

Neuromodulating the SMAS for Natural Dynamic Results

Niamh Corduff, MBBS, FRACS

Summary: Physicians using neuromodulators need to develop an in-depth and holistic understanding of the facial musculature as a single, large, functional structure that does not work in isolation. In this Special Topic, I review the anatomy of the continuous fibromuscular layer of the face, discuss how certain age-related indications develop as a consequence of imbalances to this unified structure, and propose considerations for neuromodulator-based interventions of the upper, mid, and lower face. I provide evidence-supported recommendations on the most optimal applications of neuromodulators to help rebalance the musculoaponeurotic layer for more natural outcomes. Through outcomes of my patients, I show how the facial mimetic muscles can be modulated with careful placement of botulinum toxin, without causing unnatural facial expressions, to achieve an expressive, well-balanced face that reflects health, vitality and happiness. (*Plast Reconstr Surg Glob Open* 2021;9:e3755; doi: 10.1097/GOX.0000000000003755; Published online 25 August 2021.)

INTRODUCTION

Bryan Mendelsson's description of the five tissue layers of the face¹ provided insight for surgeons performing facial aesthetic surgery but is also relevant to physicians using neuromodulators to rebalance the facial musculature. The facial mimetic and flat muscles comprise a single, large, functional structure and do not work in isolation. I review the anatomy of the continuous fibromuscular layer of the face and discuss how to use neuromodulators to rebalance the musculoaponeurotic layer, or "layer 3" to achieve more natural outcomes.

The Superficial Musculoaponeurotic System

The superficial musculoaponeurotic system (SMAS) layer is a singular cohesive fibromuscular sheet incorporating a fascia that extends to invest the superficial facial muscles to variable degrees and extends from the neck into the face and scalp.^{1,2} A less-extensive anchoring of the SMAS to the facial skeleton and a more robust attachment to the overlying soft tissues³ enables facial expressions. The SMAS incorporates a superficial thin fibrous layer and a deep thicker layer that encloses three flat muscles: the frontalis, orbicularis oculi, and platysma. In nonmuscular areas, these fibrous layers fuse to form an aponeurotic layer (Fig. 1).^{1,2} Depending on the function of

the area, the morphology of the aponeurotic component also varies. Over the less mobile lateral face, the fibrous SMAS is fused with the parotid capsule and is thick.⁴ The galea aponeurotic is strong, well-defined and has limited mobility. In contrast, the aponeurotic layer over the highly mobile cheek is very thin and difficult to delineate.^{1,5-7} The enclosed superficial flat muscles attach to the bone through retaining ligaments (orbicularis retaining, zygomatic, temporal, masseteric, and mandibular ligaments) and to the skin through the retinacular cutis fibers.^{1,2} Contraction of these flat muscular parts of the SMAS cause it to tense along with the face surface. Mimetic muscles attach to the underlying skeleton and reinforce the SMAS in its deeper aspect. The muscles either fuse with the SMAS or continue through to the dermis.^{8,9} They exert a localized directional pull on the SMAS and function around the ocular and oral openings.

The fibrous retinacular cutis ligaments relay movement in the SMAS to the superficial layers of the face.⁴ The SMAS can be regarded as a continuous sheet capable of connecting, supporting tensioning and moving the mobile soft tissues of the face. Unlike the skeletal muscles moving bones across joints, muscular movements of the face cannot be considered in isolation. The combination of tensioning different areas of the SMAS and the varied directional effect of the mimetic muscles on this structure allows the human face to generate multiple, emotive

From the Cosmetic Refinement Clinic, Geelong, Victoria, Australia.

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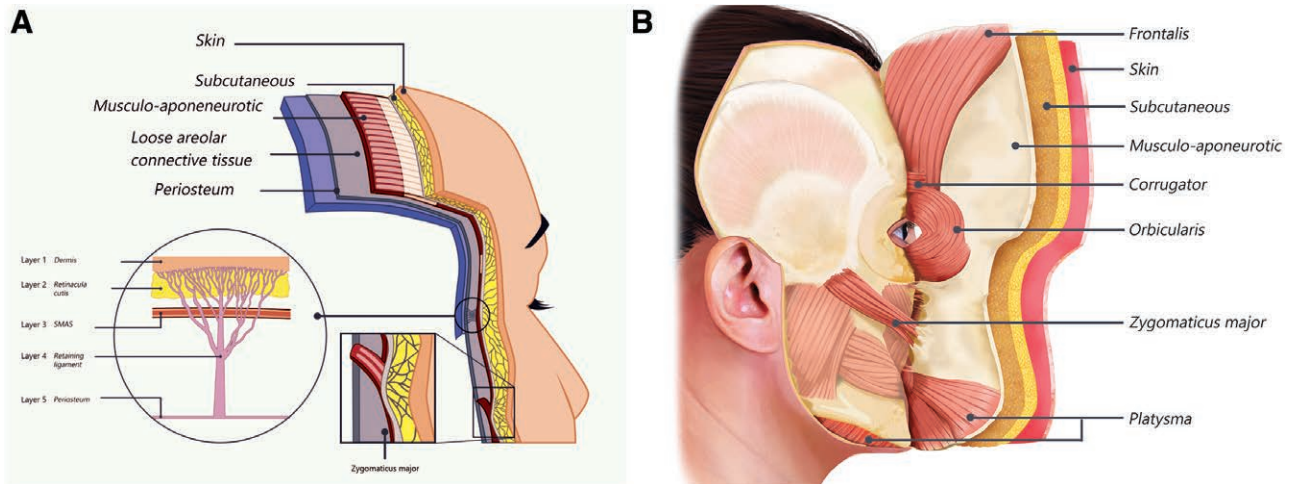


Fig. 1. The five facial layers (A) and the SMAS with its fibromuscular components (B). The flat tensioning muscles within the SMAS are attached to the underlying bone through retaining ligaments. The small directional mimetic muscles, such as the zygomaticus major, pass from a small bony attachment into the deep aspect of SMAS, which is attached to the facial skin by the retinacula cutis ligaments passing through the subcutaneous layer. The complexities of tensioning and directional movement within the SMAS are transmitted to the skin via the retinacula cutis ligaments, reflecting the myriad of facial expressions in the human face.

expressions of varying forms and intensities that are critical for communicating moods.

In Australia, three botulinum toxin A (BoNT/A) preparations are approved for use by the Therapeutic Goods Administration: onabotulinumtoxinA,¹⁰ abobotulinumtoxinA,¹¹ and incobotulinumtoxinA (incoA; Merz Pharma GmbH).¹² It is the author's experience that both onabotulinumtoxinA and incoA can be used interchangeably in a 1:1 ratio to give comparable results, both in terms of longevity and efficacy; however, incobotulinum toxin is used preferentially due to its low immunogenicity profile.^{13,14}

Upper Face—Treatment Considerations and Author Recommendations

In the forehead, the frontalis interdigitates with the orbicularis oculi and has fibrous connections to the overlying skin and brow.¹⁵ The resting tone of the frontalis is an important consideration for the brow position.^{16,17} The centripetal effect of frontalis contraction toward a line of convergence tenses the upper facial SMAS.¹⁸ The mimetic muscles of the glabella complex arise from their bony attachments to exert a directional pull on the SMAS. The existing literature describing the anatomy of these muscles is inconsistent and contradictory. The full extent of the lateral-most portion of the corrugator supercilii muscle is underestimated,^{19,20} while the presence or absence of the depressor supercilii¹⁰ is debated. These small muscles pass from their small bony origins to the deep muscular parts of the SMAS (frontalis and orbicularis), and through to the dermal attachments. For the glabella, five different patterns of movement have been described²¹ yet understanding the underlying muscular contributions of these intertwined and variable muscle fibers is important when assessing patients. Physicians should not rely on uniform approaches when planning neuromodulation treatments. Treating forehead lines in women requires considering the balance of this area of the SMAS. Unlike the low

and flat brow position in men, women have arched and higher brows, and as the frontal bone recedes in aging, the brow flattens and drops, increasing the resting tone in the SMAS tensioning zone of the frontalis and resulting in forehead lines.

Four patterns of forehead lines, which reflect the differences in the underlying anatomy of the frontalis muscle, have been described.²² Facial expressions of surprise, concentration, displeasure, and frustration are reflected through upper face movements. When relaxed and happy, the eyes are open and the brows rest in a neutral position. During aging, resting tension in the procerus and corrugators increases,²³ producing an expression of grumpiness and displeasure, yet aesthetic manipulations should relax resting tones but not compromise a patient's frowning ability. Brow depressors should be relaxed in combination with minimal doses of neuromodulator in the frontalis. This strategy may not completely abolish the lines but will preserve a feminine appearance in female patients. BoNT/A injection patterns should be customized to areas of intense frontalis activity and asymmetry. Up to 15 injection points of incoA can be administered over a broad area of the active forehead, or as few as four points to correct small areas of furrowing (Fig. 2).

For female patients, the author administers 5U–8U of incoA for the whole frontalis. This is hyperdiluted in 5 mL or 7.5 mL of saline to increase spreadability, with injection points placed at 1.5-cm to 2-cm intervals. Potency is determined by the number of toxin units placed per injection point.^{24,25} With ultra-low dosing (0.25U–0.5U per point), longevity is shortened to 6–8 weeks. The author's endpoint is a reduction in intensity and depth of furrows, with preservation of some movement and animation for communication.

Weakening of the medial frontalis fibers may produce compensatory increase in the lateral tension in the frontalis, producing a Mephisto or "Spock" appearance (Fig. 3).



Fig. 2. Effect of incoA frontal injection on brow position (A). B (before), C (after) 8U of incoA was distributed between 12 injection points. No change in brow position was observed in a patient with blepharochalasis, before and after low-dose incoA injection but some facial expression is preserved, as shown by the minimal movement when brows are raised before (D) and after incoA (E).

Risk of this can be assessed before treatment by digitally immobilizing the glabella and instructing the patient to raise their eyebrows. A dose of 0.5U or 1U of BoNT/A, specifically, incoA, is injected where hyperactivity may occur, concurrently with toxin treatment of the glabella.

When the brow is pulled inferomedially, a “corrugator dimple” often forms above the medial brow, at or just beyond the terminal inserting transverse fibers of the corrugator where the orbicularis and frontalis intersect. It is often injected with neuromodulators in a classical “five-point glabella treatment,”²⁶ which may produce a “gull-wing” brow shape with medial flattening (Fig. 4).



Fig. 3. The “Spock” or “Mephisto” brow. The pull of lateral frontalis fibers on the lateral brow can produce an unbalanced upward lift.

Injecting the dimple with neurotoxin will not significantly affect corrugator movement but rather, the orbicularis, which contributes to medial movement of the brow. The intersecting frontalis fibers are also weakened, producing the “gullwing brow.” The thickest part of the corrugator muscle is above and behind the medial half of the eyebrow between the medial canthus and pupil²⁷ and thins out as it extends laterally and superficially.²⁸ A three-point injection targets the middle third of the corrugator at its thickest part, along with the procerus. Toxin should be injected deep into the muscle belly, which can be palpated on frowning. A 13-mm needle is directed along the muscle and incoA is injected in a slow and retrograde manner (Fig. 5) (See Video [online], which displays a video demonstration of the three-point injection procedure).²⁹

This technique can completely immobilize the frown. However, most patients will retain some functionality from lateral orbicularis fibers that preserve frown-mediated visual cues of emotions such as disappointment or frustration. This more conservative strategy will also prevent the “gullwing brow.” However, frowns with significant orbicularis activity may benefit from more lateral injections of 1U–2U of incoA. To further relax and elevate the medial brow, an additional 1U–2U of incoA may be injected at the point of maximal contraction in the medial orbicularis and depressor supracilii, between the medial brow and the medial canthus. The orbicularis oculi resting tone can also affect brow position. Tension in this muscular part of the SMAS can be reduced with targeted toxin injections to lift the eyebrow tail and produce a more relaxed, youthful appearance. Up to four supero-lateral points can be injected with 2.5U of incoA per point.

MIDFACE TREATMENT CONSIDERATIONS AND AUTHOR RECOMMENDATIONS

Consideration needs to be given to treating the lower crow’s feet with BoNT/A. In smiling, the lip elevators act through the SMAS to pull the oral commissure upward and laterally.³⁰ The confluence of the zygomatic minor muscle fibers with the lower orbicularis oculi fibers³¹ enables their simultaneous dynamic activity. The orbicularis oculi tenses the SMAS as the lip elevators activate, enabling the lifting cheek skin to be redraped into the zygomatic area (a Duchenne smile, Fig. 6).³² Nonfunctional orbicularis oculi in this area after BoNT/A treatment of the lower crow’s lines will produce a disingenuous smile. If the skin does not redrape evenly, a “shelf” can be created below the eye. Treatment of lower crow’s feet must be done cautiously, for example, by placing 0.25U–1U (low dose) of hyperdiluted toxin per point, very superficially for a softening effect.

Engagement of the levator labii superioris alaeque nasi (LSAN) can produce a sneer by lifting the alar and upper lip. Hyperactivity of this muscle can also cause a “gummy” smile.^{33,34} The uppermost LSAN fibers are implicated in “bunny” lines.³⁵ The author recommends cautiously customizing toxin dose to target the specific hyperactive part of the muscle, with just 1–2 units sufficient for the upper fibers in the bunny lines. When treating the lower LSAN where it inserts into the alar, imbalances—such



Fig. 4. The “gullwing” brow. The classical five-point glabella injection visibly flattened the medial half of the brow, producing the “gullwing” shape. The medial frontalis fibers have been relaxed at the “corrugator dimple.”



Fig. 5. Corrugator injection technique. The muscle belly is grasped between the fingers to guide a 13-mm needle along the muscle belly to its fullest part. A video demonstration of this is available online.

as an unopposed risorius pulling laterally into a “joker smile”—must be avoided. In treatment-naïve patients, 0.5U of incoA can be injected into the LSAN bulge as it crosses to the alar. At two weeks posttreatment, an additional 0.5U can be administered if needed. To rebalance the smile, this can be repeated until the correct amount is reached. The required dose for that individual patient is then known for future treatments. In the author’s practice, it is rare to need more than 1U per LSAN. Again, instead of considering muscles individually, the SMAS layer should be regarded as one entity, with treatment targeted to weaken areas of excess directional pull and zones of tension to balance the face.

Lower Face Treatment Considerations and Author’s Recommendations

In the lower face, the platysma is part of the SMAS³⁶ and its uppermost superficial fibers extend superior-medially from the upper chest into the neck, across the mandible where some of its attachments interdigitate with the perioral depressor mimetic muscles.³⁷ The risorius muscle may be considered as part of the SMAS.³⁸ Rebalancing the lower



Fig. 6. Duchenne smile. The patient is pictured smiling before (Duchenne smile) (A) and after (B) BoNT/A treatment of the orbicularis for crow's feet, which produced a disingenuous smile.



Fig. 7. Lower face BoNT/A treatment. The patient is shown before (A) BoNT/A injections into points on the depressor anguli oris and platysma, resulting in a softening and lifting of the lower face and oral commissure (B).



Fig. 8. Lower face BoNT/A treatment. Depressor anguli oris and platysma shown activated (A) and relaxed (B). Post-BoNT/A treatment is shown in bottom photographs, with improvement in the position of the mouth at rest reflecting a facial expression of contentment rather than unhappiness.

face requires consideration of the effects of the platysma's tensioning across the jawline in combination with the mimetic, directional depressor muscles (Figs. 7, 8). IncoA is placed in three to five injection points of 2U each along the ramus of the mandible at 1.5-cm intervals, starting just lateral to the origin of the depressor anguli oris extending posteriorly. A second parallel row of toxin can also be injected 2 cm below the mandibular border to further relax upper neck platysmal tensioning and define the jawline, as in the Nefertiti lift.³⁹ This second, lower row will address some of the platysma banding. In areas where there are visible residual bands that the patient wishes to resolve, additional targeted injections of 2 U of incoA can be injected directly into those bands. The directional pull of the depressor anguli oris on the SMAS and oral commissure can be targeted by injecting into the belly of the muscle from the middle of the marionette line, directed upward and laterally and at 45 degrees with 2.5U of incoA. Rebalancing of the lower face in this manner can remove the dour facial expression associated with a higher resting tone in this region.

CONCLUSIONS

Botulinum toxin injections for aesthetic facial indications have increased exponentially over recent years.⁴⁰ We have discussed how the mimetic muscles are interconnected with the SMAS layer exerting a directional pull on this layer which is tensioned by its intrinsic flat muscles. This dynamic dimension can also be regarded as a mobile mask overlying the facial skeleton, that can be tightened in different zones through tensioning of the intrinsic flat muscles, or pulled in different directions by the underlying mimetic muscles. The

ability to tension different parts of the connected SMAS layer and move different parts of it in a planar direction generates facial expressions and emotions. Using neuromodulators, these “tensioning zones” and “directional mimetic muscles” can be modulated to effect facial expressions. Traditionally, neuromodulators have been used in aesthetic medicine to immobilize the underlying muscle and remove facial lines and wrinkles. Consequently, physicians have created some unnatural facial expressions. Combining neuromodulators, used primarily to rebalance the single functional unit of the facial musculature and SMAS, with other skin quality-focused modalities to improve wrinkle appearance, will produce more natural patient outcomes. The author believes that an ideal outcome should be an expressive, well-balanced face that reflects health, vitality, and happiness.

Niamh Corduff, MBBS, FRACS
Tenancy 9/400-404 Pakington St
Newtown, VIC 3220
Australia
E-mail: niamh.crc@outlook.com

PATIENT CONSENT

The patients provided written consent for the use of their images.

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