Botulinum Toxin for Forehead

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Abstract

Today botulinum toxin is considered a gold standard cosmetic procedure for the frontal lines, and although different brands have been introduced to the market, understanding the individual mimics and real muscle extension lead to a differentiated natural outcome. For good and beautiful features, the patient must be evaluated dynamically and other issues must be considered such as the brow level, the facial and rhytids asymmetry as well as muscle hypertrophy and extension. Based on these individuality, the doctor might be comfortable to rapidly classify the lines and predict the distribution of the sites to determine the amount of botulinum toxin to be injected to each one. The physician's aim is a natural look and a long-term treatment, not only to minimize the rhytids, but to prevent the deep forehead lines. Different clinical presentations require an individual analysis and planning.

Keywords

Botulinum Toxin · Forehead · Frontal · Forehead Lines · Rhytids

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Introduction

An increasing number of patients seek minimal invasive procedures. One of the most requested procedures is the treatment with botulinum toxin type A (BoNTA). The treatment of dynamic rhytids and lines with BoNTA is effective and leads to a high rate of improvement with a rapid onset and long duration of action (longer than 4 months for some patients) (Carruthers and Fagien 2004).

The facial movements result from the contraction of the facial muscles creating transient wrinkles and furrows perpendicular to the direction of the muscular contraction. Hyperfunctional lines are common in the forehead on individuals that are highly expressive. The horizontal lines are caused by the contraction of the frontalis muscle, and its contraction might be an important tool to raise a ptotic brow or eyelid to improve the visual field especially concerning elderly patients. Frontalis contraction may also be an emotional response signaling surprise or interest and the forehead lines may give an impression of aging (Cox et al. 2003).

The use of BoNTA to improve the aesthetic appearance of horizontal forehead lines is optimized when clinicians take into account variations in frontalis muscle function, position, and extension as well as considering the anatomy of the brow, its height and shape and then a proper injection technique can be chosen when they devise individualized treatment regimens.

The injection of BoNTA produces durable improvement in the appearance of moderate to severe horizontal forehead lines. It is like an "educational process," leading the patient to lessen the strength of the muscle action through the years. Dose and injection technique must be adjusted and individualized based on the variability of the anatomy and function/volume of the muscles in the forehead and upper face as well as on the patient goals (Cox et al. 2003; Finn and Ellen-Cox 2005). Optimal aesthetic outcomes can be achieved by skillfully balancing the opposing effects of the frontalis muscle and its intricate interactions with the procerus, corrugator supercilii, depressor supercilii, and orbicularis oculi muscles. It must be treated carefully since this is the only one that raises the brow and all other muscles are depressors.

Anatomy and Treatment Plan

The frontalis muscle elevates the brow and is associated with the development of the horizontal forehead rhytids. The goal in treating the forehead is to maintain some movement of the frontalis muscle and avoid complete paralysis, resulting in natural mimics without compromising the height, position, or shape of the brows and the eyelid.

There are significant challenges for the inexperienced practitioners for several reasons as listed below:

(Carruthers and Fagien, 2004) Individual variability in frontalis structural anatomy
(Cox et al. 2003) Individual variability in frontalis functional (habit/expression) anatomy
(Finn and Ellen-Cox 2005) Difficulty in treating it isolatedly because of the potential for the eyebrow ptosis on one hand and failure to efface lines on the other
(Tamura 2002) The potential for over treating and producing a stiff and an artificial appearance

The frontalis is a large, vertically oriented muscle, and there is a considerable individual variation of its structural features. Although usually depicted as two somewhat fan-shaped bands, the midline fibers overlap substantially in some individuals. Forehead shape also differs between individuals in both vertical and horizontal directions. In addition, some individuals have numerous fine forehead lines, whereas others have a single deep horizontal furrow as described by Tamura (2002).

These anatomic features and their variations play an important role in determining the treatment plan for horizontal forehead rhytids. The identification and classification of the patterns (Braz and Sakuma 2010) of the frontalis muscle contraction provide an individualized approach for each patient, which is one of the most important pillars of a successful treatment outcome (Lorenc et al. 2013).

The frontalis interacts with procerus, corrugators, and orbicularis oculi muscles and it is

localized at the forehead, superiorly to the eyebrows and inferiorly to the scalp. It originates at the aponeurotic galea near the coronal suture, inserting on the supraciliary ridge of the frontal bone and onto fibers of the procerus, corrugator, and orbicularis oculi muscles and it is vertically oriented.

Concerning the areas to be treated and the sites of the injections, we need to analyze the functional portion (pars that actually is responsible for the rhytides) of the muscle and then, treat preferably only the upper half of the forehead maintaining the brow mobility but minimizing the wrinkles.

Braz et al. published a review analyzing the muscular contraction pattern, and it was classified according to the predominant hyperkinetic area that was observed at a frontal muscle's maximum contraction. Three major contraction patterns were identified: total, medial/central, and lateral. In 50.6% of cases, the total pattern was observed: the horizontal rhytids observed in the center of the forehead extend laterally beyond the mid-pupillary line, up to the end of the brows (Fig. 1a). The medial pattern was observed in 25.3% of cases: the horizontal rhytids are concentrated in the central region of the forehead, predominantly between the mid-pupillary lines (Fig. 1b). The lateral pattern was observed in 24% of the cases: the horizontal rhytids prevailed on the sides of the forehead, mainly occurring laterally to the mid pupillary line (Fig. 1c).

Technique and Doses

We suggest the techniques and dosages at this chapter based on onabotulinum A. There are differences between ona, inco, and abobotulinum toxins and they are considered unique and not interchangeable. The FDA mandated in 2009 that all BoNTA product labels clarify that the potency units for each product are specific to each preparation. However, in common practice many providers have used a dose equivalent ratio of Botox® (onabotulinum) to Dysport® (abobotulinum) of 1:2, 5, or 1:3, as suggested in the literature to simplify dose comparisons when switching between products. Use of this conversion ratio is most appropriate when considering the safety profile of the products, not its efficacy. Clinical observers also describe a 1:1 between onabotulinum toxin and incobotulinum toxin (Xeomin®). Doctors will develop a familiarity

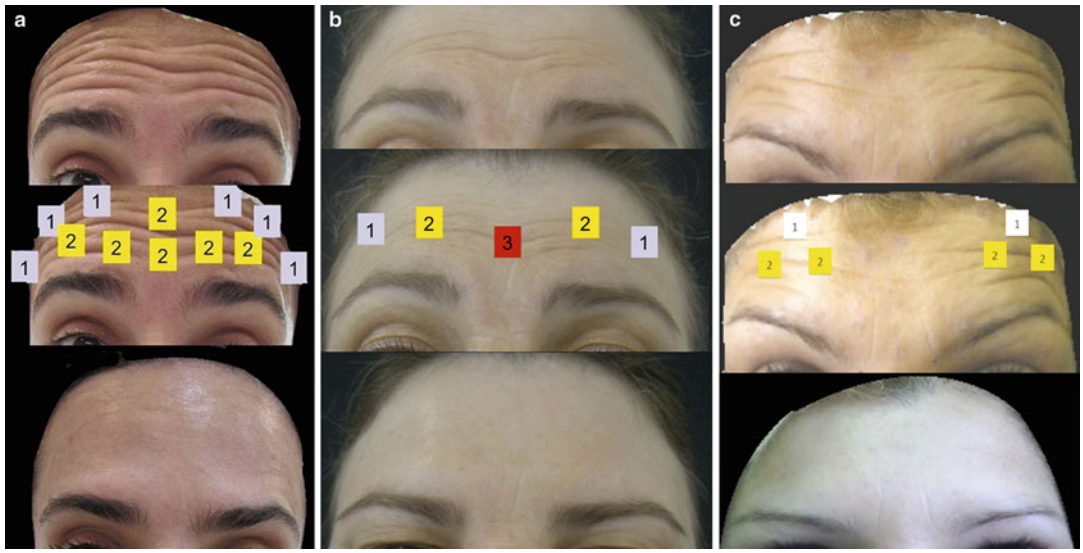

Fig. 1 Different patterns of forehead muscle contraction, sites of botulinum toxin (BT) application, and doses of BT indicated for each site: (**a**) forehead total contraction pattern, (**b**) forehead medial/central contraction pattern, (**c**) forehead lateral contraction pattern

with the efficacy and behavior of each formulation of BoNTA through experience.

Currently, no data from well-controlled studies support the idea that volume of injection contributes significantly to diffusion. In general, physicians should choose a dilution that minimizes the likelihood of diffusion to neighboring muscle groups. We prefer a dilution of 1 ml of saline solution for a bottle of 100 U of onabotulinum toxin.

Topical anesthesia like creams, ice, or vibration anesthesia can help reducing minimal discomfort associated with the injections. Plastic, single-use syringes are recommended; the insulin syringe, with no potential space at the hub, may waste less solution. A 30-gauge needle is standard, but several panel members have reported on their experiences of reduced pain with the use of a 32 gauge needle. The choice of syringes depends primarily on the practitioner preference.

The number of injection sites varies based on the aesthetic goals and the individual characteristics. The number of injection points range from two to 12 or more depending on the technique regarding recently described microdroplets® BoNTA injections. Regardless of the number of injection sites, it is important that all injections remain 1 to 2 cm above the orbital rim to reduce the potential for a brow ptosis especially in individuals who wish to maintain or elevate the brow position. For women, care should be taken to assess the natural position and shape of the eyebrows and whether they are plucked or tattooed. The injections should avoid the first horizontal line above the brows. In addition, filler may be needed to be injected to soften the inferior lines, where botulinum toxin type A injections should be avoided.

The total starting dosage for women varies between 10 and 20 U, preferable the lower dose. For men, we use to start with 20 U to 30 U. Gender differences in muscle mass allow a higher starting dose in men. In addition, men accept and prefer a flatter, less arched brow. Typically, 1 to 5 U are injected in each site, with higher doses used in men. As with other areas, the amount of units depends upon the pretreatment aesthetic analysis. Skin thickness and texture may also contribute to decide the dosage to be injected. Subcutaneous (SC) (Gordin et al. 2014) injection of botulinum toxin A (BoNTA) is equally effective in achieving paralysis of the underlying frontalis muscle as well as intramuscular BoNTA administration. In addition, the SC injection may result in less pain for the rejuvenation of the upper face with botulinum toxin A. For patients with a very thin skin, injections should be made preferably superficially at the subcutaneous plane.

Adverse Effects

Although the majority of side effects are attributed to technique and dosage, there may also be differences between the diffusion of the neurotoxins. Diffusion properties have clinical relevance where precise location of effect is desirable to avoid side effects like asymmetry, eyelid ptosis, blurred vision, and brow ptosis. The most common adverse effect is bruising because of the mechanical skin trauma.

Unsatisfactory results in the frontalis usually are due to:

- Total muscle palsy (mask face), with loss of the brow movement
- Brow ptosis
- Asymmetric muscle relaxation
- Wrinkle persistency

Aesthetics Considerations

Patient evaluation within the framework of facial enhancement will lead to a treatment plan that incorporates the creation of harmony and balance rather than wrinkle removal in isolation.

Aesthetic planning involves understanding and assessing the patient's desires and preferences in the context of an overall treatment plan. These desires and expectations must be discussed with patients before the treatment, since after then, an unattended desire seems like excuses. An extensive discussion before treatment and explanation about the mechanism of action, effects, and duration can increase the likelihood of a successful outcome.

The facial mimics muscles do not act in isolation but have a complex anatomic and physiologic

interaction. The treatment of the glabellar lines, the "crow's feet," or the forehead lines can alter the eyebrow shape and position, which are considered as main parameters to aesthetic evaluations of the upper face.

Gender differences are important for the eyebrow shape: typically, women have a more arched eyebrow, which is considered aesthetically pleasing, and the male brow is flatter. Older patients may use the frontalis to increase their visual field. Therefore, caution is needed in these circumstances.

Patients with severe, deep wrinkles may have unrealistic expectations for the outcome of botulinum toxin type A treatment. BoNTA might have an important prophylactic effect; when indicated at early stages of strong facial mimics and powerful muscle contraction, it is better to treat patients with hyperdynamics lines but do not have static lines yet.

Photographing the patient before treatment and at follow-up is also useful in documenting the effect, the duration, and in planning any touch-ups or new treatments.

The typical interval for retreatment is 3 to 4 months. The duration of the effect might depend on the total unit dosage injected, which is supported by some published data for both men and women.

Planning and Treating

- Assess facial expression at rest and during animation. Distribute the injection sites according to the mimics and muscle contraction of each individual patient.
- Evaluate the range of motion of the frontalis muscle and the rhytides lines.
- Palpate muscles during rest and contraction if possible.
- Assess brow position. In women, be sure to consider whether the brows have been plucked or tattooed. Assess for asymmetries in brow position. As few as one or two injections high up in the forehead can help to bring the eyebrows into symmetry.
- Evaluate any asymmetries and assess potential effects of botulinum toxin type A injection.
- It is not necessary to insert the needle, touch the periosteum and "back off" to inject BoNTA as suggested few years ago; however, the desired effect on brow position will dictate the site, the deepness and the right muscle for the injection.
- Be cautious with patients who have undergone surgery that might have altered the underlying anatomy. Be also cautious about scars on the site of injections.
- Recognize the variables that affect the required dosage in different individuals.
- Begin with the recommended starting doses and add more units or additional sites if necessary at a 2-week evaluation.
- Do not completely paralyze the muscles.
- Consider patient expectations as well as cultural viewpoints in planning the overall effect.
- Assess the need for treatment with other modalities, such as soft-tissue augmentation, lasers, or surgical intervention.
- Less experienced injectors of botulinum toxin type A should stay at least 2 cm above the brow.
- Use caution with lateral brow injections; stay well above the superior orbital rim.
- Centrally focused injections can allow lateral brows to elevate. Ensure that injection sites are located laterally enough to avoid a quizzical eyebrow appearance, but avoid the lower lateral forehead. A high lateral injection can modulate a severe lateral brow elevation. If injections are too centralized, it can lead to a "quizzical" eyebrow shape as a final result.
- A small amount of botulinum toxin type A administered in the procerus muscle can help prevent brow ptosis.
- A midline injection should be considered because many patients have frontalis fibers in that area, even though some schematic drawings fail to depict them but not if there is aponeurosis fascia below the hair line.
- Try not to treat only the frontalis because this is the most important elevator muscle on the upper third of the face.
- Sometimes the frontalis and brow depressors should be treated at the same time for a harmonious result. However, exceptionally we could suggest injecting these areas separately to decrease the amount of botulinum toxin type A.

Diffusion and overlap can result in immobilization. If treatments are undertaken separately, **treat the depressors first**, followed 2 weeks later by the frontalis treatment, but avoiding repeatedly injections in a short time should be avoided.

- Start with a low dose in the frontalis and avoid using a dose of botulinum toxin type A that will cause forehead immobilization. This may also facilitate a uniform dissipation of effects to the upper face and accentuate facial harmony throughout the treatment period.

Comments

Forehead rhytids are treated mostly with neurotoxins, although some practitioners prefer the concurrent use of fillers. It has been suggested that associated procedures may provide a slightly better cumulative benefit (Dubina et al. 2013) and increase the persistence of the rejuvenation treatment. Keep in mind that the majority of ours patients don't want to look done, they want to look better. The natural look is the goal!

Take Home Messages

- The horizontal lines are caused by the contraction of the frontalis muscle, and its contraction might be an important tool to raise a ptotic brow or eyelid to improve the visual field especially concerning elderly patients.
- Optimal aesthetic outcomes can be achieved by skillfully balancing the opposing effects of the frontalis muscle and its intricate interactions with the procerus, corrugator supercilii, depressor supercilii, and orbicularis oculi muscles.
- The goal in treating the forehead is to maintain some movement of the frontalis muscle and avoid complete paralysis, resulting in natural mimics without compromising the height, position, or shape of the brows and the eyelid.
- Concerning the areas to be treated and the sites of the injections, we need to analyze the functional portion (pars that actually is responsible for the rhytids) of the muscle and then, treat preferably only the upper half maintaining the brow mobility but minimizing the wrinkles.
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