

Consideration of Muscle Depth for Botulinum Toxin Injections: A Three-Dimensional Approach

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Knowledge of variable anatomy is key for excellent outcomes from the administration of botulinum toxin for aesthetic purposes. One must understand the location and function of each facial muscle to predict the patient's desired outcome. One concept often overlooked by injectors is the understanding of the target muscle's depth. In addition, a firm understanding of where each facial muscle originates and attaches can be essential to correctly identifying and injecting the correct muscle with botulinum toxin. Facial muscles often overlap each other and cross various planes. For example, an injector may be unaware that the corrugator supercilii muscle lies in different depths medially and laterally. Novice injectors may miss the variability of this muscle and inject the lower frontalis muscle by mistake. This may lead to a heavy brow look, or it could drop the area between the brows, creating an appearance of anger. This article explores a three-dimensional anatomical approach to achieve excellent outcomes, rather than the two-dimensional approach traditionally discussed. Many of the injection techniques defined in this article are considered off-label by the Food and Drug Administration at the time of this publication but are commonly discussed in peer-reviewed literature and consensus opinion reports. Twelve facial muscles often injected for positive aesthetic outcomes will be outlined as well as seven facial muscles to generally avoid.

and practitioners of many specialties are adding this cash-pay service to their practices. The package insert describes basic two-dimensional patterns of where to inject BoNT-A on-label, but an understanding of each facial muscle in three dimensions, both on- and off-label, could lead to better aesthetic outcomes. In addition, facial anatomy varies widely from person to person, so aesthetic practitioners should be able to identify each individual's muscle anatomy by assessing the patient during animation.

This article discusses 19 facial muscles for expression and mastication. Twelve of these muscles are often injected, whereas seven of these muscles are usually avoided. The purposes of each of these muscles will be explored, as well as their origins and insertions. Understanding the origin and insertion can help an aesthetic practitioner decide which depth or plane should be injected for the best outcome. The desired outcomes as well as some undesired outcomes will also be discussed.

Deep injections are defined in this article as approximately 6–10-mm deep, sometimes on or near periosteum. Medium depth injections are described in this article as approximately 2–5-mm deep, placed under the skin, passing the overlying muscle (if there is one) and into the targeted muscle. Superficial injections are achieved by creating a wheel immediately under skin, with the bevel of the needle just under the skin before the fluid is injected. See Figure 1 for a suggestion of depth for individual facial muscles.

MUSCLES OFTEN INJECTED ON-LABEL

The Food and Drug Administration (FDA) has approved cosmetic injections of BoNT-A in the corrugator, procerus, depressor supercilii, and orbicularis oculi muscles (FDA, 2013). Currently, these are the only facial muscles that are considered to be on-label for aesthetic botulinum toxin injections. Both on-label and off-label BoNT-A injections will be discussed. Refer to Table 1 for a list of each muscle discussed in this article.

Corrugator Supercilii

The corrugator supercilii muscle originates on the frontal bone medially at the superciliary arch, crosses through the frontalis muscle, and attaches to the skin laterally above the middle of the orbital arch (Goss, 1960). The frontalis overlaps the corrugator muscle by lying on top

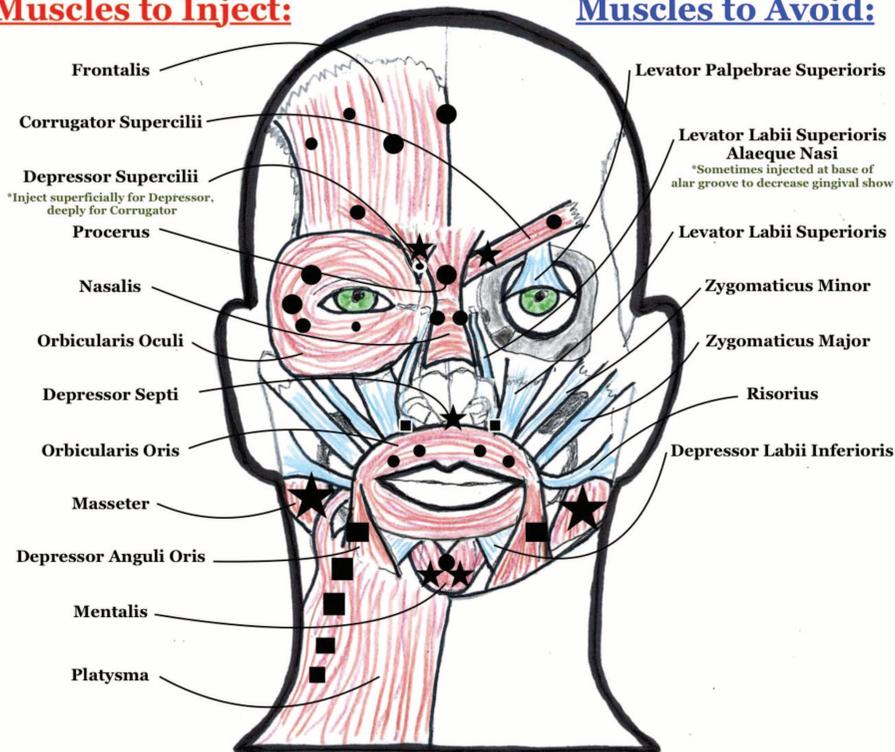
Botulinum toxin Type A (BoNT-A) for cosmetic use was the top aesthetic injectable in 2015 with 4,267,038 procedures, followed by hyaluronic acid injections with 2,148,326 procedures (American Society for Aesthetic Plastic Surgery [ASAPS], 2016). All cosmetic injectable procedures increased by 21% in 2015 (ASAPS, 2016). As the popularity of BoNT-A increases, physicians

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Muscles to Inject:**Muscles to Avoid:**

- **Superficial Depth**
(very superficial wheel with needle bevel just under skin)
- **Medium Depth**
(just under the skin into the targeted muscle)
- ★ **Deep Depth**
(Several mm below skin surface, sometimes to periosteum)

FIGURE 1. Botulinum toxin depth guide. Illustration by Julie Bass Kaplan.

medially and lies under the corrugator laterally. Therefore, if one does not understand the varying depth of the corrugator muscle, the frontalis could be the unintended target of BoNT-A. Superficial placement medially of the injection bolus could target the frontalis muscle and drop the brows rather than raising them.

Thus, a recommended injection pattern for the corrugator supercilii muscle is to inject deep medially and very superficial laterally. Corrugator length, shape, and angle can greatly vary between people. To assess where the patient's corrugator is, one could pinch the medial corrugator and have the patient push his or her eyebrows together. An injector can usually feel the muscle between his or her finger and thumb when the patient makes this animation. After confirmation of the corrugator muscle, one can inject the medial pinched area deeply, nearly to the periosteum, where the corrugator originates. Laterally, one could look for the puckering of the skin when the patient animates when pushing his or her eyebrows together. A very superficial injection just medial to the skin puckering can be made to achieve accurate placement of the lateral corrugator muscle. See Figure 1 for a diagram of suggested muscle depth.

Depressor Supercilii

The depressor supercilii is not recognized by many text books as some believe that it is a part of the orbicularis oculi muscle. Visible Body (2016) describes it as a superficial muscle of facial expression and an eye muscle. The purpose of this muscle is to lower the eyebrow. It originates with fibers of the orbicularis oculi and inserts in the subcutaneous tissue of the eyebrow (Visible Body, 2016).

If one decides to inject this muscle, be cautious of the frontalis muscle that lies just below the depressor supercilii. The two muscles have opposite purposes. The purpose of the frontalis is to raise the brows, and the purpose of the depressor supercilii is to lower the brows. BoNT-A generally gives an opposite effect of the purpose of the muscles. Thus, if lower frontalis is injected, the brows that were supposed to raise will drop. If the depressor supercilii muscle is injected, the brows that were supposed to depress will raise. Unfortunately, these two muscles that are in cross purposes lie very close together, tightly layered. It is easy to inject the wrong muscle or to inadvertently inject both at the same time. It may be easier to

TABLE 1 Twelve Common Facial Muscles Injected With Botulinum Toxin A

Muscles to Inject	Origin	Insertion	Desired Outcome	Undesired Outcome	Suggested Depth of Injection
Frontalis	Galea aponeurotica	Skin above eyebrows	Soften horizontal forehead rhytids	Brows drop	Superficial
Corrugator supercillii	Frontal bone medially at superciliary arch	Skin laterally above brows orbital arch	Soften vertical rhytids between brows	Brows drop, may drop eyelid if travel to LPS	Deep medially, superficial laterally
Depressor supercillii	Fibers of orbicularis oculi	Subcutaneous tissue of eyebrow	Raise medial eyebrows	Lower medial eyebrows if frontalis injected	Superficial
Procerus	Fascia of nasal bone and cartilage	Skin between brows	Raise bridge of nose, soften horizontal rhytid	Skin between brows drop if frontalis injected	Superficial
Nasalis	Upper frontal process of maxilla	Alar cartilage	Soften or eliminate diagonal rhytids along side of nose "bunny lines"	May inadvertently inject LLSAN, drooping upper lip	Superficial
Orbicularis oculi	Frontal bone, maxilla, medial palpebral ligament, and lacrimal bone	Lateral palpebral raphe and superior and inferior tarsi medial	Soften horizontal and diagonal rhytids, raise lateral brows, more open eye appearance	May affect smile if zygomaticus minor or major receives BoNT-A	Superficial
Depressor septi	Incisive fossa of maxilla	Septum and back part of nasal ala	Raise tip of nose	May affect movement of upper lip if orbicularis oris is injected	Deep
Orbicularis oris	Fibers of various facial muscles	Angle of mouth and skin	Soften vertical rhytids, evert lip border	Reduce function of mouth, phonation	Very superficial
Masseter	Zygomatic arch	Mandible	Reduce size of masseter and/or decrease TMJ pain	May affect smile if risorius muscle receives BoNT-A	Very deep, usually requires ½" needle
Depressor anguli oris	Oblique line of mandible (deep)	Risorius and Orbicularis oris at corner of mouth (superficially)	Lift corners of mouth, soften crescent-shaped horizontal rhytids	May inadvertently inject DLI, causing crooked smile	Deep on mandible, medium above mandible. Stay laterally to avoid DLI
Mentalis	Incisive fossa of mandible	Skin of chin	Soften mental crease, relax chin, soften dimples on chin (cobblestone appearance of chin)	May inadvertently inject DLI, causing crooked smile	Deep inferiorly on mandible, superficially above, near mental crease
Platysma	Fascia of the upper pectoralis major and deltoid muscles	Mandible and subcutaneous tissue of the lower face	Soften or eliminate vertical banding	Difficulty moving neck or swallowing difficulties	Pinch bands and inject fairly deeply and directly into platysma muscle. Do not inject deeper than platysma muscle.

Note. BoNT-A = botulinum toxin Type A; DLI = depressor labii inferioris; LLSAN = levator labii superioris alaeque nasi; LPS = levator palpebrae superioris; TMJ = temporomandibular joint.

target the deep medial corrugator supercillii for the goal of raising the brows medially, rather than trying to raise by injecting the depressor supercillii. See Figure 1 for a drawing of the depressor supercillii.

Procerus

The procerus is a superficial muscle that originates from the fascia of the lower part of the nasal bone and the upper part of the nasal cartilage. It inserts into the skin

between the two eyebrows and into the frontalis muscle. The purpose of the procerus is to pull the eyebrows down toward the nose (Visible Body, 2016). The intended outcome of injecting the procerus is to raise the skin between the two brows, which can relax the horizontal crease on the bridge of the nose. An unintended outcome is to accidentally inject frontalis, which will make the brow drop even more, increasing the depth of the horizontal rhytid across the nose.

A suggested technique for the procerus injection is to first observe the patient's animation of bringing his or her eyebrows together. If there is no horizontal rhytid formed, or no apparent action between the brows, the patient may not require a procerus BoNT-A injection. If the procerus appears to be very large and active, it may require two superficial insertion points rather than just one above the horizontal rhytid. The procerus lies on the top of the frontalis and it has opposite purposes. A superficial injection is recommended, and the dose depends on how active this muscle is for that particular patient.

Orbicularis Oculi

The orbicularis oculi is a circular-shaped superficial facial muscle of expression that surrounds the eyes. It originates on the frontal bone, maxilla, medial palpebral ligament, and lacrimal bone. It inserts into the lateral palpebral raphe and superior and inferior tarsi medial (Visible Body, 2016). The purpose of this muscle is to constrict the eyes. Thus, the intended outcome is to relax this constriction, which can lead to a larger eye appearance. In addition, lateral canthal lines, also known as "crow's feet," can also be diminished.

A suggested injection technique for this area is to have the patient close his or her eyes very tightly and observe where the muscle fibers of the orbicularis oculi are. Also, assess how much the tail of the brow depresses when the patient makes this animation. If the tail of the brow comes down, an injection into the upper orbicularis fibers may result in a raised lateral brow. Inject very superficially, creating raised wheels just under the skin. Superficial injections in the orbicularis oculi will reduce the chance of bruising as well. Usually, vessels below the skin surface can be visualized if the skin is stretched tightly before each injection.

An unintended outcome could be caused from injecting too laterally on the cheek and affecting muscles for smiling such as the zygomaticus major and minor muscles. Another unintended consequence is when the cheek raises during a smile, but the skin around the eye does not move and a "shelf" look is created when the cheeks raise during a smile. Thus, a smaller dose under the eyes medially is recommended. Another unintended consequence is that the lower eyelid may fall away from the eye (ectropion), creating weeks of a dry eye for the patient. If an injector desires to place BoNT-

A near the lower lid, assessment for good elasticity of the skin should be made to prevent this complication by the assessment of a SNAP test.

MUSCLES OFTEN INJECTED OFF-LABEL

Frontalis

The frontalis is a very thin muscle of the anterior scalp. It originates in the galea aponeurotica, a vascular layer that is superficial to the periosteum. The frontalis inserts into the skin above eyebrows. The purpose of this muscle is to raise the eyebrows as well as the skin over the nose and the eyes (Visible Body, 2016). Because BoNT-A will prevent this muscle from raising, the end result could be an unwanted drop of the eyebrows. One can counteract this anticipated fall of the brows by injecting the glabellar complex and orbicularis oculi (just under the brows) to create a lift in these two areas to counteract the expected fall from the frontalis relaxing. In addition, an unintended outcome of heavy brows may happen if too much BoNT-A is utilized in the frontalis, and not enough in the glabella to counteract the fall of the eyebrows. If the BoNT-A is placed too low into frontalis over the eyebrows, the brows could lower laterally.

One injection technique for the frontalis is to use approximately half of the dose given to the glabella and to be very cautious when injecting over the lateral brows. One could place the BoNT-A higher on the frontalis where the skin does not sag as easily as over the lateral brows. An aesthetic practitioner can push the skin of the forehead down with their finger to assess how much the patient's brows and lids drop at that particular spot before injecting. Very superficial placement of BoNT-A is recommended for the frontalis muscle.

Nasalis

The nasalis is a superficial muscle of the nose for facial expression. Its purpose is to depress the cartilaginous part of the nose, which draws the ala toward the septum (Visible Body, 2016). This expression can create diagonal rhytids across the nose, often referred to as "bunny lines" or "angry wolf lines." One may choose to inject BoNT-A into the nasalis to decrease the rhytids on the side of the nose and prevent the nasal ala from being drawn up. The nasalis originates on upper part of the frontal process of the maxilla and inserts into the alar cartilage (Visible Body, 2016).

The nasalis should be injected very superficially in the muscle belly between the rhytids created when the nasalis is contracted. If the BoNT-A inadvertently stops the levator labii superioris alaeque nasi (LLSAN) muscle from contracting, the patient may experience difficulty raising his or her upper lip when smiling. The LLSAN overlaps the nasalis superiorly and laterally and can also create

diagonal rhytids. Therefore, caution should be taken to avoid injecting the LLSAN when targeting nasalis by injecting more medially along the side of the nose and injecting fairly small doses of BoNT-A.

Depressor Septi

The depressor septi is a deep muscle of facial expression and a muscle of the nose. Its purpose is to draw the ala of the nose and the nose tip downward. It originates in the incisive fossa of the maxilla and inserts into the septum and back part of the ala of the nose (Visible Body, 2016). A desired outcome of injecting this muscle with BoNT-A is to raise the nasal tip. Caution is recommended to avoid injecting the orbicularis oris inadvertently, which could affect movement of the upper lip. A deep injection at the base of the septum is recommended, either at two points on the right and left of the septum or one deep injection at the base of the septum midline.

An unintended outcome may be that the orbicularis oris is injected instead of the depressor septi. This could affect the movement of the upper lip. Care should be taken to identify the depressor septi in animation and to inject deeply to avoid placing BoNT-A in the orbicularis oris.

Orbicularis Oris

The orbicularis oris encircles the mouth in a sphincter-like fashion. The superficial portion of the muscle closes lips and protrudes lips, whereas the deep part of the muscle presses the lips to the teeth, which aids in speech and maintains oral competence. This sphincter-like muscle originates at the fibers of many other facial muscles and inserts into the angle of the mouth and into the skin (Visible Body, 2016).

Care should be taken to inject botulinum toxin superficially in this muscle to decrease vertical rhytids but not too deep to affect speech. In addition, very small doses of BoNT-A are recommended. One unintended outcome of this procedure is difficulty with mouth movement. A patient may have difficulty sucking from a straw or eating from a spoon. In addition, speech could be affected or the ability to play a musical instrument that requires certain movements of the mouth. It is advised to start with very small doses and discuss risks with each patient.

One injection technique is to have the patient pucker to assess the gathering of the orbicularis oris. Enter just above the vermilion border of the upper lip and place a very superficial injection into the muscle bellies (usually in two symmetrical spots on each side). Avoid injecting between the philtrum columns, as this could have a flattening effect of the center upper lip. If done correctly, this injection can create a desirable eversion of the upper lip and soften vertical rhytids on the upper lip.

Masseter

The masseter has two components, the deep masseter and the superficial masseter. Both originate on the zygomatic arch and both insert directly onto the mandible. The superficial masseter inserts lower on the ramus of the mandible. The superficial masseter is often the target for botulinum toxin injections. It is important to note that the risorius muscle originates on the fascia over the superficial masseter (Visible Body, 2016). If one injects a botulinum toxin superficially in the area of the superficial masseter, this can affect the patient's ability to retract the angle of the mouth, which can result in a crooked smile. Thus, even though this muscle is called the superficial masseter, it is wise to inject botulinum toxin deeply, near where it attaches to bone. This often requires a ½" needle.

One unintended outcome is migration to the risorius muscle, which can affect the appearance of the patient's smile and mouth movement. The risorius lies on the top of the masseter, and a superficial injection into the masseter muscle can accidentally be placed in the risorius. Another unintended outcome is that the top of the masseter may be relaxed, but the bottom of the muscle may still move. This can give a strange chipmunk appearance when the patient clenches his or her jaws. The risks of both of these unintended outcomes can diminish by injecting very deeply, just above periosteum, directly into the masseter muscle.

One recommended injection technique is to have the patient clench his or her jaw and assess the borders of the masseter. Three to five injections per masseter are usually required with a ½" needle. A fairly large dose is generally advised for this strong muscle. The needle should go down to periosteum before being placed, as the masseter is firmly adhered to the mandible.

Depressor Anguli Oris

The depressor anguli oris (DAO) is a superficial muscle of facial expression that draws the angle of the mouth downward and laterally. The origin of the DAO is very deep, along the oblique line of the mandible and continuous with the platysma. It inserts superficially into the risorius and orbicularis oris near the corner of the mouth (Visible Body, 2016).

One unintended outcome is the inadvertent injection into the depressor labii inferioris (DLI), which could affect the ability for the patient to pull down a particular side of his or her lower lip when smiling. The DLI and the DAO overlap. The DLI lies just under the DAO, so to avoid injecting both of these muscles, one could plan his or her injection point to be lateral to the marionette fold and either just above the line of tension caused by turning the corners of the mouth down or 1 cm laterally and diagonally from this line

of DAO animation. It is advisable to have the patient pull the corners of his or her mouth down or show his or her lower teeth to reproduce the action of the DAO before injecting.

Mentalis

The mentalis is a deep muscle of the chin and lower mouth that originates on incisive fossa of the mandible and inserts into the skin of the chin. The purpose of the mentalis is to raise and protrude the lower lip, which wrinkles the skin of the chin (Visible Body, 2016). This muscle also elevates the skin of the chin (Kanade, Cohn, & Tian, 2000).

Patients may complain of a “pebbly” or “orange peel” quality to their chin when they talk. This appearance is also known as a “peau d’ orange” or even “golf ball” chin. It is important to note that the DLI also overlaps the mentalis and crosses under the DAO. Again, one should be cautious not to inject into the DLI when attempting to inject the mentalis or DAO because the patient would have difficulty pulling down the lower lip when smiling on the side the DLI was injected. One injection technique is to inject two points deeply in the lower chin and one superficially in the middle of the chin to decrease skin dimpling and relax the look of the chin and mental crease.

Platysma

The platysma is a superficial muscle of facial expression as well as a neck muscle. It originates on the fascia of the upper pectoralis major and deltoid muscles. The platysma inserts onto the mandible and subcutaneous tissue of the lower face (Visible Body, 2016). Platysmal bands are often injected to improve the appearance of the neck. The injection into a platysmal band is potentially effective at a medium depth, even though this is a superficial muscle. It is often easier to inject while the patient is flexing his or her platysma muscle.

Some unintended outcomes of injecting platysmal bands are difficulty swallowing and difficulty lifting the head up from a reclining position. Too many units in this area could be a problem for people with head and neck musculature issues. Care must be taken to inject only in the platysmal band itself and not in the underlying structures. Pinching the bands during animation before injection and placing the needle at a medium depth can help ensure proper placement. Some practitioners choose to inject the band as the patient animates.

MUSCLES TO GENERALLY AVOID

Depressor Labii Inferioris

The DLI is a deep muscle of facial expression and lower mouth. It originates on the mandible, where it is blended with the platysma. It inserts on the skin of the lower lip,

where the DLI muscle fibers blend with the orbicularis oris. The function of the DLI is to draw the lower lip down and laterally (Kanade et al., 2000). This function is important in a smile, especially a smile that shows lower teeth.

When this muscle is inadvertently injected with a botulinum toxin, it can result in an asymmetric smile. There are times when the aesthetic injector may want to target this muscle to match the result from a facial palsy caused by a stroke or Bell’s palsy.

Levator Palpebrae Superioris

The levator palpebrae superioris (LPS) is a muscle that raises the eyelid. It is a flat muscle that connects the skin and the connective tissue plates of the eyelids to the orbit. It originates in the sphenoid part of the orbit and inserts in the skin and tarsal plates of the eyelid (Visible Body, 2016).

One unintended complication of botulinum toxin injections to the corrugator supercilii muscle is ptosis of the eyelid. This ptosis happens when the botulinum toxin travels to the LPS inadvertently. Patients with a history of an eyelid ptosis from botulinum toxin injections should be treated with caution as they may have anatomy that predisposes them to this complication. In addition, slow and superficial injections to the lateral end of the corrugator muscle may decrease the chances of the BoNT-A reaching the LPS. Some practitioners place their thumb on the orbital rim as they inject the corrugator supercilii to prevent the BoNT-A from traveling below the orbit. It is important to assess patients for preexisting natural eyelid ptosis as these patients most likely have a weakening of the levator muscle or even a separation or levator dehiscence. Photographs should be obtained before BoNT-A is administered to document the preexisting natural eyelid position.

Levator Labii Superioris Alaeque Nasi

The LLSAN muscle is a superficial muscle of the nose and facial expression. It originates on the upper part of the maxilla and inserts into the alar cartilage and levator labii superioris (LLS). Its purpose is to raise the upper lip (Visible Body, 2016).

The LLSAN is sometimes injected with botulinum toxin to decrease a smile that shows too much gingiva, or a “gummy smile.” Sometimes it is inadvertently injected while treating rhytids along the nose also known as “bunny lines” or “wolf lines.” When this happens, the patient may not be able to show his or her upper teeth when he or she smiles, giving them a long upper lip look.

Levator Labii Superioris

The LLS is a superficial muscle of facial expression and mouth. It originates on the zygomatic bone and inserts

into the skin of the upper lip between the levator anguli oris and the LLSAN. The purpose of the LLS is to raise the upper lip and move it forward (Visible Body, 2016). If this muscle is inadvertently injected, the smile can be affected.

Zygomaticus Minor

The zygomaticus minor is a superficial muscle of facial expression that draws the upper lip outward and upward as well as laterally. It is an essential muscle for smiling. It originates on the zygomatic bone and inserts in the subcutaneous tissue of the upper lip (Visible Body, 2016). This is the only deep muscle in the face that opens lips (Kanade et al., 2000). This muscle is sometimes accidentally injected when the injector is trying to diminish lateral canthal lines, or crow's feet, resulting in changing the appearance of the patient's smile. It is important to assess where the orbicularis oculi is and where the zygomaticus minor and major are.

Zygomaticus Major

The zygomaticus major is a superficial muscle of expression that originates on the zygomatic bone and inserts into the orbicularis oris, DAO, and the levator anguli oris. It draws the angle of the mouth laterally and upward. This muscle is also important for the function of smiling (Visible Body, 2016). It is also important to avoid injecting this muscle to maintain the patient's natural smile.

Risorius

The risorius is one of the superficial muscles of expression and mouth. It originates in the fascia over the masseter and inserts at the skin of the corner of the mouth. Its purpose is to retract the angle of the mouth, such as the expression of smiling (Visible Body, 2016). See the

section on the masseter muscle for unintended cosmetic outcomes of the risorius.

CONCLUSION

A thorough knowledge of facial muscles of expression and mastication is essential for excellent aesthetic outcomes of BoNT-A. One must grasp how each of these muscles lies in three dimensions, rather than just two dimensions. Because the muscles often overlap each other and have opposite functions, the aesthetic practitioner must know how deep to place the BoNT-A for each muscle. An understanding of intended and unintended outcomes of each area can help the practitioner plan each injection. Facial assessment is critical to determine each individual's unique muscle structure as well. Every patient has unique facial muscles, and a "cookie-cutter" approach is not recommended for excellent aesthetic outcomes. Finally, understanding where each muscle originates and inserts is extremely important when determining which depth to inject. Thus, a three-dimensional approach and a clear understanding of these 19 muscles can lead to excellent outcomes and satisfied patients.

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