Clinical Approaches and Procedures in Cosmetic Dermatology

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Botulinum Toxins, Fillers and Related Substances

Springer
Clinical Approaches and Procedures in Cosmetic Dermatology

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The series “Clinical Approaches and Procedures in Cosmetic Dermatology” intends to be a practical guide in cosmetic dermatology. Procedures in cosmetic dermatology are very popular and useful in medicine, indicated to complement topical and oral treatments not only for photodamaged skin but also for other dermatoses such as acne, rosacea, scars, etc. Also, full-face treatments using peelings, lasers, fillers and toxins are increasingly being used, successfully substituting or postponing the need for plastic surgeries. Altogether, these techniques not only provide immediate results but also help patients to sustain long-term benefits, both preventing/treating dermatological diseases and maintaining a healthy and youthful skin. Throughout this series, different treatments in cosmetic dermatology will be discussed in detail covering the use of many pharmacological groups of cosmeceuticals, the new advances in nutraceuticals and emerging technologies and procedures.

More information about this series at http://www.springer.com/series/13496
When I received the invitation from Maria Claudia Almeida Issa (M.D., Ph.D.) and Bhertha Tamura (M.D., Ph.D.) to write one of the chapters of this marvelous book, I was very happy. Later, the mission to write the prologue of this book – whose editors, having to their credit numerous publications in the international scientific field of cosmetic dermatology, dignify the Brazilian dermatology – left me extremely honored. In this book, some of the leading medical doctors and research scientists from Brazil and a few from other parts of the world present their professional experience in the field of cosmetic dermatology.

Cosmetic dermatology is constantly evolving. Procedures for rejuvenating the skin are actively sought by people nowadays. As dermatology grows as a specialty, an increasing proportion of dermatologists will become proficient in performing different procedures. Even those who do not perform cosmetic procedures must be well versed in the details to be able to guide their patients.

There have been numerous major advances in the field of cosmetic dermatology, including the use of botulinum exotoxin, soft tissue augmentation, chemical peels, cutaneous lasers, and light source–based procedures, and the state of the art of dermatologic and cosmetic prescriptions have been developed and enhanced by dermatologists and plastic surgeons.

Botulinum toxin and fillers are routinely used to bring youthful appearance. Over time, a number of indications and different techniques have been developed, promoting even better results. The knowledge of anatomy related to toxin and filler applications is fundamental to achieve good results with safety. This volume covers all these topics and would serve as a good reference for doctors who already handle these procedures and for those who are planning to begin.

The series “Clinical Approaches and Procedures in Cosmetic Dermatology” offers a wonderful and embracing text. It was a pleasure to contribute to this unique book, along with so many renowned authors.

This work project is certainly a text of inestimable value for those who wish to deepen their knowledge in the field of cosmetic dermatology.

Hoping that you will enjoy learning from this book!

Mônica Manela Azulay
Preface

Nowadays, life expectation has increased, and for a better quality of life, people are looking for ways to enhance physical beauty and aesthetics and improve health. Dermatologists and plastic surgeons who work in the field of cosmetic dermatology can help patients to maintain a healthy and youthful skin. Topical and oral treatments associated with full-face procedures using peelings, lasers, fillers, and toxins are increasingly being used, successfully substituting or postponing the need for plastic surgeries.

This series of books is very special among those already published, as it encompasses all topics related to this area of dermatology. All authors are experts in the field of cosmetic dermatology. Literature review and its correlation with authors’ experience is a differential feature of this work.

This work has been divided into four volumes due to the breadth of the topics, which cover skin anatomy, histology, and physiology; patients’ approaches; common cosmetic dermatosis; topical and oral treatments; and cosmetic procedures.

Among cosmetic procedures, patients recognize botulinum toxin and fillers as those which bring the best satisfaction in short term. In this volume, authors report minutely the use of botulinum toxin, fillers, and collagen biostimulators. They describe the anatomy related to the use of botulinum toxin and fillers, explaining different techniques according to the region to be treated. Indications, contraindications, and management of possible complications are also discussed.

The series “Clinical Approaches and Procedures in Cosmetic Dermatology” was prepared to be a guide in cosmetic dermatology. It can be considered a complete encyclopedia in the field of cosmetic dermatology, and, for this reason, it is extremely useful for those who already work with cosmetic dermatology as well as for beginners in this field. This is a new reference work project, and we are delighted to have you on board.

August 2018
Brazil

Maria Claudia Almeida Issa
Bhertha Tamura
When we were invited to write a book on cosmetic dermatology, we could not imagine the dimension of this work project.

After drawing the program content, we realized that a comprehensive handbook series in this field would be built. Nevertheless, it would not be possible without the efforts and experiences of our invited partners. They deserve our acknowledgment and our deep appreciation.

To all collaborators, our very special thanks.

Maria Claudia Almeida Issa
Bhertha Tamura
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Dr. Maria Claudia Almeida Issa is among the leading dermatologists in Brazil and Latin America, especially in what regards cosmetic dermatology. Dr. Issa holds a Ph.D. in Dermatology from the Federal University of Rio de Janeiro (2008) and an M.Sc. in Dermatology from the Fluminense Federal University (1997). She is currently an Associate Professor within the Department of Clinical Medicine – Dermatology, at the Fluminense Federal University, Brazil. Her research focuses on photodynamic therapy, non-melanoma skin cancer, lasers, photoaging, and dermal remodeling. Finally, Dr. Issa has an extensive clinical experience in cosmetic dermatology, being registered as a dermatologist at the Brazilian Society of Dermatology since 1995 and member of the American Academy of Dermatology.
Dr. Bhertha Tamura holds M.Sc. and Ph.D. degrees in Dermatology from the Hospital das Clínicas de São Paulo – Universidade de São Paulo. She is a specialist in general surgery and dermatology. She is also a counselor for the Brazilian Society of Dermatologic Surgery and the Brazilian Society of Dermatology, member of the Scientific Commission of the Brazilian Society of Dermatology, Chief of the Department of Dermatology at the Complexo Hospital Heliopolis (São Paulo, Brazil), and member of several international dermatological societies.
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Part I

Anatomy View, Indications, Complications, and Management of Botulinum Toxin
Facial Anatomy View for Aesthetic Botulinum Toxin Injection

Bhertha Tamura

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Abstract
Anatomy has been focused since the first papers of crow’s feet and frown lines treated with botulinum toxin (BT). The knowledge and deep understanding of the synergism and antagonism of the muscle contraction still generates a lot of doubts and is essential for an excellent outcome after the injection of BT. We already know that the patients, most of all, are wondering if they will have a natural look after the treatment. Several authors have published the importance of having an individualized analysis in order to achieve great results at absolutely low risk of asymmetries or other complications.

Keywords
Facial anatomy · Botulinum toxin injection · Muscle contraction · Aesthetic

Introduction
If we are chasing a differentiated result for very special patients, it is absolutely imperative that we can classify each muscle, pair of muscle, their location, their action, and their role in the mimics.

There are beauty concept differences between cultures and ethnics, but basically the aim is to get a natural result with a maximum relaxation of the muscles that perpetrates the facial lines. Recently many authors also consider the prophylaxis of the wrinkles when the patients have hyperkinetic movements at specific areas of the facial mimics.

There is not a rule or a standard technique for the injection of botulinum toxin (BT). To reach a natural result, it is necessary to understand facial muscle dynamics.

Facial Muscles
We need to have in mind the synergistic and antagonistic action of the muscle complexes at the face, but first of all, know exactly their location, function, origin, and insertion (Altruda Filho et al. 2005; Gardner et al. 1978; Haddock et al. 2009).

The frontalis and occipitalis venter of the frontalis muscle originates at the galea aponeurotica of the skull and inserts at the orbicularis oculi muscle. At its anterior portion, the muscle divides in pair and is joined by the superficial fascia. This pair can get together at the medial part of the frontal region near the hair implantation; they can extend in different ways, and they are responsible for different patterns of the frontal mimics from one individual to the other changing the botulinum toxin dosage and sites of injection depending on the extension of the muscle. It raises the eyebrows and wrinkles of the frontal area. Figure 1 shows a very good example of the galea aponeurotica between the muscle bundles, area that does not need BT injection in patients that have this muscle pattern.

Fig. 1 Figure 1 shows a very good example of the galea aponeurotica between the muscle bundles, area that does not need BT injection in patients that have this muscle pattern.
Corrugator Supercilii

The corrugator supercilii originates (Gardner et al. 1978) at the internal and anterior orbital margin, superior and medial to the nose, and inserts at the frontalis muscle and the superciliary skin. Its contraction pulls the eyebrow together and downward leading to the glabellar hyperkinetic lines – the frown lines (Fig. 2).

They are intimately related to the orbital septum and to the palpebrae elevator muscle. And this is the most frequent reason for the lid ptosis after BT treatment near the glabella area, and this proximity is shown on Fig. 3.

Procerus Muscle

The procerus muscle originates (Haddock et al. 2009) from the nasal bone at the glabella and inserts at the forehead skin. This muscle pulls down the medial part of the eyebrow and is responsible for the horizontal wrinkles at the glabellar area (Fig. 1) and when long or hypertrophic is also responsible for the nasal horizontal lines that are a challenge for the cosmetic treatment.

Orbicularis Oculi

The orbicularis oculi muscle (Altruda Filho et al. 2005; Gardner et al. 1978; Haddock et al. 2009; Sobotta and Becher 1977) originates from the palpebral and orbital ligament and joins to the horizontal fibers of the nasalis muscle (Fig. 4) and inserts at the lateral palpebral raphe. It is a circular muscle that acts like a sphincter, and it arises from the nasal part of the frontal bone, from the anterior surface and borders of a short fibrous band, and from the frontal process of the maxilla in front of the lacrimal groove. The lateral portion of the orbicularis oculi pulls down the eyelid. It is responsible for the closure of the eyelids and the crow’s feet lines.

The orbicularis oculi pars inferior orbitalis closes the lids and squeezes them against the eye and originates at the lacrimal bone, frontal process of the maxillae, the skin around the orbit and is also responsible for the lower lid lines.

This muscle can be wide in some individuals; it can reach the eyebrow and cover the malar area being responsible of the very long crow’s feet lines.
that can go on until the preauricular and also to the inferior temporal area. The perioral and periorbital round muscle acting like a sphincter has a different response to BT; one injection does relax that part of the muscle, not all of it. If we inject botulinum toxin A, for example, it will relax about 1 cm at that location and not the role muscle as a unit.

When we analyze these wrinkles for BT injection, we understand that they need to be treated per area, as at the crow’s feet, medial ocular or nasociliary area adding the procerus and nasalis muscle contraction and lower eyelid lines separately. These lines can also extend inferiorly and laterally until the zygomatic arch and the deep layer arising from the sphenoidal tuberculae and inserting onto the margins and medial side of the coronoid process and the temporal crest of the mandible. It elevates and retracts the mandible.

**Pterygoid Muscle**

The lateral pterygoid or external pterygoid is a muscle of mastication with two bundles. It lies superiorly to the medial pterygoid. At the lower part of the temporal area we consider the medial and lateral pterygoid muscle (superior and inferior bundle). The superior bundle of the pterygoid lateral muscle originates from the lateral part of the lateral sheet of the pterygoid process and the facies temporalis alaris majoris ossis sphenoidal is and inserts at the temporomandibular joint. The inferior bundle originates at the lateral facies of the lateral pterygoid plate, pyramidial process of the palatine, and the maxillary tuberosity inserting at the fovea pterygoidea (Altruda Filho et al. 2005; Haddock et al. 2009; Sobotta and Becher 1977). The muscle protracts, moves laterally, and stabilizes the articular disc and the opening of the mouth. The medial pterygoid muscle originates from the facies lateralis of the pterygoid process, fossa pterygoidea, and the pyramidial process of the palatine and the maxillary tuberosity inserting at the medial side of the mandible angle and elevates the mandible and acts synergistically with the masseter (Tamura 2010a, b).

**Temporalis Muscle**

The temporalis muscle (Sobotta and Becher 1977) is a mastication muscle, not a mimics muscle. It lies at the temporal fossa, covers the temporal bone, and is superior to the zygomatic arch. Botulinum toxin to relax this muscle is indicated for patients with bruxism who have hypertrophic masseter added to a temple hypertrophy. BT is also indicated to relax the temporalis muscle for migraine treatment. The temporalis muscle arises from the deep part of the temporal fascia and the temporal fossa (superficial layer) passing medially to the zygomatic arch and the deep layer arising from the sphenoidal tuberculae and inserting onto the margins and medial side of the coronoid process and the temporal crest of the mandible. It elevates and retracts the mandible.

**Nasalis and Depressor Septi Nasi**

At the nasal region, the nasalis muscle has two bundles, one that inserts at the nasal alae (dilates the nostrils) and the transversal area of the nasal...
At the nasal region, the *nasalis* muscle has two bundles, one that inserts at the nasal alae 1 (dilates the nostrils) and the transversal area of the nasal dorsum – the dilator naris muscle (compress the nostrils) 2 and number 3 is the *levator labii superioris alaeque nasi* muscle.

The *levator labii superioris alaeque nasi* muscle (Fig. 7) elevates the superior lip and the nasal alae, helps to dilate the nostrils, originates from the frontal maxillae process, and inserts at the nostrils and the superior lip. The treatment of this muscle is a key point for the success when we are treating the wide and complete gummy smile that shows the molar teeth. Botulinum toxin injected at this sight smoothes the nasolabial fold. We suggest that the injection site should be at the bundle that inserts at the nostril, medial to an imaginary line between the nasal area and not laterally (Tamura 2010a, b).

**Musculus Levator Labii Superioris Alaeque Nasi**

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**Levator Labii Superioris**

The *levator labii superioris* (Sobotta and Becher 1977) elevates the superior lip and originates at the infraorbital margin of the maxilla foramen inserting to the superior lip. Relaxing this muscle...
we treat the gummy smile at the medial part of the superior lip; relaxing it too much leads to patient dissatisfaction, so lower BT dosage injection is advisable.

**Zygomaticus Minor and Major**

The muscle *zygomaticus minor* pulls the upper lip upward and outward and is innervated by the facial muscle (Fig. 8). It originates at the zygomatic bone posterior to the zygomaticomaxillary suture and inserts at the *orbicularis oris* of the upper lip and with the *zygomaticus major* muscle draws the lips corners upward and outward. The *major* originates from the temporal process of the zygomatic bone and inserts at the angle of the mouth (Altruda Filho et al. 2005; Sobotta and Becher 1977; Tamura 2010a, b). It is very important to be precise to not inject in these muscles unless the drop and relaxation of the smile is the aim, for instance, when we want to give symmetry to a patient with facial paralysis.

The *risorius* muscle (Albinus muscle, Santorini muscle) pulls outward and laterally the angle of the mouth lengthening the *rima oris*. *Risorius* muscle originates from the *platysma*, the *masse-ter*, and the *fascia parotidea* and inserts at the *orbicularis oris* and the skin at the corner of the mouth. *Zygomaticus major* and minor as well as *risorius* can be relaxed with BT to soften the nasolabial fold and the wrinkles on the cheek area. When these muscles are treated certainly the smile will change drastically.

**Musculus Levator Anguli Oris, Levator Labii, and Orbicularis Oris**

The muscle that elevates the mouth angle is the *levator anguli oris*, which originates from the canine *fossa*, deeply to the *levator labii*, and inserts at the mouth angle. Around the lips, the *orbicularis oris* (Fig. 9) sits at the mouth *rima*, very superficially and inserts at the skin and the lips mucosa (Altruda Filho et al. 2005; Gardner et al. 1978; Sobotta and Becher 1977). This muscle contracts as a sphincter, and the BT injection does relax only parts of it and not all of it. If we are wondering to treat the upper and the lower lip, injections must be apart and even along the upper lip; mostly injections are made equally one side and the other side. As shown in Fig. 9, we must remember that it is very superficial and thin, though the injections must be also very superficial and near the vermilion of the lip. The superficial injection also avoids relaxing the other muscles of the lower face as the elevators (*zygomaticus major* and minor, *levator labii superioris*, *levator labii superioris alaeque nasi* muscle), the *depressors labii* (with *mentalis* muscle), and the mouth angle (*depressor anguli oris* muscle).
Buccinator Muscle and Masseter

The cheek muscle, buccinator is located posteriorly to the oral fat and originates from the posterior pterygomandibular raphe and the posterior portion of the alveolar portion and inserts at the angle of the mouth, interspersing with portions of the orbicularis oris (Altruda Filho et al. 2005; Gardner et al. 1978; Sobotta and Becher 1977). Buccinator flattens the cheek, keeps its tension, retracts the angle of the mouth and is part of the mastication muscle group also helping to suck and whistle. It is intimately related to the tongue and the orbicularis oris muscle keeping the food between the teeth and the oral cavity. When BT relaxes this muscle or its paralysis due to a Frey’s syndrome, the food accumulates at the oral vestibule. We need to remember this muscle when treating the masseter with BT to not inject too deep at the buccinator muscle.

Masseter (Fig. 10) lies at the parotideomasseteric area and does have a superficial and a deep bundle. The superficial part originates at the inferior margin of the two-thirds anterior zygomatic arc and the deep portion originates at the internal side of the posterior third and the deep bundle inserts along the lateral branch of the mandible; its main action is to elevate the mandible and is considered as the most powerful muscle of the human body. Understanding masseteric hypertrophy with or without bruxism is a key for the new concept of contouring the lower face.

Depressor Anguli Oris (DAO), Depressor Labii, and Mentalis

The muscular layer of the chin comprehends the depressor anguli oris, the depressor labii, and the mentalis muscle (Altruda Filho et al. 2005; Gardner et al. 1978; Sobotta and Becher 1977). The origin of the depressor anguli oris is the base of the anterior mandible (first molar to the mental tubercle), and it inserts at the mouth angle and other lip muscles. It is the most superficial of the group and the most lateral of the mandible (reference for BT injection) which pulls down the corner of the mouth.

The depressor labii originates at the base of the mandible (over to the origin of the depressor
anguli oris) and inserts at the inferior lip, and the mentalis muscle originates at the mental fossa (cranial to the mental tubercle) under the central incisive and lateral teeth and inserts at the chin skin, which wrinkles the chin and puckers the lower lip (Fig. 11). The shape of the mentalis and its decussation can differ individually. For this reason, sometimes it is necessary to re-treat some area isolated to improve the natural effect of the relaxation.

At the oral commissure the so called marionette lines comes out by the contraction of the DAO, depressor labii and the platysma muscle and flaccidity of the SMAS (superficial muscle aponeurotic system).

The platysma muscle (Altruda Filho et al. 2005; Sobotta and Becher 1977; Tamura 2010a, b) (Fig. 11) does have some action with the facial muscle as it stretches and pulls downward and outward the neck skin with the help of the DAO laterally and downward at the anterior jaw line. It originates at the sternoclavicular joint, clavicle, and scapular acromio and inserts at the base of the mandible and some fibers at the mouth angle. This muscle has a strong portion and runs to the anterior part of the chin toward the lip reaching the so-called modiolus complex. Platysma might sometimes spread laterally until the mandible angle and the dynamic evaluation of its extension are essential for the BT injection plan.

**Take Home Messages**

- The knowledge and deep understanding of the synergism and antagonism of the muscle contraction still generates a lot of doubts and is essential for an excellent outcome after the injection of BT.
- Patients look for a natural look after the injection of botulinum toxin (BT).
- Several authors have published the importance of having an individualized analysis in order to achieve great results at absolutely low risk of asymmetries or other complications.
- There is not a rule or a standard technique for the injection of botulinum toxin (BT). To reach a natural result, it is necessary to understand facial muscles dynamics.

**References**


Botulinum Toxin for Forehead

Beatriz Rosmaninho Caldeira Avé

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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 supercili, depressor supercili, 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

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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