The Platysma Contraction Pattern in Healthy Adults: A Vector Analysis Study

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Background: The platysma muscle's role in lower face dynamics is complex. Multiple insertion points to soft-tissue structures at various levels in the lower face create a multifaceted contraction pattern. To avoid adverse effects in cosmetic procedures when targeting the platysma, its anatomy and physiology must be understood. Clinical observations hint at a bidirectional contraction pattern.
Methods: Eighteen healthy volunteers (13 women and five men) with a mean age of 44.2 ± 10.1 years were enrolled. Skin displacement vector analysis was used on maximal platysma contraction to characterize and calculate the movement of the neck and lower face skin.
Results: In all of the participants, a bidirectional movement of the skin was observed: the skin of the lower face and inferior to the jawline moved caudally, whereas the skin of the lower neck moved cephalad. Both movements converged at a line situated at 54% ± 10% and 55% ± 8% of the length between the clavicle and the inferior base of the ear lobe in men and women, respectively ($P = 0.70$).
Conclusions: The platysma is a bidirectional muscle with a line of convergence. Whereas the superior portion acts as lip depressor, the lower portion elevates the skin of the upper chest and lower neck. This transition can explain some of the clinically observed adverse effects of neuromodulation of the neck area. It can potentially direct neuromodulation injections to focus above the convergence line to better address lower face descent. *(Plast. Reconstr. Surg.* 153: 601, 2024.)

The platysma's role in neck banding and wrinkling and in lower face shaping and contouring has long been appreciated. Anatomical considerations lie at the base of our understanding of the observed signs, and the platysma muscle's complex anatomy has been continually explored and described by many.[1–6] The platysma is a broad, sheet-like muscle in the anterior neck, originating from the fascial coverings of the pectoralis major and deltoid muscles and inserting on the lower border of the mandible, the skin of the lower lip, and to the skin and muscles of the lateral perioral region.[7] Some anatomical studies showed the platysma to insert as cephalad as the skin of the cheek, the mandibulocutaneous ligament, or the zygoma.[8] The platysma has a variable anatomical configuration, with studies showing two-thirds of patients to have decussation of the right and left platysma fibers at variable locations (from as inferior as the level of the thyroid cartilage to as superior as 1 to 2 cm below the chin),[8] and one-third of patients to have a no-decussation pattern.[8–11]

The contraction of the platysma is equally complex as its anatomy. It is considered a depressor of the lower lip and face,[7,12] and its contracture is also responsible for the appearance of vertical platysma bands and lines and wrinkles below the mandibular border and inferior to the lower lip.[3] Variations in muscle fascicle orientation and variation in attachments between the

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skin and the deeper fascial layers in different platysma configurations[13] lead to different patterns of platysma bands.

The administration of neuromodulators to treat the signs of aging has shown an increase in demand in recent years and showed only a modest decrease during the 2019 pandemic.[14] The platysma's role in lower face shaping and contouring was noted by multiple authors either during neck rejuvenation procedures or when using neuromodulation.[1–6] The platysma is often targeted by neuromodulatory agents to decrease the appearance of platysma bands,[15] create a slimmer facial silhouette,[5] and negate midface and lower face decent.[16] The muscle's complex movement pattern helps explain some of the difficulties in obtaining a satisfactory result when targeting the platysma.

Recently, Cotofana et al.[17] described the bidirectional movement of the frontalis muscle, showing that the frontalis is not a simple brow elevator but has a more complex contracture pattern with a line of convergence present approximately at 60% of the muscle's height. There is a strong correlation between the action of the frontalis muscle and the platysma muscle, both being part of the superficial musculoaponeurotic system (SMAS); these are thin, broad muscles and often have a midline decussation.

We speculated that a similar bidirectional contraction pattern is present for the platysma and that there may also be a line of convergence where the neck chin depressor transitions to the upper chest elevator action. The current study was aimed to investigate motion patterns of the skin of the neck in healthy volunteers during maximal platysma contracture. We sought to explore the skin motion patterns by using vector displacement analyses to better understand the intricate activity of the platysma.

PATIENTS AND METHODS

Study Sample

The study sample is composed of 18 healthy volunteers. Volunteers were excluded if they had previous neck surgery or received any treatment to shape/alter the platysma muscle in the previous 6 months. Participants were informed about the aims of the study and provided written informed consent for the use of their data and images. The study was approved by the institutional review board of the University of Miami. This study adhered to the tenets of the Declaration of Helsinki.

Imaging

The study was fashioned after a similar skin displacement vector analysis by Frank et al.[18] Three-dimensional images of the neck of the volunteers were obtained using a Vectra H1 Camera system (Canfield Scientific, Inc). Two consecutive images of the necks of the volunteers were taken at rest and on maximal platysma activation by asking the volunteers to show their lower teeth and say "ee." Each follow-up image was aligned to its respective baseline image to compute differences in skin position. Applying the automated algorithm of the Vectra Software Suite, values for local changes in skin displacement were calculated and visualized. The system uses a markerless tracking system that provides a noncontact and noninvasive optical imaging technique, which quantitatively tracks skin movement and deformation under mechanical perturbations. It uses digital image correlation to map each pixel-patch from a baseline image to its corresponding pixel-patch in a follow-up image. By applying this shift across an entire image, the technique achieves a dense mapping between baseline and follow-up images. This technique builds a dense correspondence of tens of thousands of points across the entire image. Surface changes are visualized through vectors drawn on the patient's photographs; different parameters such as strain or displacement can be objectively measured and analyzed. The insertion of the platysma muscle is variable; therefore, two points representing the muscle's vertical length were chosen. The first, corresponding to the upper border of the measurement was set at the base of the lobe of the ear. The second point was set at the intersection of a vertical line emanating from this point and the patient's clavicle corresponding to the lower border of the measurement. This allowed a constant anatomical location for measurement purposes (Figs. 1 and 2). [**See Video (online)**, which depicts analysis of skin displacement in the frontal and three-quarters views with platysma activation. The *arrows* represent a computer-generated skin displacement vector based on pixel tracking. The *arrow*'s color represents the degree of displacement, with warmer colors representing a greater degree of displacement. The skin of the lower face is moving caudally, whereas the skin of the chest and lower neck is moving cranially. The opposing movements meet at a line approximately 55% of the distance between the clavicle and the base of the lobule of the ear.]

Cadaveric Dissection

The platysma muscle of one cadaveric head was dissected from the overlying skin and subcutaneous

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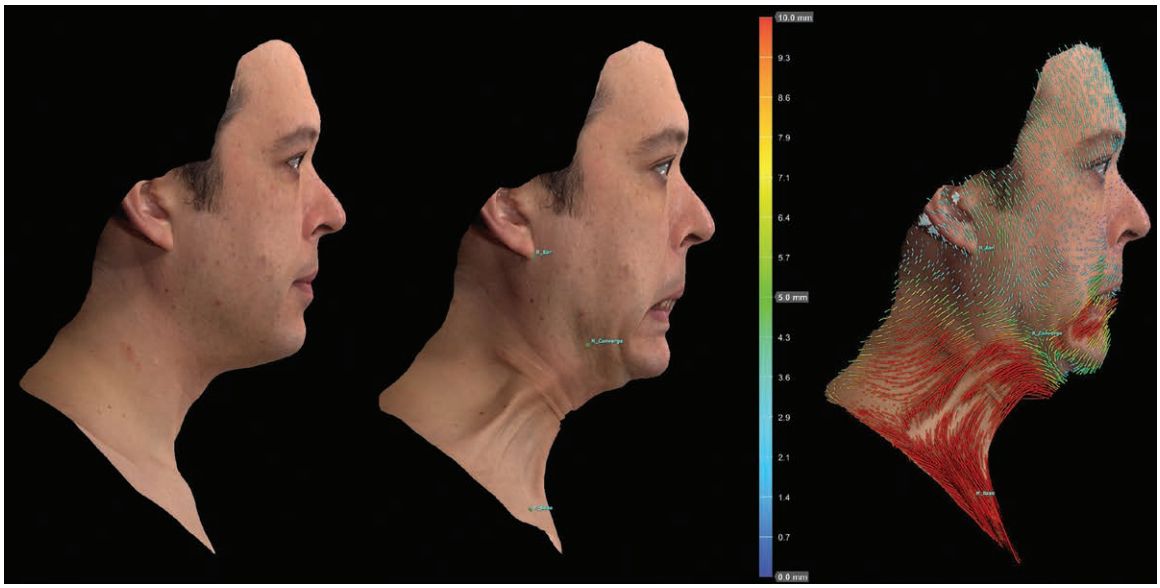


Fig. 1. Processed three-dimensional scan representing the contracture of the neck evaluated in the study and the difference in skin displacement represented through vectors in male White volunteer. The *arrows* represent skin displacement and are automatically calculated by tracking of skin features along consecutive photographs.

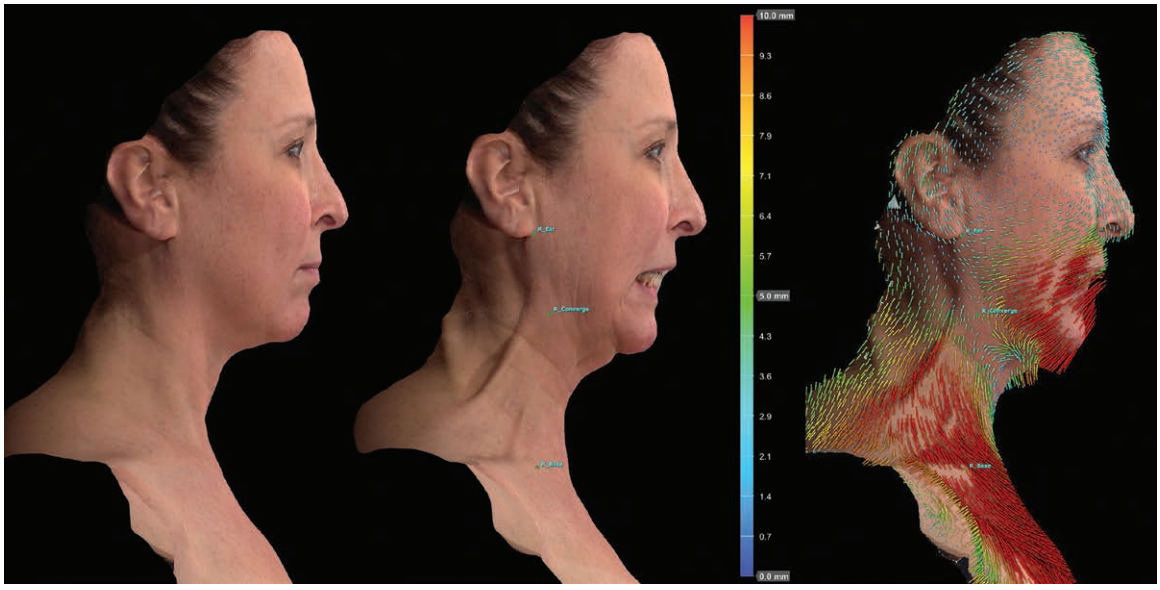


Fig. 2. Processed three-dimensional scan representing the contracture of the neck evaluated in the study and the difference in skin displacement represented through vectors in a female White volunteer. The *arrows* represent skin displacement and are automatically calculated by tracking of skin features along consecutive photographs.

tissue. Before dissection, blue dye was injected subcutaneously immediately inferior to the jawline, and green dye was injected subcutaneously just above the clavicle (Figs. 3 and 4). Dissection of the platysma muscle was then carried from the clavicle in the cranial direction, and in the caudal direction from a line connecting the base of the ear and the corner of the mouth. This dissection was carried until the two pockets were connected.

Data Analysis

The length and the direction of the skin displacement vector based on the skin movement of the neck on maximal platysma contraction were calculated by the Vectra Software Suite. A lateral view was chosen, to allow the most accurate calculation of distances. In the frontal and oblique views, skin displacement measurements were less accurate because of the neck's natural convexity.

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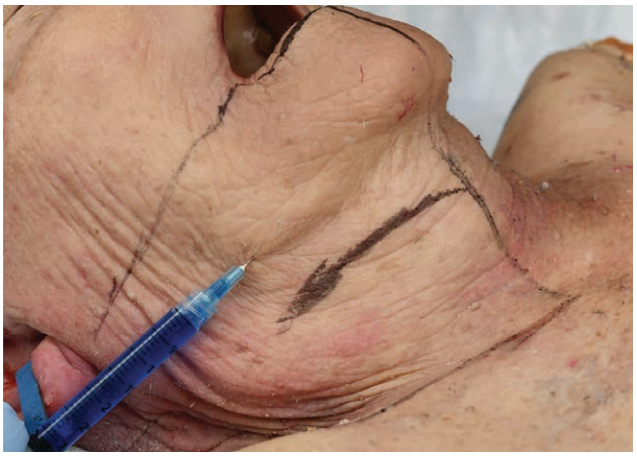


Fig. 3. Subcutaneous injection of blue dye inferior to the jawline before layer-by-layer dissection of the neck.

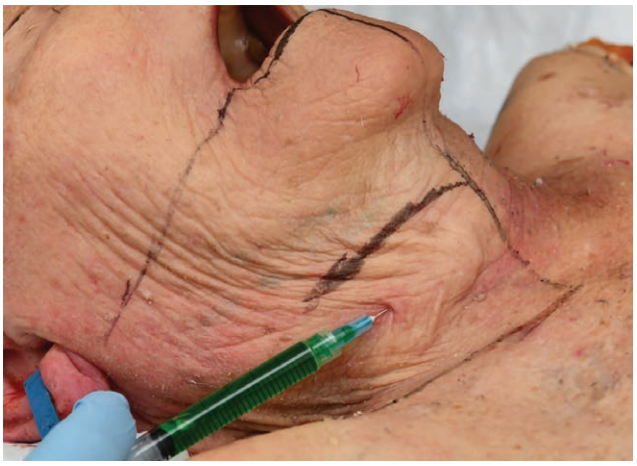


Fig. 4. Subcutaneous injection of green dye superior to the clavicle before layer-by-layer dissection of the neck.

Statistical Analysis

The orientation and magnitude of displacement of the skin overlying the platysma was recorded and analyzed. Skin displacement (ie, change in skin position on muscle contraction in millimeters) and skin compression (ie, percentage reduction in total muscle length) were calculated based on the images obtained. Differences in values for sexes were calculated using independent sample *t* tests. All statistical analyses were performed using SPSS statistics (IBM), and the results were considered significant at the level of $P \geq 0.05$.

RESULTS

Cohort

There were 18 volunteers analyzed (five men and 13 women). Mean age was 44.2 ± 10.1 years for men and 39.8 ± 11.9 years for women (range, 27 to 70 years; $P = 0.49$).

Platysma Length and Contraction Pattern

The mean length of the platysma measured from the clavicle to the base of the ear lobe was 143 ± 12 mm in men and 130 ± 7 mm in women ($P > 0.001$). A bidirectional skin displacement pattern was noted in all volunteers. The skin overlying the superior part of the platysma moved caudally, and the skin overlying the inferior part of the platysma moved cranially. This bidirectional movement was noticeable by depression of the lower face, lowering of the corners of the mouth, depression of the inferior lip, and depression of the skin overlying the mandibular border. The elevation of the skin overlying the inferior part of the platysma was noticed by elevation of the skin superior to the clavicle. The position of the line of convergence relative to the total height of the platysma was 54% ± 10% in men and 55% ± 8% in women ($P = 0.70$).

Cadaveric Dissection

One cadaveric head was dissected (male, 74 years old, no history of neck surgery). Dissection in the supraplatysmal plane demonstrated that the blue dye (injected subcutaneously superior to the clavicle) and the green dye (injected subcutaneously inferior to the jawline) met at a horizontal line approximately 50% to 55% of the distance from the clavicle to the base of the earlobe (Fig. 5), where one would expect the line of platysma convergence to be present.

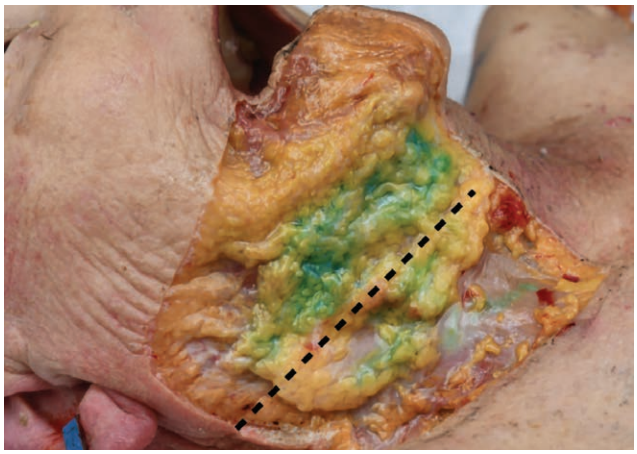


Fig. 5. The dissected neck, showing blue dye (turned greenish because of the underlying yellow fatty tissue) superior and green dye inferior to a horizontal line present at 50% to 55% of the distance between the clavicle and the base of the ear, at the approximate anticipated location of the platysma line of convergence.

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DISCUSSION

Our study showed a bidirectional movement of the skin of the neck on platysma contracture using a skin displacement analysis: the skin of the lower neck moves cranially and the skin of the upper neck and lower mandible moves caudally. These movements meet at a horizontally oriented line inferior to the lower border of the mandible. This convergence line was seen in all patients and was present at approximately 55% of the distance between the clavicle and the base of the earlobe. This finding is similar to the one described for the frontalis muscle in the forehead by Cotofana et al.,[17] where a sheet-like muscle shows a distinct bidirectional movement pattern in a muscle that lacks robust bony insertion.

Anatomically, the complex anatomical nature of the platysma can explain such bidirectional movement. The platysma muscle originates from the upper portion of the thorax: the fascial coverings of the pectoralis and the subcutaneous tissues of the subclavicular and acromial regions. The muscle inserts at three locations along the lower face: medially into the mentum; lateral to that to the subcutaneous tissues overlying the orbicularis oris, depressor anguli oris, and risorius muscles; and farther laterally into the periosteum of the ramus of the mandible.[3,12] Additional anatomical studies show an even more cephalad insertion point at the subcutaneous layers of the cheek skin.[4,8] An anatomical study by Shah and Rosenberg of over 70 patients during deep plane rhytidectomy demonstrated that the platysma exists 4 cm above the angle of the jaw along a line drawn between the lateral canthus and the mandibular angle.[6] The platysma muscle's limited bony connections and lack of anchor point allow bidirectional contraction, pulling the soft tissues of the lower face down and those of the chest and lower neck superiorly.[3]

The action of the platysma muscle is likely transferred to the overlying skin by means of a network of adhesions between the platysma and the subcutaneous skin, and between the superficial and deep cervical fascia at various levels of the neck.[13] Recently, Sandulescu et al. described the presence of a network of horizontal and vertical fascial thickenings that connect the platysma muscle to the overlying skin in a double-layered SMAS-like fashion that transmits platysma contractions to the overlying skin.[1] Interestingly, their study involved obtaining a block of tissue (composed of skin, SMAS, and platysma) at a level that corresponds to the platysma line of convergence. It is possible that the described horizontal fascial thickening is present at the platysma convergence line acting as a pulley, helping to create the bidirectional platysma movement. The presence of this fascial attachment also helps explain the presence of a horizontal neck rhytide seen in some patients. Our cadaver dissection further supports the presence of such a horizontal fascial line, suggested by the dyes meeting at the presumed convergence line.

Our study adds to the current knowledge by demonstrating the skin displacement during platysma contraction. Functional analyses such as this help gain better understanding of the muscle's finer vectors of movement and of overlying skin position changes. Although this study did not evaluate platysma neuromodulation, it helps explain some of the clinical observations related to such treatment. Neuromodulatory treatments of the platysma were initially aimed at reduction of platysma bands and horizontal neck lines[19]; however, the spectrum of applications of neuromodulators in the neck and lower face region has grown significantly to include raising the corners of the mouth[20] and facial contouring.[3,5,21,22] The "Nefertiti" lift, suggested by Levi, which is used for lower face contouring, involves neuromodulation at multiple points along the mandible and the superior platysma.[5] This approach therefore targets the muscle portion that usually moves caudally, leaving the cranially moving platysma in the lower neck untreated. In patients with a hyperactive platysma, this unopposed lower platysma can create bunching of skin and new wrinkling following injection.[3,23]

By observing the individual's platysma contracture pattern and paying attention to the platysma convergence line, providers can possibly achieve better results. Our study may be helpful in more precisely placing neuromodulator injections to soften vertical platysma bands and improve neck contour. Skin vector analysis suggests that neuromodulator treatment should be concentrated above the platysma convergence line, therefore limiting caudal movement of the skin of the lower face. The platysma below the line of convergence can be treated in a more conservative fashion, allowing it to counteract gravitational pull on the skin of the neck and possibly reduce sagging. The authors modified their platysma neurotoxin injection pattern to accommodate the findings in this study. Three or four injection spots per platysma band are now used, with the spots being closer together in the upper part of the platysma, focusing treatment above the line of convergence to better inhibit the

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Fig. 6. Schematic representation of the pattern of botulinum toxin injections for platysma bands. An asymmetric vertical pattern, focusing on the upper part of the platysma, is favored. The *dashed horizontal line* represents the platysma line of convergence at approximately 55% of the distance between the earlobe and the clavicle. Superior to the *dashed line*, the dose for each injection spot is 2 to 2.5 U of botulinum toxin. Inferior to the *dashed line*, the injections are spaced farther apart; in patients with mild banding, only 1 to 1.25 U of botulinum toxin is used in each injection spot.

caudal movement of the skin of the lower face as an adjunct to treating the vertical neck band itself (Fig. 6). We typically use 2 to 2.5 U of botulinum toxin type A (Botox; Allergan, Dublin, Ireland) per injection spot, for a total of 6 to 8 U per platysma band. Each patient is individualized, and some are treated with conservative doses (1 to 1.25 U of Botox) to the area of the platysma below the presumed line of convergence. Treatment of horizontal neck lines has been challenging from both surgical and nonsurgical approaches. Our finding of a platysma accordion-like horizontal contraction and line of convergence help to explain the cause of these lines, but does not offer new techniques to deal with this challenging problem in neck rejuvenation.

Applying our findings to surgical neck rejuvenation is not straightforward, because most surgical techniques start by dissection of the platysma from the overlying subcutaneous layer, confounding any postoperative observation. Despite this, the platysma line of convergence might help locate the ideal location for performing horizontal platysma incisions. Horizontal transection of the platysma along this line might both weaken the platysma and create unidirectional postoperative platysma contraction. Although theoretical, this has the potential to avoid reappearance of a horizontal neck line that one would expect if the platysma is transected above the line of convergence and the lower part of the platysma still has a bidirectional contraction. Transection of the platysma below the line of convergence is potentially less problematic, as the superior platysma is tucked under the mandible and a horizontal line there is less likely to be visible. Current techniques already place the lateral platysma myotomy at the approximate location of the platysma line of convergence,[24] possibly because of improved outcomes with such placement.

A strength of the present study Is the algorithmic approach, minimizing human error and providing an objective measurement. The methodology used in this study, analyzing the three-dimensional skin displacement vectors produced during platysma contraction, allows quantifying minute skin movements.[18] Limitations of the study include its relatively small sample size. A larger sample size could potentially shed more light on nuances in the profile of skin displacement in different ethnicities, genders, ages, and platysma decussation configurations. Additional cadaver dissection could focus on better describing the interconnections between the platysma and the overlying skin. Future research in the area can address these issues and directly assess the effects of different neuromodulation treatment patterns on the movement of the platysma, leading to more tailored treatments.

CONCLUSIONS

This study demonstrates the bidirectional movement of the platysma and the associated bidirectional skin movement. The skin overlying the lower platysma moved cephalad, and the skin overlying the superior part of the platysma moved caudal. The opposing movements met at a line approximately 55% of the height between the base of the earlobe and the clavicle. Clinically, this helps to explain some of the observations seen after neck neuromodulation and can potentially aid in better planning for optimal aesthetic outcomes in future treatments.

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DISCLOSURE

Dr. John P. Fezza is a speaker for Palette Resources, Allergan, and Revance Therapeutics, and a consultant for Merz Aesthetics. Dr. Sykes is a speaker for Palette Resources. Dr. Yoelin conducted research for Allergan and Merz Aesthetics, and is a consultant for Allergan, Galderma, and Suneva Medical. Dr. Wendy W. Lee is a speaker for Palette Resources and a consultant for Allergan, Galderma, Evolus, Revance Therapeutics, Mallinkroft Pharmaceuticals, Horizon Therapeutics, Ophthalmology Web, and Solta Medical. The remaining authors have no financial interests to disclose.

PATIENT CONSENT

Patients provided written informed consent for the use of their images.

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