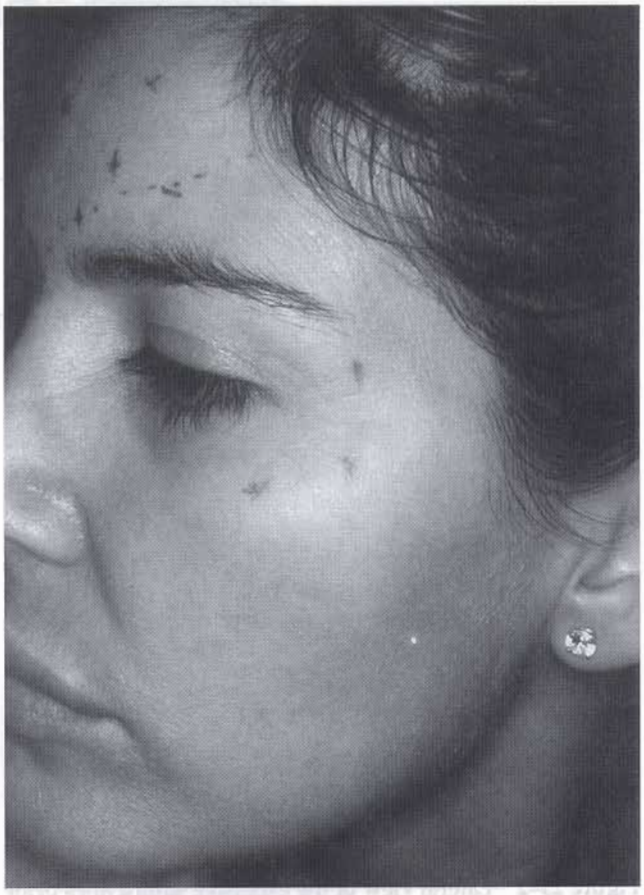


Figure 23–6 A lateral view showing the crow's feet marks for injection.

injected, where the muscles have been well identified can be injected without EMG using a 30-gauge 0.5-in. needle. We are currently developing a 30-gauge coated 1-in. needle that can be used with a portable EMG monitor to allow for very accurate toxin placement without the discomfort of the larger 27-gauge needle. After the injection is performed, gentle pressure can be applied to the needle site to avoid ecchymosis. Carruthers has developed a technique of gentle pressure away from the eye or important adjacent muscle to aid in the diffusion to areas of desired weakness. The patient is asked not to rub or massage the injected area for about 6 hours so as to avoid excess diffusion to adjacent muscles, and thereby decrease the chance of excess weakness of adjacent facial muscles.

Glabellar Injections[4,9–11]

Glabellar injections control the hyperactivity of the corrugator and procerus muscles, which is responsible for producing "scowl" lines. In our series, we have injected 7.5 to 25 units in this area to control the muscle contractions producing the glabellar lines. We usually start with 2.5 to 5 units per 0.1 cm^3 in each corrugator muscle and 2.5 units per 0.1 cm^3 into the procerus. The dose depends on the preinjection assessment of the size of the muscle. Men generally have larger muscles and require larger doses. The corrugator muscle can be injected

with several individual needle sticks or the muscle can be "skewered" on the EMG needle and injected on needle withdrawal. The injection of the corrugator muscle should extend laterally enough to encompass the length of the muscle without passing the midpupillary line. Too much lateral extension too close to the brow may lead to weakness of the levator muscles of the upper lid and produce ptosis.

If ptosis is produced, the patients can be treated with apraclonidine 0.5% eyedrops (Iopidine, Alcon, Inc., Fort Worth, Texas). This drop stimulates Müller's muscle (adrenergic muscle), which is below the levator muscle. Treatment usually produces a 1- to 2-mm elevation of the lid margin.

Frontalis Injections[4,9–11]

The frontalis muscle pulls in a vertical direction, creating horizontal pleats in the forehead skin. Toxin should not be injected close to the brow as this may cause brow ptosis or even levator ptosis. We like to raise the injection site progressively away from the brow as you proceed laterally to leave some functional frontalis, thereby leaving some expressive function to the lateral brow while eliminating most of the forehead wrinkles. Most of our patients prefer to have some residual mimetic function of the brow. If there are a number of rows of horizontal forehead lines, several rows of injections can be made to encompass the lines. Again, circles of 1 to 1. 5 cm^3 are drawn to ensure that all desired areas of weakness are included in the toxin injection plan. After the plan is drawn, the forehead is treated with ice or EMLA. The underlying frontalis muscle is then injected with EMG guidance to assure needle placement within the hyperfunctional muscle (Fig. 23–7). We generally inject 2.5 units per 0.1 cm^3 at each mark over the forehead. Our dose range is 10 to 30 units. If there is a particularly hyperactive area near the brow, we will use a more concentrated solution (5 units per 0.1 cm^3) in that area of the frontalis muscle to avoid excess diffusion to adjacent muscles.

Figure 23–7 Patient 2 weeks post Botox injection of hyperfunctional facial lines. Note the loss of lines in the forehead area and a diminution of the crow's feet lines.

Brow Adjustment[12]

Often, weakening the glabellar or frontalis muscles causes an arching of the lateral brow upward if the lateral frontalis was not treated. Lateral frontalis weakening often causes brow ptosis. If too much arching is produced, a small amount of toxin (1 unit per 0.1 cm^3) can be injected into the lateral frontalis to drop the brow slightly. If not enough brow elevation was achieved, 1 unit per 0.1 cm^3 injected at the orbital rim laterally will weaken the attachment of the orbicularis oculi and allow for more pull by the frontalis to elevate the brow laterally.

"Crow's Feet" Injections[4,8–11,13]

Lateral orbital lines, or "crow's feet" lines, result from hyperactivity of the lateral portion of the orbicularis oculi muscle. This muscle functions in the closing of the eye, blinking, and squinting, but excessive lateral activity will excessively pleat the lateral orbital facial skin, creating crow's feet. Small amounts of Botox can weaken the lateral aspect of this muscle and thereby decrease the wrinkling of the skin without interfering with eye blink or eye closure. To accomplish the desired weakening, pen marks are drawn 1 cm from the lateral canthi. The patient is asked to squint, and if there are hyperfunctional lines above the mark, a second mark is made in this superior area. The squint lines below the first lateral mark are then addressed with another mark made in the inferior area to encompass the lower wrinkles (Figs. 23–1, 23–2, 23–5, 23–6, 23–9, 23–10). Marks are made bilaterally. Do not make injections too close to the eyelids or orbit, as this may cause delayed eye closure, decreased blink, epiphora, mild ectropian, or possible diplopia.

The skin is then treated with ice or EMLA. Patients are generally injected around the eyes with a 30-gauge, 0.5-in. needle for comfort. If there has been difficulty in obtaining a desired result, the EMG needle is used to improve the accuracy of needle placement. Our starting dose is generally 2.5 units per 0.1 cm^3 in each of the previously drawn marks. Our usual dose is 7.5 to 15 units per side.

Nasolabial Folds[6,9]

These hyperactive lines can be softened with injection at the connection between the orbicularis oris and the levator muscles (zyngomaticus major and minor and levator anguli oris). However, weakening of these muscles changes the character of the patient's smile and is unacceptable to most people. Use of filler materials and other approaches often produce better results.

Nasal Flare

Some patients have excessive and bothersome flaring of the nasal alae. This flaring is the result of excessive contraction of the nasalis muscle. We have utilized a technique described by Carruthers in which 5 units per 0.1 cm^3 is injected into the nasalis bilaterally. This has produced excellent results if used in small volumes to avoid diffusion to the lip elevator muscles.

Mentalis Injections[4,6,10]

Patients with excessive lip pursing have hyperactive mentalis and orbicularis muscles. This phenomenon occurs especially after chin implants or orthognathic surgery, and the activity may produce abnormal lip postures with a "peau d'orange" skin appearance. We have found that small amounts of Botox (2.5 to 5.0 units) on each side may be used to prevent this overactivity and improve the skin's appearance. The injection is given at a point halfway between the vermilion border of the lower lip and the edge of the mentum, and 0.5 to 1 cm medial to the oral commissure. The EMG technique is used and the patient is asked to pucker his or her lips. When the needle is in a most active place within the mentalis muscle, the toxin is injected. The toxin should not be injected too close to the lip to avoid excessive weakness of the orbicularis oris muscle and consequent change in smile or drooling.

Platysmal Band Injections[14,15]

Patients who have prominent platysmal bands before or after facelift may have benefit from Botox injections without a submental incision for muscle plication. We perform these injection by first marking the anterior and posterior edges of the muscle bilaterally. The region of the excessive platysmal banding is marked and horizontal lines spaced about 2 cm apart are drawn. Generally three horizontal lines is sufficient. The EMG monopolar needle is used to skewer the muscle starting from a skin stick medially at the edge of the band. The needle is passed perpendicularly to the muscle fibers. The patient can activate the platysma while the injection is given by depressing the lower lip. Once the muscle is skewered, the toxin is injected on withdrawal of the needle. The muscle is generally injected with 2.5 to 5.0 units per 0.1 cm^3 per site with two or three sites per side. The dose range in our series is 7.5 to 20 units per side. One needs to keep the volume and dose small to prevent diffusion to the strap muscles of the anterior neck, which can cause dysphonia or dysphagia if weakened.

Adjunctive Botox Injections[16]

Relaxation of the underlying facial musculature has been found to be extremely beneficial to enhancing the results of laser resurfacing or with the use of fillers such as collagen. The best results are staged, starting with Botox injections and having the patient return after a week for the second procedure. If the patient is having laser resurfacing, relaxing the skin folds around wrinkles allows proper orientation of the collagen fibers to give the best and longest lasting results. With the continued underlying weakness, the skin heals without the fold, until the muscular strength returns at 4 to 5 months, at which time Botox injections may be repeated.

Botox can relax the skin lines and therefore minimize the amount of collagen or other filler needed to enhance the cosmetic result. Once the persistent furrow is filled, the material seems to last much longer without the constant muscle squeezing effect. Therefore, less material is needed to correct the line, and the material lasts longer when used in conjunction with Botox.

FOLLOW-UP

After the injections are complete, the patients are asked to return to our office at two weeks postinjection to reevaluate the facial lines and the results of the toxin. New photographs are taken, and once again the ratings are made by the physician and the patient. If the hyperfunctional lines are still bothersome to the patient, additional toxin may be injected. The dose and the location of the additional toxin should be determined based on the amount and location of excessive function. The dose and location of the additional toxin are mapped for future reference. When the muscles are adequately weakened and a pleasing facial skin contour is achieved, the patient is instructed to come back when the facial lines again become prominent and bothersome. In general, this is about 4 to 6 months. In some patients who have been treated a number of times, the Botox effect seems to last for longer and longer periods, perhaps related to a behavior modification (Figs. 23–7 to 23–10).

COMPLICATIONS[17,18]

Complications of Botox injections include mild bruising or local pain at the site of injection. There also may be transient weakness of adjacent muscles related to diffusion of the toxin.

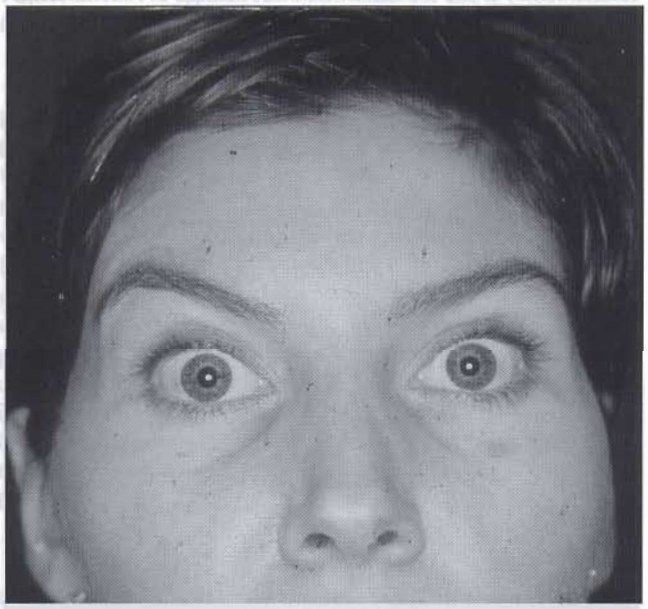


Figure 23–8 Patient 2 weeks post Botox injection. Note the flat forehead with no wrinkles, but elevation of the lateral brow and only lateral brow expressivity upon gesturing or attempts at brow elevation.

Figure 23–9 Patient 2 weeks post Botox injection. Note the loss of crow's feet lines and the pleasing contour of the periorbital skin.

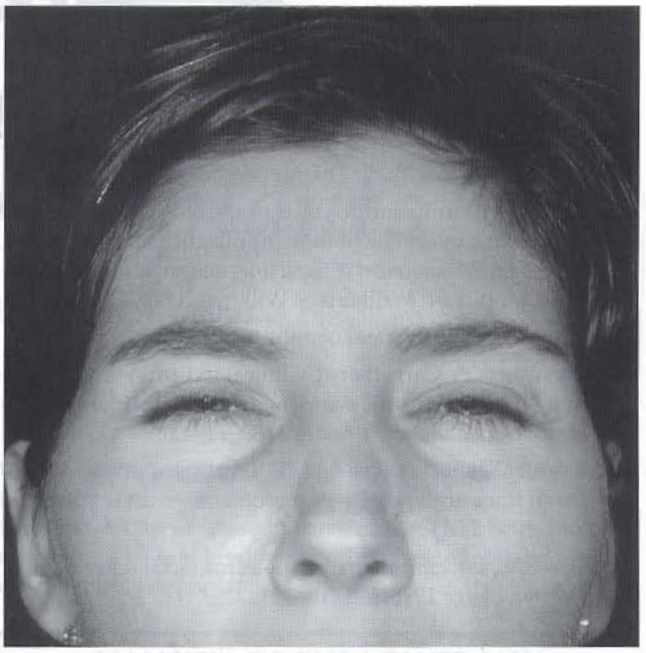


Figure 23–10 Patient 2 weeks post Botox injection. Note the minimal number of lateral orbital lines with squinting.

This effect on adjacent muscles is technique- and dose-related. To minimize this side effect, one should use the smallest volume and dose possible. We have used EMG guidance to allow very accurate placement of the needle in the most active part of the muscle. EMG guidance has allowed us to maximize the effect with a minimal dose. Careful placement of small amounts of toxin will eliminate or minimize unintended adjacent muscle weakness. If local adjacent muscle weakness, such as ptosis, occurs, it will be self-limited. There have been no long-term complications or hazards of Botox use. Muscle biopsies taken from patients after repetitive Botox injections have not shown any permanent atrophy or degeneration. Some patients receiving high doses (300 units or more, such as for torticollis) may develop antibody to toxin. These antibodies have not produced hypersensitivity reactions or anaphylaxis. However, the antibodies do block the effect of the toxin, making the patient resistant to further therapy.

Over the past 15 years, we have found botulinum toxin injections for hyperfunctional facial lines to be extremely safe and useful. The injections may be used alone or in combination with peels, resurfacing or filling techniques. Patient satisfaction is extremely high.

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