

A Study of Glabellar Contraction Patterns in African Descendants

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ABSTRACT

Background: Botulinum toxin is a well-established treatment for dynamic glabellar lines. Glabellar contraction patterns were described previously in the general Brazilian population and also among Koreans, Chinese, and Indian individuals. So far, no study has addressed glabellar contraction “patterns” in Black subjects.

Objective: To identify the glabellar contraction patterns in the Black population for a better treatment approach with botulinum toxin treatment.

Method: Pairs of photographs – at rest and under contraction – from 103 Black patients were analyzed according to a previously described classification based on the predominance of eyebrow approximation, depression, or elevation movements. Results: The 5 glabellar contraction patterns described previously – “U,” “V,” “convergent arrows,” “omega,” and “inverted omega” – could be identified in these patients.

Conclusion: The classification of glabellar wrinkles enables a more accurate individualized treatment with botulinum toxin in Black subjects, in addition to other ethnic groups.

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INTRODUCTION

The glabella is the first area to be noticed in facial expression, and its contraction is usually associated with negative feelings.^{1,2} It is also the most frequently area studied and the first to receive US Food and Drug Administration (FDA) approval for cosmetic botulinum toxin treatment.^{3,4}

Contraction of the glabella changes the position and height of the eyebrows, that are fundamental in face recognition and facial expression.^{5,6} It involves the action of several muscles such as corrugators and orbicularis oculi (which approximate and depress the eyebrows), procerus and depressor supercili (depressors), and the frontalis muscle (the only lifter of the upper face).⁷

Understanding the importance and necessity of this research lies in recognizing that glabellar expression lines stem from repetitive muscle contractions, which evolve from dynamic

lines into static wrinkles over time.⁸⁻¹⁰ These wrinkles manifest differently due to various factors such as gender – where men typically exhibit thicker, oilier skin, larger muscle mass, well-defined superciliary arches, a more pronounced glabella,¹¹ wider facial movements, and more severe facial wrinkles, particularly excluding the perioral area.¹²⁻¹⁴ Additionally, factors such as aging contribute, with volume loss and changes in muscle tone or laxity influencing wrinkle formation. Ethnicity, sun exposure, and physical activity further contribute to the variations observed in the development of these wrinkles.¹⁵⁻¹⁷ Understanding these multifaceted influences is crucial for developing effective treatment and prevention strategies.

Although the anatomy is similar among individuals, how individuals engage their musculature varies.⁸ A study showed that Europeans have generally larger facial movements than Asians, especially in the eyebrow, nose, and mouth regions. An exception must be made to the eye region, where Asians have a larger excursion of the eyelids.¹⁹ It is important to

understand the aging characteristics, aesthetic concerns, and related problems among diverse populations, and this topic has gained interest in recent years.

Similar to individuals of all ethnic backgrounds, Black people have unique natural features and cosmetic concerns that require a detailed understanding by the treating dermatologist or cosmetic physician.²⁰⁻²³ The morphology of the skull has some particular features like a shallow and rectangular orbit, a longer forehead, moderate brow ridges, and wide and rounded nasal openings.¹¹ The skin is thicker, with extra layers of cornified cells, higher melanin content, and a thicker dermis rich with large and active fibroblasts producing collagen bundles that are arranged parallel to the epidermis.²⁴ These characteristics may protect against sun damage and retard the appearance of aging signs like wrinkles for several years. Conversely, they increase the tendency of melasma and post-inflammatory hyperpigmentation and the risk of the development of keloids after injuries.²⁴

Botulinum toxin treatment can improve the severity of glabellar wrinkling in repose and during animation, relax the appearance of the upper face, reduce the frequency of negative facial expressions, and impact the shape and lift of the eyebrows.²⁵

Black patients are underrepresented in cosmetic clinical trials, although they form a considerable portion of the global population. In 2020, a systematic review of glabellar botulinum toxin clinical trials in the US found that among 19 randomized controlled trials (RCTs) on BTX-A, only 5.4% of the study

participants were Black.²⁶ Only 3 clinical trials had specifically addressed the glabellar botulinum toxin treatment in Black patients. In those controlled studies, the glabellar wrinkles were considered moderate or severe, and the dose were fixed.²⁷⁻²⁹

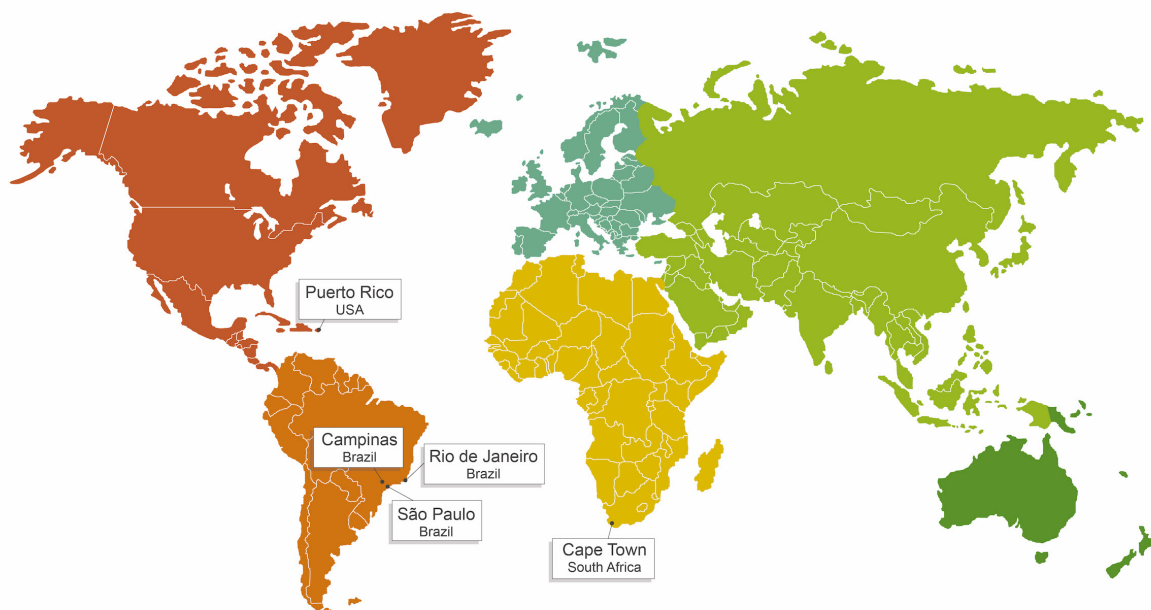
In practice, it is essential to customize treatment based on individual requirements. Understanding the classification of glabellar wrinkles aids in selecting the appropriate dose of neuromodulator aligning it with muscle engagement and mass.⁸ Previous studies have outlined glabellar contraction patterns in diverse populations, including Brazilians,^{7,18} Koreans,³⁰ Chinese,^{31,32} and Indians.³³

What makes identifying the glabellar contraction pattern significant? It is crucial for enhancing comprehension of the involved muscles and ultimately devising a more effective treatment strategy with botulinum toxin therapy.¹⁸ So far, no study has addressed glabellar contraction patterns in Black subjects.

MATERIALS AND METHODS

Pairs of photographs – at rest and under contraction – from 103 Black patients were analyzed according to previously described classification based on the predominance of eyebrow approximation, depression, or elevation movements. Patients with a previous history of ablative, surgical, or filler procedures in the region were excluded from the analysis. The photographs were taken at rest and during full contraction of the glabella on the same day using the same camera, lighting, and distance. The subjects' photographs were selected from the authors'

FIGURE 1. Location of the centers that contributed to cases.



private clinics in São Paulo, Campinas, Rio de Janeiro (Brazil), Cape Town (South Africa), and Puerto Rico (USA), and also from the Dermatology Clinic outpatient unit at the Hospital do Servidor Público Municipal of São Paulo, Brazil. These cities are highlighted in their respective countries on the map, as shown in Figure 1.

This study followed the ethical rules of the 2000 Declaration of Helsinki, and all patients consented to be part of the study. For each photograph pair, 2 evaluators (SM and ARTA) observed the space between the eyebrows to identify the predominant single or associated movement of approximation (eyebrows come together), depression (lower position than at rest), or elevation (higher location than at rest), and classified these into one of the 5 contraction patterns, named "U", "V", "converging arrows", "omega", and "inverted omega".

RESULTS

A total of 206 photos at rest and under contraction of glabella from 103 individuals were analyzed. Of the cases, 70 (67,96%) were women, and 33 (32,03%) were men, all with Black skin. The patients' ages ranged from 16 to 83 years old (mean 48,73

years). The 5 glabellar contraction patterns described previously – "U", "V", "converging arrows", "omega", and "inverted omega" – were identified in these patients. Table 1 is a summary of the frequency of contraction patterns according to gender.

"U" Pattern

Seen in 32 (31,06%) Black individuals, this pattern was the most frequently observed in the total group and women (34.28%; Figure 2). In this particular expression, where the space between the eyebrows is narrowed and depressed, there is a varying degree of intensity but limited range observed (the contraction stops before reaching the midpoint of the pupil), creating a movement resembling the letter "U". At rest, the eyebrows maintain an arched position. The muscles involved are the procerus and corrugators. Patients exhibiting this pattern would benefit from treatment using the traditional 5-injection-site model, with the dosage per injection point tailored based on muscle strength.

"V" Pattern

Seen in 30 (29.12%) individuals, this pattern was the second most frequently observed in the total group and men (39.39%).

TABLE 1.

Frequency of Contraction Patterns in Black People According to Gender

Pattern	Male N(%)	Female	Total
U	8 (24,24)	24 (34,28)	32 (31,06)
V	13 (39,39)	17 (24,28)	30 (29,12)
Converging arrows	6 (18,18)	18 (25,71)	24 (23,30)
Inverted omega	4 (12,12)	7 (10)	11 (10,67)
Omega	2 (6,06)	4 (5,71)	6 (5,82)
Total	33 (32,03)	70 (67,96)	103 (100)

FIGURE 2. Clinical photographs showing at left the glabella at static position and at right the "U" pattern of glabellar contraction lines.

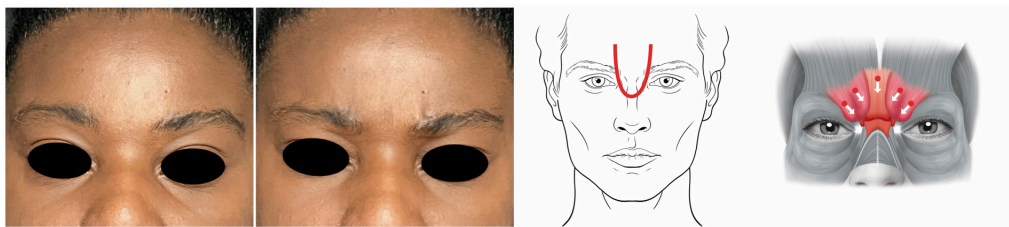


FIGURE 3. Clinical photographs showing at left the glabella at static position and at right the "V" pattern of glabellar contraction lines.

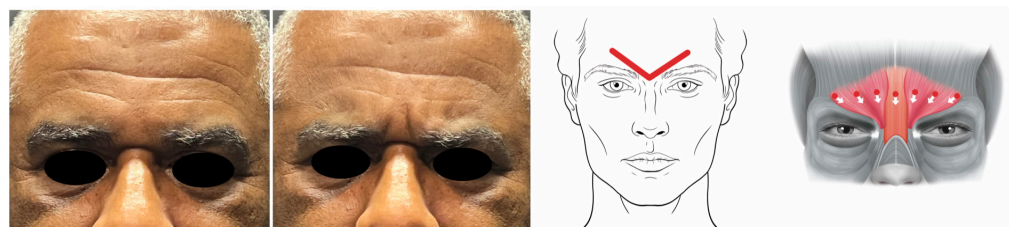
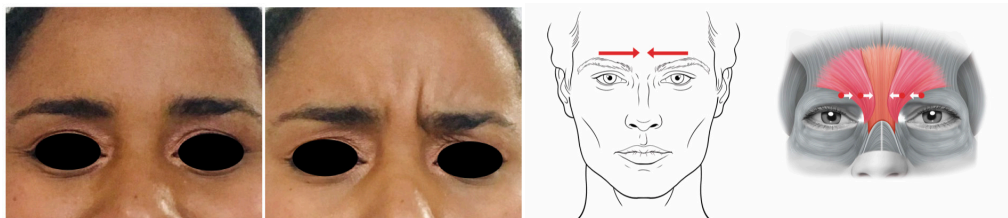
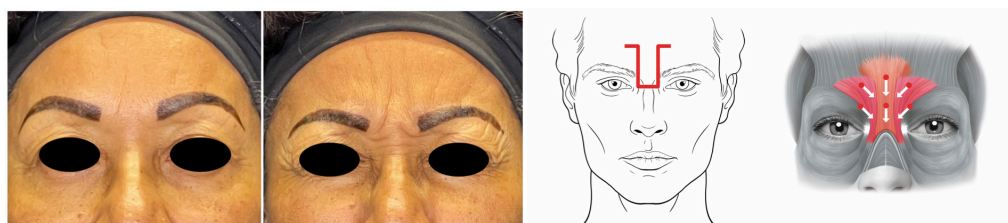
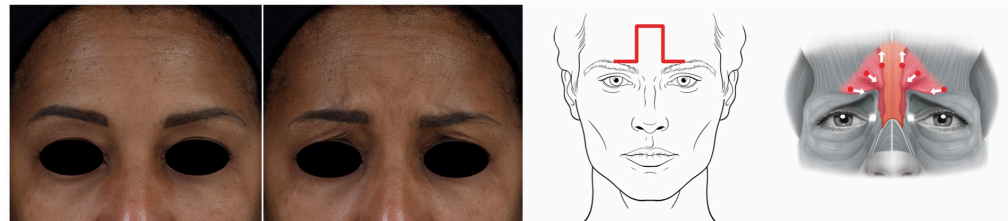


FIGURE 4. Clinical photographs showing at left the glabella at static position and at right the “converging arrows” pattern of glabellar contraction lines.**FIGURE 5.** Clinical photographs showing at left the glabella at static position and at right the “inverted omega” pattern of glabellar contraction lines.**FIGURE 6.** Clinical photographs showing at left the glabella at static position and at right the “Omega” pattern of glabellar contraction lines.

(Figure 3). Wide-range approximation and depression of the glabella is observed (the contraction extends beyond the mid-pupillary line). At rest, the eyebrows are flat, rectified, and lower. In addition to the participation of corrugators and procerus, there is also recruitment of the medial portion of the orbicularis oculi muscle. These patients will be better addressed by using the 7-site injection model with doses selected according to the muscle strength but usually concentrated at the procerus and corrugators.

“Converging Arrows” Pattern

Seen in 24 individuals (23.30% of cases), this pattern was the third most frequently observed in the total group, but the second most frequent pattern in women (Figure 4). In this “brow opposers” pattern, the eyebrows mainly get together, with little or no depression or elevation, the final movement being a horizontal approximation. The opposing forces between the procerus and frontalis are balanced. Corrugators and the medial portion of the orbicularis oculi muscles are involved. The injection technique should be more horizontal, targeting the recruited muscles and sparing or using lower doses at those not involved.

“Inverted Omega” Pattern

Seen in 11 cases (10.67%), this pattern was the fourth most frequently observed in the total group, in men, and women (Figure 5). Contrary to the previous pattern, here, the eyebrows barely join each other. The predominant movement is depression far more than approximation. The movement resembles an inverted Omega letter. There is action of depressor supercili, procerus, and the internal portion of orbicularis oculi pars palpebralis muscles, and also recruitment of the nasalis. The most appropriate treatment would be higher doses deposited into the procerus and depressors supercili and additional sites at the internal portion of the orbicularis oculi pars palpebralis and nasalis muscles. A minimal dose may or may not be injected into the corrugators.

“Omega” Pattern

Seen in 6 cases (5.82%), this pattern was the least frequently observed (Figure 6). In this easy-to-identify pattern, the eyebrows get together and raise at the glabella, taking the form of the Greek letter Omega. There is participation of corrugators, the medial portion of the orbicularis oculi, and co-contraction of the frontalis, but little or no procerus action. The best approach

TABLE 2.

Frequency of Contraction Patterns in General Brazilian Population Compared With Black Population						
Pattern	Brazilian Male	Population Female	Total	Black Male	Population Female	Total
U	8 (17,4)	99 (34,4)	107(32)	8 (24,24)	24 (34,28)	32 (31,06)
V	24(52,2)	77 (26,7)	101(30,2)	13 (39,39)	17 (24,28)	30 (29,12)
Converging arrows	9 (19,6)	55(19,1)	64(19,2)	6 (18,18)	18 (25,71)	24 (23,30)
Omega	4(8,7)	30(10,4)	34(10,2)	2 (6,06)	4 (5,71)	6 (5,82)
Inverted omega	1 (2,2)	27(9,4)	28(8,4)	4 (12,12)	7 (10)	11 (10,67)
Total	46(100)	288 (100)	334(100)	33 (32,03)	70 (67,96)	103 (100)

would be injecting toxin into the corrugators, orbicularis oculi, and medial portion of the frontalis muscle, with higher doses into the corrugators and orbicularis and lower doses into the frontalis sites. The procerus would be spared or receive only a minimal dose.

DISCUSSION

In recent years a huge advance in the knowledge of facial anatomy and the aging process has occurred. Regarding upper facial mimetic muscles, anatomical dissection of fresh cadavers detailed the origin and insertion of this musculature and their variations.³⁴ These muscles originate in the bone or at the superficial fascia, insert into the skin, and are closely associated with each other, with synergistic and antagonist activities.⁷ It is the balance between muscles that lift the skin (elevators) and those depressing it (depressors) that control facial expression. Recently dynamic models using body painting techniques have been used to reflect on the surface the action of the underlying involved muscles during facial expressions.³⁵ This is useful because variations in weight, strength, muscle activity, and muscle insertion sites produce differences in the contraction patterns in different people, and this is what makes each subject unique. Another factor that may impact facial expressions are the languages spoken in the different cultures.^{7,36} In the real world, treatment must be tailored to individual needs, and the classification of glabellar wrinkles help us to correctly choose the dose of neuromodulator according to muscle recruitment and mass.

Glabellar contraction patterns were studied previously in the general Brazilian population and also among Korean,³⁰ Chinese,^{31,32} and Indian³³ subjects. They are mainly divided into 2 groups: one based on the predominant movement between the eyebrows and the other based on the wrinkle shape formed between the eyebrows. Our subject sample was predominantly female (63%), with a mean age of 48 years, which is similar to all studies evaluating glabellar patterns of contraction in different populations.

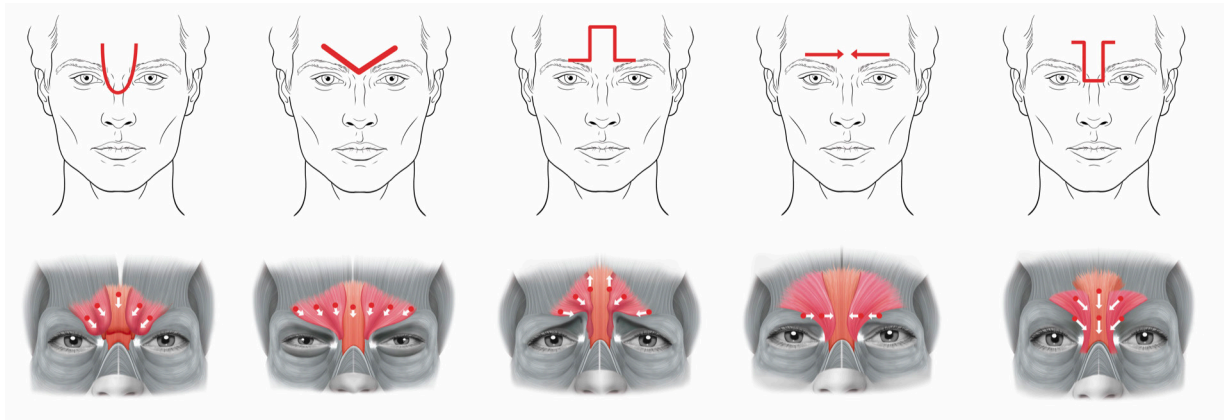
In the general Brazilian population study, the most frequent pattern found was the “U” (also most frequent in females) followed by the “V” type that was more prevalent in men. The distribution pattern was similar to our Black subjects study

where the main pattern was “U”. In men, the “V” pattern was the most frequently found and in women it was the “U”. Table 2 shows the frequency of each contraction pattern found in this study and compared with the De Almeida’s trial.

Two retrospective trials with 945 Chinese patients also analyzed the glabellar contractions using the movement-based classification system.^{31,32} The most frequent pattern found in that population was the “converging arrows”, followed by the “U” type. Their higher frequency of “converging arrows” compared with Westerners was attributed to reduced muscular activity and strength in that population,³⁰ and also to some anatomical ethnic differences like a flatter nasal apex and shorter corrugators described in a previous study with Chinese cadavers.³⁷ Black individuals may also have a flat nasal apex and large nose base. Variations in the shape and insertion sites of the corrugator supercili muscle were described in previous publications^{34,37}; but we are not aware of cadaveric studies specifically addressing these muscle features in Black subjects. The Black population studied in this sample is made up of the Brazilian population, which is already mixed, and also of Black patients from South Africa and Puerto Rico, unlike other studies in which only one ethnic group was studied.

The Korean and Indian studies used a glabellar classification based on the shape of the wrinkles formed during contraction, and named as “U”, “11”, “X”, “phi(π)” and “I”.³⁰ What is the correlation to De Almeida’s Classification? A similar “U” pattern, that was also the most frequent among Koreans, the “11” corresponds to the “converging arrows”; their “phi(π)” pattern is the “Omega”; their “X” correlates to the “Inverted Omega”; while no correlation regarding the “I” type could be done.

The Korean study suggests the natural evolution of the glabellar wrinkles would be initial perpendicular lines (the “11” wrinkles), progressing with the addition of a horizontal line secondary to the procerus involvement (forming the “U” pattern), and posteriorly including the frontalis (“ π ” and “I” patterns) and/or nasalis muscles (“X” type of wrinkle). In our results this sequence could not be observed, especially in those patients with the “converging arrows-and-omega” patterns of contractions that didn’t usually recruit the procerus muscle.

FIGURE 7. Illustration of muscle force vectors and the corresponding glabellar pattern.

In De Almeida's 2012 paper, a subset of patients was analyzed after several botulinum toxin treatment cycles to see if any change in the original contraction pattern occurred after repeated muscle blockage. All patients recovered their initial contraction model when the neuromodulator effect disappeared, recruiting the same muscles as always. This way, the best way to predict the wrinkle formation is to observe the most frequent mimetic muscles recruited for each patient according to their unique features. Figure 7 demonstrates the muscular movement schematically, in each pattern.

The Indian study, in another dark skinned ethnic population, added a new "W" type to the Korean classification, and found the "11" or "converging arrows" to be the most frequent pattern.³³

In the second study with Chinese patients, Hsieh et al compared the 2 classification systems³¹ and concluded that

both classifications could be used on the Chinese population; but since the frequency of certain patterns may be associated with age-related volume loss, De Almeida's classification system provided a more convenient guidance and easy clinical reference for treating Chinese patients in daily clinical practice.

Table 3 demonstrates the most prevalent glabellar contraction pattern in each ethnic group studied so far.

TABLE 3.

Main Glabellar Contraction Patterns in Different Ethnic Groups		
Population	Main Pattern	Percentage
Black	"U"	31,06%
Korean	"U"	44,6%
Indian	"11" (converging arrows equivalent)	40%
Chinese	Converging arrows	30,3%

FIGURE 8. Top: a 59-year-old Black woman at rest and under contraction, showing a "V" type glabellar pattern. Bottom: Her long-term treatment at day 240.

We know that dynamic glabellar lines, without effective treatment, will become static wrinkles over the time.⁸⁻¹⁰ Preventive botulinum toxin treatment has being recommended for maintaining a youthful appearance for a prolonged period in life. Like other ethnic groups, glabellar contraction patterns can also be observed in Black patients. The classification based on the predominant movement can be used in young patients before the formation of wrinkles, but also in older subjects already affected by age-related volume loss. The correct assessment helps the aesthetic physician to adjust the neuromodulator dose and injection sites, to achieve not only an effective initial result but also a long lasting treatment effect. This is demonstrated in Figure 7, which shows a 59-year-old Black woman with a “V” type glabellar contraction pattern and her long-term treatment follow up.

CONCLUSION

The same 5 patterns described previously could be observed in Black subjects, related not to age or gender but to involved muscles. The classification of the glabellar contraction pattern in different ethnic groups leads to individualized, tailored, and improved neuromodulator treatment. It can also be a useful tool to improve botulinum toxin treatments in this population.

DISCLOSURES

Suelen Montagner, Najara Gomes dos Santos, Camila Trindade de Almeida, Izolda Heydenrych, Katleen da Cruz Conceição, and Jose Raul Montes have no conflicts of interest to disclose. Carla de Sanctis Pecora has affiliations with Merz Aesthetics. Cheryl Burgess and Ada Regina Trindade de Almeida have affiliations with Allergan Aesthetics and Merz Aesthetics.

Ethics Statement: This study was approved by the ethics and research committee of Hospital of the Public Servants of São Paulo. (CAAE number: 76911624.8.0000.5442)

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