Aesthetic Surgery Journal Advance Access published January 17, 2016

Cosmetic Medicine

Patient Perceived Benefit in Facial Aesthetic Procedures: FACE-Q as a Tool to Study Botulinum Toxin Injection Outcomes

Aesthetic Surgery Journal
2016, 1–11

DOI: 10.1093/asj/sjv244
www.aestheticsurgeryjournal.com
OXFORD UNIVERSITY PRESS

Brian L. Chang, BS; Anthony J. Wilson, MD; Anthony J. Taglienti, MD; Catherine S. Chang, MD; Nancy Folsom, RN; and Ivona Percec, MD, PhD

Abstract

Background: There are numerous methods of assessing patient satisfaction with botulinum toxin type A neuromodulation of the glabellar rhytids. As the use of aesthetic neuromodulation increases both in breadth and number of procedures, there is a need for more comprehensive tools to evaluate patient-reported outcomes. The FACE-Q is a recently validated patient-reported outcome instrument that can be used to measure patient perceptions of botulinum toxin type A neuromodulation.

Objectives: This study used the FACE-Q to assess patient satisfaction following botulinum toxin type A neuromodulation of the glabellar rhytids.

Methods: 57 female patients completed the FACE-Q, a survey that evaluates patients' satisfaction with their facial appearance. After this baseline survey, the patients received injections of one of onabotulinumtoxinA (Botox, Allergan, Dublin, Ireland), abobotulinumtoxinA (Dysport, Galderma, Lausanne, Switzerland), or incobotulinumtoxinA (Xeomin, Merz Pharmaceuticals, Frankfurt am Main, Germany) in the glabella. Two weeks post-injection, the patients completed the FACE-Q again. The percentage changes in patient responses were tabulated to determine how neuromodulation affects patient satisfaction with their facial appearance. The percentage changes for each of the neurotoxin groups were compared to determine if patient satisfaction with neuromodulation varies with the type of neurotoxin.

Results: Patient satisfaction with their overall facial appearance increased by 28% following neuromodulation. Patients stated that they believe they look an average of 5.6 years younger post-neuromodulation. There were no significant differences among the treatment groups.

Conclusions: The FACE-Q demonstrates that patients are more satisfied by their overall facial appearance and age appearance following neuromodulation of their glabellar rhytids. Patients are equally satisfied with the improvement of their facial appearance regardless of which neurotoxin they received.

Level of Evidence: 2

Accepted for publication November 2, 2015.

Neuromodulation with botulinum toxin type A (BoNT-A) is the most common cosmetic procedure performed in the United States, with 3.6 million procedures performed in 2014.[1] While FDA approval for aesthetic BoNT-A injections is limited to the treatment of glabellar and lateral canthal lines, the aesthetic use of BoNT-A injections has markedly expanded to frequently include treatment of the frontalis, nasalis, and musculature of the lower face and neck.[2,3] The expanded use of BoNT-A, both in terms of numbers and indications, prompts the need for a useful and reliable means of assessing patient satisfaction following aesthetic BoNT-A neuromodulation for the optimization of patient outcomes.

Prior studies indicate patients are highly satisfied with their results following BoNT-A treatment.[4] However, methods of evaluating patient satisfaction for such studies are varied, both with respect to the aspects of facial aesthetics being assessed

From the Division of Plastic Surgery, University of Pennsylvania, Philadelphia, PA.

Corresponding Author:
Dr Ivona Percec, Division of Plastic Surgery, University of Pennsylvania, Perelman Center For Advanced Medicine, 7st Floor South Pavilion, 3400 Civic Center Boulevard, Philadelphia, PA 19104, USA.
E-mail: ivona.percec@uphs.upenn.edu

as well as the type of scales used to make the assessments.[4] Several of these studies of BoNT-A neuromodulation of glabellar rhytids asked patients a single question about their overall satisfaction with their facial appearance pre- and post-neurotoxin injection and used a three-, four-, five-, or seven-point range of satisfaction levels.[5-12] More comprehensive surveys such as the Facial Line Treatment Satisfaction Questionnaire, Facial Line Outcomes Questionnaire, Self-Perception of Age, and Freiburg Questionnaire on Aesthetic Dermatology and Cosmetic Surgery, have also been used to demonstrate the positive patient-perceived effects of BoNT-A neuromodulation.[13-18] These questionnaires asked patients about multiple facets of facial appearance satisfaction including youthfulness, attractiveness, confidence, and their psychosocial well-being as a result of their facial appearance.

As the number of neurotoxins and their aesthetic uses increase, additional studies must be conducted to evaluate the efficacy, safety, and administration of BoNT-A neuromodulation. An important component of such analyses is the identification of the most useful and reliable methods of assessing patient satisfaction with BoNT-A injection outcomes. The FACE-Q is a newly developed and validated patient-reported outcome instrument that can be used for measuring patient perceptions of cosmetic facial procedures.[19-21] The developers of the FACE-Q describe the questionnaire as a "short, easy to complete, reliable, valid and responsive" patient-reported outcome tool for any type of surgical or non-surgical facial aesthetic procedure.[20] Two important advantages of the FACE-Q instrument are that it is well calibrated to measure pre- to post-procedure change and that it performs equivalently regardless of patient age, gender, and ethnicity.[20] The developers of the FACE-Q identified four domains of patient satisfaction: appearance appraisal, adverse effects, process of care, and quality of life. Each of these domains has a series of individual surveys to assess, for example, appearance appraisal of skin or process of care of information. Physicians trying to assess the patient-perceived efficacy of an aesthetic intervention can handpick the qualities for their analysis metrics. The ability to tailor the FACE-Q's content to specific aspects of facial anatomy, as well as to specific qualities of patient satisfaction, makes the FACE-Q instrument incredibly important to evidence-based medicine studies of aesthetic facial interventions, as the similarly designed and well documented BREAST-Q instrument has been to breast intervention studies.[22-24] Several of the FACE-Q instruments have already been used successfully to assess patient satisfaction with rhinoplasties and facelifts.[25,26]

This study is the first to use the FACE-Q to assess patient-perceived satisfaction with BoNT-A neuromodulation. The goal of this study is to use the FACE-Q to better understand patient-perceived satisfaction with BoNT-A neuromodulation and to determine specific factors underlying patient satisfaction. In particular, this study examines the effect of patient-specific characteristics, including age, Fitzpatrick skin type, and Glogau wrinkling on patient satisfaction. Further, this study intends to examine whether the degree of satisfaction or dissatisfaction is dependent on the type of neurotoxin administered: onabotulinumtoxinA (Botox, Allergan, Dublin, Ireland), abobotulinumtoxinA (Dysport, Galderma, Lausanne, Switzerland), or incobotulinumtoxinA (Xeomin, Merz Pharmaceuticals, Frankfurt am Main, Germany). Finally, this study quantifies the relationship between patients' self-reported satisfaction with BoNT-A neuromodulation and their objective, quantitative facial strain reduction. This study introduces the FACE-Q as a new, effective, alternative instrument to analyze patient-reported outcomes following aesthetic BoNT-A neuromodulation of the glabellar rhytids.

METHODS

Seventy-five female patients between the ages of 18 and 75 were prospectively recruited at the Hospital of the University of Pennsylvania, Department of Plastic Surgery following Institutional Review Board (IRB) approval (Protocol #819609) and informed consent. This IRB additionally covered a concurrent study that investigated the use of digital image correlation to objectively quantify glabellar strain.[27] Female patients of any Fitzpatrick skin type, Glogau score, or degree of rhytid etching who have never been treated with a neurotoxin were eligible for this study. The exclusion criteria included patients who have previously been treated with a neurotoxin, are older than 75 years of age, are pregnant, have had a prior condition or surgery that affects facial animation, have a known contraindication to neurotoxins, or have an open wound. To adhere to the manufacturer-recommended dose for glabellar treatment and to minimize neurotoxin efficacy variability secondary to increased muscle mass in males, male patients were excluded from this study.[28,29] Treatment randomization was performed in the following manner: (1) each neurotoxin, onabotulinumtoxinA, abobotulinumtoxinA, and incobotulinumtoxinA, was randomly assigned a letter designation, A, B, or C; 2) a Microsoft Excel (Redmond, WA) spreadsheet was generated with assigned letters in repeating order (A, B, C, A, B, C, etc.); and 3) patients were assigned the letter corresponding to the specific neurotoxin in the order in which they enrolled in the study. The nurse who prepared the syringes was the only personnel to know which letter corresponded to which neurotoxin, and she provided the injector with the correct syringe when the patient told her which letter they were assigned. Therefore, the patients, injector, and evaluators were blinded to which neurotoxin a given patient received.

Because all three of these neurotoxins are used commonly in clinical practice, this study sought to investigate patient-reported satisfaction with all formulations used in the United States. This study therefore was powered to have enough patients to determine an overall pre- to

post-treatment effect, but was not specifically designed to evaluate the different toxins secondary to limited funding resources. The comparative analysis was performed to determine whether, even with the relatively small sample size, there were patient-reported differences in response to the different neurotoxin treatments.

Patients underwent baseline imaging of the glabella using digital image correlation (DIC) to objectively quantify glabellar strain as described in prior work.[30,31] Following baseline imaging, patients answered the FACE-Q, a 63-question survey that asks patients to evaluate their satisfaction with their overall appearance, age appearance, and the appearance of cheeks, nasolabial folds, lower face and jawline, chin, and neck. Afterwards, patients had their Fitzpatrick skin type and Glogau score evaluated by a single trained investigator. Patients were then treated. All of the neurotoxins were consistently diluted, and all dilutions were performed on the day of injection. One hundred units of onabotulinumtoxinA were diluted in 2.5 cc of preservative-free saline. Three hundred units of abobotulinumtoxinA were diluted in 2.5 cc of preservative-free saline. One hundred units of incobotulinumtoxinA were diluted in 2.5 cc of preservative-free saline and inverted, per manufacturer instructions. Individual syringes with either 20 units of onabotulinumtoxinA, 60 units of abobotulinumtoxinA, or 20 units of incobotulinumtoxinA were prepared and a single trained injector injected each patient with a single syringe in five distinct and consistent injection locations (Figure 1). Patients were instructed to return 4 days post-injection for re-imaging, 14 days post-injection for re-imaging and for re-evaluation by the FACE-Q, and 90 days post-injection for re-imaging. The 75 patients were divided into three groups, each coming in on a different set of dates to facilitate the injections and imaging. The first group of patients began imaging in June 2014, and the third group of patients completed imaging in December 2014. The imaging data from these patients are described in a separate study.[27]

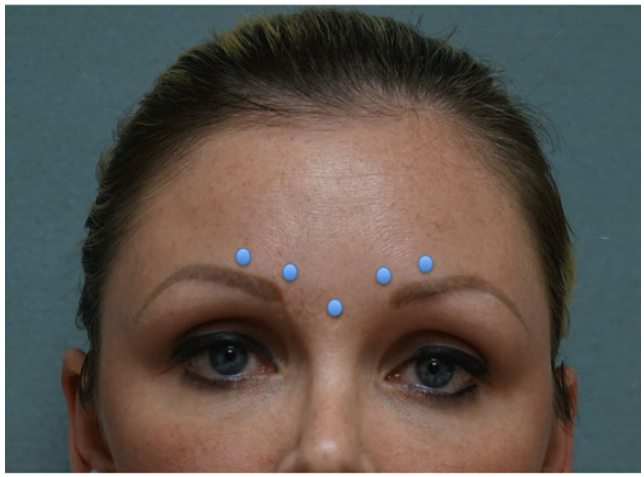

Figure 1. Each patient underwent standardized injection of the corrugator and procerus muscles in the five marked injection points by a single trained injector. Each patient was injected with a randomly-assigned neurotoxin that was prepared according to the manufacturer's instructions. There was no variation of dose or injection location among the patients. The subject in this photo is a 33-year-old female staff member who was used as an example to depict the injection points; she was not a patient in the study and received no course of treatment.

The answers to the FACE-Q were compiled by research electronic data capture and exported to Microsoft Excel and JMP (Cary, NC) for statistical analysis. For each of the FACE-Q sections, the responses to the questions in that section can be summed and converted to a Rasch transformed score, which ranges from 0 (lowest satisfaction) to 100 (highest satisfaction). This single metric serves as a proxy for the patient's overall satisfaction with the appearance of that aspect of his or her face. The average percentage change in response was calculated for each of the questions and for all of the Rasch scores. The t test was used to determine if the patients' satisfaction with their facial appearance statistically significantly changed from baseline to 14 days post-injection. ANOVA, followed by multiple comparisons tests, was used to determine if the percentage changes in FACE-Q responses depended on the neurotoxin treatment type or patient characteristics including age, Fitzpatrick score, and Glogau score. For these analyses, the patients were categorized into three age groups: young (under 40), middle-aged (40 to 60), and old (over 60). In addition, the patients were categorized into two Fitzpatrick groups: light-skinned (I to III) and dark-skinned (IV to VI). Finally, the patients were categorized into two Glogau groups: mild wrinkling (I and II) and severe wrinkling (III and IV). Linear regression analysis was used to calculate the correlation between patients' subjective improvement in their facial appearance and their objective, quantitative glabellar strain reduction as measured by DIC. For all tests, a P-value of $< .05$ was considered statistically significant.

RESULTS

Seventy-five female patients were initially recruited for this study, with 25 patients randomized to each of the three neurotoxin groups. A total of 57 patients completed the FACE-Q both on the injection date and the 14-day follow-up date and were eligible for this analysis. Two patients were removed from the study, one for a history of myasthenia gravis and one for an open wound on the face. Five patients did not return on day 14. Eleven patients did not complete the survey on both of their visits. The average age of the 57 patients with pre- and post-neurotoxin FACE-Q responses was 49.6 years (range, 32-75 years). These patients were evenly distributed among the neurotoxin treatments, primarily had Fitzpatrick skin types of II-IV, and had moderate

Table 1. Distribution of Patients

Neurotoxin Treatment		Fitzpatrick Score		Glogau Score		Age	
OnabotulinumtoxinA	18 (32%)	I	5 (9%)	I	7 (13%)	30-40	14 (25%)
AbobotulinumtoxinA	20 (35%)	II	9 (16%)	II	24 (44%)	40-50	19 (33%)
IncobotulinumtoxinA	19 (33%)	III	28 (51%)	III	17 (31%)	50-60	11 (19%)
		IV	11 (20%)	IV	7 (13%)	60-70	11 (19%)
		V	1 (2%)			70-80	2 (4%)
		VI	1 (2%)				

The 57 patients were evenly distributed among the neurotoxin treatments and were relatively evenly distributed over the 30 to 70 year age range. The majority of the patients had moderate Fitzpatrick and Glogau scores.

Table 2. Patient Demographics

Distribution of ONA-A Patients ($N = 18$)						Distribution of ABO-A Patients ($N = 20$)						Distribution of INCO-A Patients ($N = 19$)					
Fitzpatrick		Glogau		Age		Fitzpatrick		Glogau		Age		Fitzpatrick		Glogau		Age	
I	0%	I	17%	30-40	33%	I	11%	I	0%	30-40	15%	I	17%	I	22%	30-40	26%
II	17%	II	44%	40-50	28%	II	16%	II	42%	40-50	30%	II	17%	II	44%	40-50	42%
III	72%	III	33%	50-60	17%	III	37%	III	42%	50-60	25%	III	44%	III	17%	50-60	16%
IV	11%	IV	6%	60-70	22%	IV	37%	IV	16%	60-70	25%	IV	11%	IV	17%	60-70	11%
V	0%			70-80	0%	V	0%			70-80	5%	V	6%			70-80	5%
VI	0%					VI	0%					VI	6%				

There were no significant differences in patient demographics among the three neurotoxin treatment groups.
ABO-A, abobotulinumtoxinA; INCO-A, incobotulinumtoxinA; ONA-A, onabotulinumtoxinA.

Glogau wrinkle scores of II-III (Table 1). There were two patients for whom the Fitzpatrick and Glogau scores were not recorded. When comparing the neurotoxin groups, there were no significant differences in age ($P = .64$), Fitzpatrick skin type ($P = .18$), or Glogau wrinkling ($P = .29$) (Table 2).

While all 57 patients were presented with the FACE-Q in its entirety, not all patients answered every question on both survey dates. Of the 63 questions, an average of 62.5 were answered in the pre-treatment survey, and an average of 62.2 were answered in the post-treatment survey. Forty-six percent of patients answered the survey in its entirety on both dates. Combining both surveys, 28% missed one question, 11% missed two, 5% missed three, and 11% missed more than three questions.

The first component of the FACE-Q assesses the patients' satisfaction with their overall facial appearance. Post-neuromodulation, patients reported a 38% increase in symmetry ($P < .01$), 12% increase in balance ($P < .01$), 31% increase in appearance at the end of the day ($P < .01$), 36% increase in freshness ($P < .01$), 47% increase in restfulness ($P < .01$), 24% increase in appearance of profile ($P < .01$), 29% increase in appearance in photos ($P < .01$), 23% increase in appearance when waking up ($P < .01$), and 23% increase in appearance under bright lights ($P < .01$) (Table 3). The post-neuromodulation Rasch score was 28% greater than the pre-neuromodulation Rasch score ($P < .01$) (Table 3). This indicates that patients' satisfaction with their overall facial appearance was statistically significantly greater after neuromodulation. However, there was considerable variation in how patients' satisfaction with their facial appearance changed after neurotoxin treatment, as 19% of patients were actually less satisfied with their facial appearance following their botulinum toxin injection (Figure 2). Patients receiving incobotulinumtoxinA had a 36% increase in satisfaction with overall facial appearance, compared to 29% for onabotulinumtoxinA patients and 18% for abobotulinumtoxinA patients; however, these differences were not statistically significant ($P = .33$) (Table 4). The change in patients' satisfaction with their facial appearance overall did not correlate with their age ($P = .58$), Fitzpatrick score ($P = .87$), or Glogau score ($P = .77$) (Table 5).

The second component of the FACE-Q assessed the patients' age appearance. After neurotoxin treatment, patients

less-strongly believed that they don't recognize themselves ($P < .01$) and that they don't look like themselves ($P = .01$) because of how old they look (Table 6). There were no significant differences in responses to the other questions regarding patients' perceptions of their age (Table 6). However, the Rasch score was 30% greater following neuromodulation ($P < .01$), indicating that patients overall were more satisfied with how old they appear following BoNT-A neuromodulation (Table 6). Although patients overall were more satisfied with their age appearance post-injection, 23% of patients had decreased satisfaction with their age appearance (Figure 3). Patients receiving abobotulinumtoxinA had a 35% increase in satisfaction with age appearance, compared to 34% for incobotulinumtoxinA patients and 19% onabotulinumtoxinA patients; however, these differences were not significant ($P = .79$) (Table 7). Patients over 60 had a 46% increase in age appearance, compared to 19% for patients under 40, and 27% for patients between 40 and 60; though again, these differences were not significant ($P = .62$) due to the variability and relatively small sample size (Table 8). The change in patients' satisfaction with their age appearance did not correlate with their Fitzpatrick score ($P = .60$) or Glogau score ($P = .64$) (Table 8). A separate but related question asked patients how old they think they look relative to their actual age. Prior to injection, patients, on average, stated that they look 6.4 years older than their actual age. After injection, patients, on average, stated that they look only 0.8 years older than their actual age. This decrease of 5.6 years was statistically significant ($P < .01$), indicating that patients felt that they look younger following neuromodulation (Table 6). This finding was not correlated with neurotoxin ($P = .26$), age ($P = .39$), Fitzpatrick score ($P = .61$), or Glogau score ($P = .73$).

The third component of the FACE-Q assessed patients' satisfaction with specific regions of the face. Patient satisfaction with the appearance of their cheeks increased in almost all of the evaluated characteristics: 15% increase in smoothness ($P < .01$), 19% increase in attractiveness ($P < .01$), 19% increase in contour ($P < .01$), and 20% increase in youthful fullness ($P < .01$) (Table 9). The Rasch score was 25% greater post-neuromodulation ($P < .01$), indicating that patients overall were more satisfied with the appearance of their cheeks post-injection (Table 9). Patients receiving abobotulinumtoxinA had a greater increase in satisfaction, 44%, than patients receiving onabotulinumtoxinA, 11%

Table 3. Post-Neuromodulation Change in Satisfaction with Facial Appearance Overall

Facial Appearance Aspect	Average Percentage Change	*P*-Value
Symmetry	+38.0%	0.002
Balance	+12.3%	0.001
Proportion	+6.3%	0.054
Appearance at the End of Day	+30.8%	<0.001
Freshness	+36.3%	<0.001
Restfulness	+46.5%	<0.001
Profile Appearance	+23.5%	0.001
Appearance in Photos	+28.7%	<0.001
Appearance when Waking Up	+22.8%	0.001
Appearance under Bright Lights	+23.2%	0.002
Rasch Transformed Score	+27.7%	<0.001

Average percentage change, pre- to post-neuromodulation, in the questions and overall Rasch score for the satisfaction with facial appearance overall section.

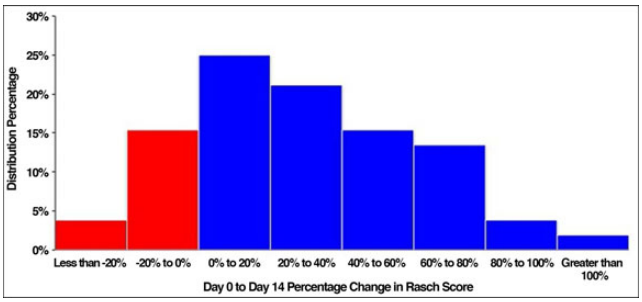

Figure 2. Distribution of the percentage changes in Rasch score for satisfaction with facial appearance overall. The columns in red indicate patients whose satisfaction with their facial appearance decreased following neuromodulation, highlighting the variability in patient-reported outcomes.

Table 4. Post-Neuromodulation Change in Satisfaction with Facial Appearance Overall by Treatment

Neurotoxin Treatment	N	Average Percentage Change in Rasch Score	Comparison *P*-Value
OnabotulinumtoxinA	18	+28.9%	Overall: 0.333 ONA-A vs ABO-A: 0.365 ONA-A vs INCO-A: 0.554 ABO-A vs INCO-A: 0.143
AbobotulinumtoxinA	17	+18.3%	
IncobotulinumtoxinA	17	+35.7%	

Average percentage change, pre- to post-neuromodulation, in the Rasch score for the satisfaction with facial appearance overall section by neurotoxin treatment group. There were no significant differences among the treatment groups.
ABO-A, abobotulinumtoxinA; INCO-A, incobotulinumtoxinA; ONA-A, onabotulinumtoxinA.

Table 5. Post-Neuromodulation Change in Satisfaction with Facial Appearance Overall by Demographics

	Group	N	Average Percentage Change in Rasch Score	Comparison *P*-Value
Age	Under 40	13	+19.3%	Overall: 0.579 40- vs 40-60: 0.386 40- vs 60+: 0.335 40-60 vs 60+: 0.769
	40 to 60	28	+29.4%	
	Over 60	11	+33.0%	
Fitzpatrick	I to III	39	+29.0%	Overall: 0.865
	IV to VI	12	+27.1%	
Glogau	I and II	30	+29.8%	Overall: 0.769
	III and IV	21	+26.9%	

Average percentage change, pre- to post-neuromodulation, in the Rasch score for the satisfaction with facial appearance overall section by patient demographics. Change in satisfaction with overall facial appearance was not associated with patient age, Fitzpatrick score, or Glogau score.

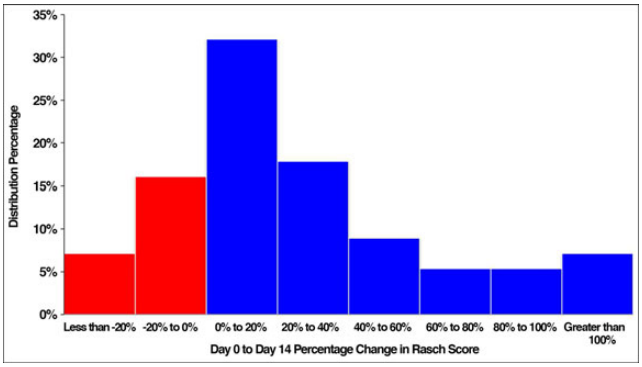

Figure 3. Distribution of the percentage changes in Rasch score for satisfaction with age appearance. The columns in red indicate patients whose satisfaction with their age appearance decreased following neuromodulation, highlighting the variability in patient-reported outcomes.

(*P* = .04) (Table 10). There were no significant differences between onabotulinumtoxinA and incobotulinumtoxinA (*P* = .51) or between abobotulinumtoxinA and incobotulinumtoxinA (*P* = .14) (Table 10). The change in patients' satisfaction with their facial appearance overall did not correlate with their age (*P* = .38), Fitzpatrick score (*P* = .36), or Glogau score (*P* = .19) (Table 11). Furthermore, there were no significant changes, relative to baseline, in patient satisfaction with their nasolabial folds (*P* = .10), lower face and jawline (*P* = .46), chin (*P* = .13), and neck (*P* = .17) following neuromodulation (Tables 12-15). The FACE-Q scales relating to the upper face were not validated at the time of the study and thus could not be applied.

Table 6. Post-Neuromodulation Change in Satisfaction with Age Appearance

Consequence of Age Appearance	Average Percentage Change	*P*-Value
Don't Recognize Themselves	−6.9%	0.002
Don't Look Like Themselves	−11.3%	0.013
Bothered by Their Age Appearance	−7.3%	0.124
Look Older than They Want To	−9.8%	0.064
Worried by Their Age Appearance	+10.8%	0.234
Reminded of How Old They Are	−0.9%	0.911
Look Older than They Want to in Photos	−4.1%	0.535
Rasch Transformed Score	+29.5%	0.004
Age Appraisal Scale: Number of years older or younger they think they look, relative to their actual age.	−5.6 Years (−9.2%)	0.001

Average percentage change, pre- to post-neuromodulation, in the questions and overall Rasch score for the satisfaction with age appearance section.

The fourth component of the FACE-Q assessed negative sequelae of the face. The sole negative sequelae that bothered patients post-treatment compared with pre-treatment was difficulty with facial expressions (*P* = .05) (Table 16).

Finally, there was an inverse relationship between the Rasch score in overall facial appearance and average glabellar strain, representing increased patient satisfaction with lower glabellar strain. However, this finding was not significant either pre-neurotoxin treatment (*P* = .43) or post-neurotoxin treatment (*P* = .15). Importantly, there did not appear to be a correlation between the change in patient satisfaction and the amount of glabellar strain reduction (*P* = .83).

DISCUSSION

This study demonstrates that the FACE-Q is a reliable, valid, and effective instrument to assess the patient-reported outcomes of BoNT-A neuromodulation. As aesthetic neurotoxin injection applications continue to expand, the FACE-Q should be utilized as a measurement tool for assessing the efficacy of aesthetic BoNT-A neuromodulation on patient satisfaction. What differentiates the FACE-Q from other patient-reported outcome instruments is its comprehensiveness. Like other questionnaires, the FACE-Q can capture changes in patients' satisfaction with their overall facial appearance due to aesthetic intervention. Unlike other questionnaires, the FACE-Q can assess satisfaction with specific facial regions and, further, can assess patients' perceptions of their age appearance. This breadth eliminates the need for combining multiple surveys, such

Table 7. Post-Neuromodulation Change in Satisfaction with Age Appearance by Treatment

Neurotoxin Treatment	N	Average Percentage Change in Rasch Score	Comparison *P*-Value
OnabotulinumtoxinA	18	+19.4%	Overall: 0.788 ONA-A vs ABO-A: 0.531 ONA-A vs INCO-A: 0.572 ABO-A vs INCO-A: 0.950
AbobotulinumtoxinA	19	+35.0%	
IncobotulinumtoxinA	19	+33.5%	

Average percentage change, pre- to post-neuromodulation, in the Rasch score for the satisfaction with age appearance section by neurotoxin treatment group. There were no significant differences among the treatment groups.
ABO-A, abobotulinumtoxinA; INCO-A, incobotulinumtoxinA; ONA-A, onabotulinumtoxinA.

Table 8. Post-Neuromodulation Change in Satisfaction with Age Appearance by Demographics

	Group	N	Average Percentage Change in Rasch Score	Comparison *P*-Value
Age	Under 40	14	+18.6%	Overall: 0.621 40- vs 40-60: 0.725 40- vs 60+: 0.345 40-60 vs 60+: 0.453
	40 to 60	29	+27.2%	
	Over 60	13	+46.1%	
Fitzpatrick	I to III	42	+31.8%	Overall: 0.600
	IV to VI	13	+19.2%	
Glogau	I and II	31	+24.5%	Overall: 0.635
	III and IV	24	+34.3%	

Average percentage change, pre- to post-neuromodulation, in the Rasch score for the satisfaction with age appearance section by patient demographics. Change in satisfaction with age appearance was not associated with patient age, Fitzpatrick score, or Glogau score.

Table 9. Post-Neuromodulation Change in Satisfaction with Cheeks

Cheek Appearance Aspect	Average Percentage Change	*P*-Value
Symmetry	+9.0%	0.083
Smoothness	+15.0%	0.002
Attractiveness	+19.1%	<0.001
Contour	+18.7%	<0.001
Youthful Fullness	+20.2%	<0.001
Rasch Transformed Score	+25.4%	<0.001

Average percentage change, pre- to post-neuromodulation, in the questions and overall Rasch score for the satisfaction with cheek appearance section.

as the Facial Lines Outcomes and Self-Perception of Age questionnaires.[17]

The finding that patient satisfaction with the overall appearance of their face increased by 28% after BoNT-A neuromodulation is consistent with other studies that have found a positive patient-perceived effect of BoNT-A neuromodulation on their facial appearance.[4] Unlike previous studies, this is the first to examine whether patient satisfaction differs among onabotulinumtoxinA, abobotulinumtoxinA, and incobotulinumtoxinA formulations. Patients treated with incobotulinumtoxinA had the greatest percentage change in the Rasch transformed score for "Satisfaction with Facial Appearance Overall" at 36%. Patients treated with onabotulinumtoxinA had a 29% change, and patients treated with abobotulinumtoxinA had an 18% change. However, due to the variability in patient satisfaction, these differences were not statistically significant ($P = .33$). Nevertheless, this finding is particularly interesting in light of prior research comparing these three neurotoxins. One study reported that incobotulinumtoxinA has a more rapid onset and a longer duration of treatment than onabotulinumtoxinA and abobotulinumtoxinA, when using the Merz 5-point scale for glabellar frown lines.[32] In contrast, the data from the toxin comparison study of the same patients in this study using the DIC technology suggest that onabotulinumtoxinA has a greater quantitative effect on glabellar strain reduction than incobotulinumtoxinA.[27] Additional research is required to evaluate potential differences in patient satisfaction among neurotoxins in relation to quantitative strain reduction, as well as the optimal assessment tool for strain reduction. However, it remains clear that patient satisfaction with their overall facial appearance improves following all formulations of BoNT-A neuromodulation.

A distinct benefit of BoNT-A neuromodulation that is uniquely captured by the FACE-Q instrument is that patients are more satisfied with how old they look following neurotoxin injection. The patients in this study believe their aging appearance is on average 30% better and that they look younger 5.6 years younger following any BoNT-A formulation injection. This is consistent with a prior study that used the Self-Perception of Age questionnaire and found that patients felt that they looked 3.9 years younger following BoNT-A injection than at baseline.[17] Furthermore, that same study found that patients who felt that they looked older

Table 10. Post-Neuromodulation Change in Satisfaction with Cheeks by Treatment

Neurotoxin Treatment	N	Average Percentage Change in Rasch Score	Comparison *P*-Value
OnabotulinumtoxinA	16	+10.8%	Overall: 0.101 ONA-A vs ABO-A: 0.038 ONA-A vs INCO-A: 0.512 ABO-A vs INCO-A: 0.135
AbobotulinumtoxinA	17	+44.0%	
IncobotulinumtoxinA	18	+20.9%	

Average percentage change, pre- to post-neuromodulation, in the Rasch score for the satisfaction with cheek appearance section by neurotoxin treatment group. Patients receiving abobotulinumtoxinA had a significantly greater increase in satisfaction than that of patients receiving onabotulinumtoxinA.
ABO-A, abobotulinumtoxinA; INCO-A, incobotulinumtoxinA; ONA-A, onabotulinumtoxinA.

Table 11. Post-Neuromodulation Change in Satisfaction with Cheeks by Demographics

	Group	N	Average Percentage Change in Rasch Score	Comparison *P*-Value
Age	Under 40	12	+9.2%	Overall: 0.383 40- vs 40-60: 0.180 40- vs 60+: 0.293 40-60 vs 60+: 0.912
	40 to 60	27	+31.0%	
	Over 60	12	+29.2%	
Fitzpatrick	I to III	39	+22.2%	Overall: 0.364
	IV to VI	12	+36.1%	
Glogau	I and II	29	+18.1%	Overall: 0.193
	III and IV	22	+35.1%	

Average percentage change, pre- to post-neuromodulation, in the Rasch score for the satisfaction with cheek appearance section by patient demographics. Change in satisfaction with cheek appearance was not associated with patient age, Fitzpatrick score, or Glogau score.

Table 12. Post-Neuromodulation Change in Satisfaction with Nasolabial Folds

Nasolabial Fold Appearance Aspect	Average Percentage Change	*P*-Value
Depth	+0.6%	0.914
Appearance when Face Is Still	−0.5%	0.934
Agedness	+0.8%	0.891
Appearance when Smiling	+1.2%	0.842
Appearance Compared to Others	+3.3%	0.622
Rasch Transformed Score	−12.2%	0.099

Average percentage change, pre- to post-neuromodulation, in the questions and overall Rasch score for the satisfaction with nasolabial folds appearance section.

Table 13. Post-Neuromodulation Change in Satisfaction with Lower Face and Jawline

Lower Face and Jawline Appearance Aspect	Average Percentage Change	*P*-Value
Prominence of Jawline	+3.4%	0.473
Sculpture of Jawline	+6.7%	0.285
Jawline Profile Appearance	+3.7%	0.459
Niceness of Lower Face	+5.4%	0.241
Smoothness of Lower Face	+9.7%	0.074
Rasch Transformed Score	+2.3%	0.464

Average percentage change, pre- to post-neuromodulation, in the questions and overall Rasch score for the satisfaction with lower face and jawline appearance section.

Table 14. Post-Neuromodulation Change in Satisfaction with Area under Chin

Chin Appearance Aspect	Average Percentage Change	*P*-Value
Appearance of Area Under Chin in Profile	−0.6%	0.927
Loose Skin and Fat	+3.9%	0.588
Sagging Skin and Fat	+8.2%	0.242
Lack of Contour	+3.1%	0.651
Fullness	+3.1%	0.722
Rasch Transformed Score	−12.6%	0.128

Average percentage change, pre- to post-neuromodulation, in the questions and overall Rasch score for the satisfaction with area under chin appearance section.

than their actual age at baseline reported that they looked 10.4 years younger relative to baseline following neurotoxin treatment.[17] Similarly, the patients in our study who felt they looked older than their actual age at baseline reported that they looked 7.9 years younger relative to baseline following treatment, suggesting that improvement in age appearance following BoNT-A treatment may be more effective for patients who believe they look older than their chronological age. Furthermore, while not statistically significant, older patients appeared to be more satisfied with their appearance

Table 15. Post-Neuromodulation Change in Satisfaction with Neck

Neck Appearance Aspect	Average Percentage Change	*P*-Value
Sagging Skin	+11.4%	0.099
Agedness	+6.7%	0.308
Wrinkles	+1.8%	0.774
Appearance in Profile	−4.9%	0.310
Appearance When Grimacing	0.0%	1.000
Hanging Skin	+0.9%	0.861
Appearance in Collared Shirts	−1.6%	0.823
Depth of Horizontal Lines	+3.5%	0.585
Appearance Compared to Others	+1.9%	0.758
Need to Cover Neck	+1.1%	0.844
Rasch Transformed Score	−11.7%	0.172

Average percentage change, pre- to post-neuromodulation, in the questions and overall Rasch score for the satisfaction with neck appearance section.

Table 16. Post-Neuromodulation Change in Late Negative Sequelae

FACE-Q Question	Average Percentage Change	*P*-Value
Numbness	6.4%	0.070
Tightness	8.8%	0.181
Not Smooth	−2.7%	0.702
Sensitivity	0.0%	1.000
Tingling	0.6%	0.848
Feeling of Scars	3.3%	0.345
Discomfort	−0.3%	0.900
Itching	−3.0%	0.086
Appearance of Scars	−2.6%	0.475
Pulling	−1.5%	0.546
Swelling	−4.5%	0.156
Firmness	1.2%	0.532
Difficulty with Facial Expressions	7.9%	0.049
Bruising	0.0%	1.000
Difficulty with Facial Movements	−0.9%	0.322

Average percentage change, pre- to post-neuromodulation, in the questions for the late negative sequelae section.

post-BoNT-A neuromodulation. Patients over 60 years old reported a 33% increase in satisfaction with their overall facial appearance and a 46% increase in satisfaction with their age appearance, in contrast to 19% and 19%, respectively, for patients under 40 years of age. Therefore, patient age is likely a significant contributor to the variation in patient reported satisfaction with BoNT-A neuromodulation, with older patients, not unexpectedly, benefitting more from such treatments than younger ones. This congruency with the Self-Perception of Age indicates that the FACE-Q does effectively capture the changes in age appearance following neuromodulation.

While it is clear that patients in general are satisfied with their BoNT-A treatment, the FACE-Q data demonstrate that there is a subset of patients who do not appreciate a benefit, with 19% of patients reporting a decrease in satisfaction with their overall facial appearance, and 23% of patients feeling that they looked older following BoNT-A treatment. Interestingly, many of the patients who did not report a positive effect of BoNT-A via the FACE-Q demonstrated large quantitative reductions in glabellar strain via DIC measurements, as described in this study's parallel study.[27] These observations are consistent with the clinical experience of neuromodulation that suggests not all patients are comfortable with or accepting of a change in their appearance following this treatment. This suggests that the overall efficacy of a toxin on quantitative strain reduction may not directly correlate with patient satisfaction and perhaps reflects the anecdotal clinical experience with patients wishing to avoid the "frozen look." Alternative explanations are that some patients may have unrealistic expectations, may require treatment of additional anatomic regions for an attractive synergistic effect, or may require specifically tailored treatments of the glabella that were not possible while keeping within the protocol of this study. Nevertheless, these observations require further exploration with additional studies to optimize patient outcomes.

Of additional interest is that BoNT-A neuromodulation can increase patient satisfaction in facial regions not directly treated, as demonstrated by patients who were 25% more satisfied with the appearance of their cheeks post-BoNT-A neuromodulation. Because it has been reported previously that BoNT-A injections can positively affect patients' emotional and psychosocial wellbeing, one possible explanation of this finding is that patients' satisfaction with respect to how their face looks overall may bias their perceptions of cheek appearance as well.[33-35] In contrast, patients' satisfaction with the other regions of their face did not improve following BoNT-A neuromodulation, suggesting that the cheek finding may indeed be anatomically

related to the improvement of glabellar animation and upper face dynamics.

Finally, there was an inverse relationship between patient satisfaction with facial appearance and their degree of glabellar strain. This inverse relationship was stronger at the 14-day follow-up, with a linear regression slope of −0.77 (1% increase in glabellar strain is associated with a 0.77% decrease in satisfaction with facial appearance) than at baseline, with linear regression slope of −0.35. However, this correlation was not statistically significant. Surprisingly, the degree of glabellar strain reduction did not correlate with the change in patient satisfaction with overall facial appearance, a finding that is not entirely surprising, and that suggests that patients with a more moderate effect post BoNT-A neuromodulation may be more satisfied, perhaps secondary to a more "natural" correction.

While the use of FACE-Q to assess patient-reported outcomes of aesthetic procedures has its merits, there are some limitations of the survey and this study. The survey that was administered to the patients included only the sections that were currently validated and available for research use at the time of the study and therefore did not contain the section that specifically assessed patient satisfaction with the forehead. Though at the time that the study was conducted, the FACE-Q scales for the upper face were not validated or available for research purposes, we hypothesized that the effect of glabellar neuromodulation on patient-perceived benefits is likely not limited to the glabellar region alone and thus could initially be examined using available FACE-Q scales. Our data confirm the beneficial effects of glabellar neuromodulation on other areas of the face. Future studies incorporating the now-validated upper face scales will be conducted and this limitation does not negate the clear and robust findings of improved overall satisfaction and age appearance following BoNT-A neuromodulation. Another shortcoming is that less than half the patients completed the entire survey on both dates. One possible explanation is that a given patient omitted a question because of the length of the survey or because the question was not deemed relevant by the patient. This limitation can be resolved in the future by having the survey program allow the patient to move on to the next section only after all the questions in the previous section have been answered. An alternative explanation is that some patients became fatigued by the length of the survey and elected to avoid questions that they did not wish to answer. This suggests that the FACE-Q's strength, its comprehensiveness, may also be a potential downfall. Physicians must carefully consider potential survey fatigue and how a long survey can adversely affect a patient's opinion in answering the questions regarding their satisfaction. Therefore, careful selection of the most important and relevant sections in tailoring the FACE-Q survey instrument for a specific study is important to maintain a high response rate for evidence-based aesthetic medicine.

CONCLUSION

The FACE-Q is an effective patient-reported outcome instrument that confirms the literature regarding overall satisfaction and improvement in age appearance following BoNT-A neuromodulation. The FACE-Q survey used in this study is the first to demonstrate that patient satisfaction following neuromodulation of the glabella is not statistically significantly different between onabotulinumtoxinA, abobotulinumtoxinA, and incobotulinumtoxinA formulations. Patient satisfaction with BoNT-A neuromodulation does not correlate with patient age, skin color, or degree of skin wrinkling, though there is an inverse trend for patient satisfaction, advancing age, and degree of glabellar strain. The inverse correlation between the FACE-Q-determined patient satisfaction and the DIC-determined glabellar strain indicates that patients are overall more satisfied with lower glabellar strain, but not necessarily a large change in their strain profile. Overall, this study demonstrates that the FACE-Q instrument should be utilized as a comprehensive tool for assessing patient outcomes following aesthetic BoNT-A neuromodulation.

Disclosures

Dr Percec is a paid consultant for Galderma. This position started after the completion of this study. The other authors declared no potential conflicts of interest with respect to the research, authorship, and publication of this article.

Funding

The Center for Human Appearance at the University of Pennsylvania funded this study and a co-study described in the paper. The funding was used for the described neurotoxins and to pay for imaging services from Trilion Systems for using imaging technology.

REFERENCES

1. Cosmetic surgery national data bank statistics. *Aesthet Surg J*. 2015;35(Suppl 2):1-24.
2. FDA. *Medication Guide Botox Cosmetic for Injection*. Silver Spring, MD: FDA; 2013.
3. Sepehr A, Chauhan N, Alexander AJ, Adamson PA. Botulinum toxin type A for facial rejuvenation: treatment evolution and patient satisfaction. *Aesthetic Plast Surg*. 2010;34:583-586.
4. Fagien S, Carruthers JD. A comprehensive review of patient-reported satisfaction with botulinum toxin type A for aesthetic procedures. *Plast Reconstr Surg*. 2008;122:1915-1925.
5. Ascher B, Zakine B, Kestemont P, Baspeyras M, Bougara ASantini J. A multicenter, randomized, double-blind, placebo-controlled study of efficacy and safety of 3 doses of botulinum toxin A in the treatment of glabellar lines. *J Am Acad Dermatol*. 2004;51:223-233.
6. Prager W, Bee EK, Havermann I, Zschocke I. Onset, longevity, and patient satisfaction with incobotulinumtoxinA

for the treatment of glabellar frown lines: a single-arm, prospective clinical study. *Clin Interv Aging*. 2013;8:449-456.
7. Ahn KY, Park MY, Park DH, Han DG. Botulinum toxin A for the treatment of facial hyperkinetic wrinkle lines in Koreans. *Plast Reconstr Surg*. 2000;105:778-784.
8. Keen M, Blitzer A, Aviv J, et al. Botulinum toxin A for hyperkinetic facial lines: results of a double-blind, placebo-controlled study. *Plast Reconstr Surg*. 1994;94:94-99.
9. Rzany B, Ascher B, Fratila A, Monheit GD, Talarico S, Sterry W. Efficacy and safety of 3- and 5-injection patterns (30 and 50 U) of botulinum toxin A (Dysport) for the treatment of wrinkles in the glabella and the central forehead region. *Arch Dermatol*. 2006;142:320-326.
10. Beer KR. Comparative evaluation of the safety and efficacy of botulinum toxin type A and topical creams for treating moderate-to-severe glabellar rhytids. *Dermatol Surg*. 2006;32:184-197.
11. Carruthers A, Carruthers J. Prospective, double-blind, randomized, parallel-group, dose-ranging study of botulinum toxin type A in men with glabellar rhytids. *Dermatol Surg*. 2005;31:1297-1303.
12. Lowe P, Patnaik R, Lowe N. Comparison of two formulations of botulinum toxin type A for the treatment of glabellar lines: a double-blind, randomized study. *J Am Acad Dermatol*. 2006;55:975-980.
13. Cox SE, Finn JC, Stetler L, Mackowiak J, Kowalski JW. Development of the facial lines treatment satisfaction questionnaire and initial results for botulinum toxin type A–treated patients. *Dermatol Surg*. 2003;29:444-449.
14. Stotland MA, Kowalski JW, Ray BB. Patient-reported benefit and satisfaction with botulinum toxin type A treatment of moderate to severe glabellar rhytides: results from a prospective open-label study. *Plast Reconstr Surg*. 2007;120:1386-1393.
15. Lowe NJ, Ascher B, Heckmann M, Kumar C, Fraczek S, Eadie N. Double-blind, randomized, placebo-controlled, dose-response study of the safety and efficacy of botulinum toxin type A in subjects with crow's feet. *Dermatol Surg*. 2005;31:257-262.
16. Sommer B, Zschocke I, Bergfeld D, Sattler G, Augustin M. Satisfaction of patients after treatment with botulinum toxin for dynamic facial lines. *Dermatol Surg*. 2003;29:456-460.
17. Fagien S, Cox SE, Finn JC, Werschler WP, Kowalski JW. Patient-reported outcomes with botulinum toxin type A treatment of glabellar rhytids: a double-blind, randomized, placebo-controlled study. *Dermatol Surg*. 2007;33:S2-S9.
18. Carruthers J, Carruthers A. Botulinum toxin type A treatment of multiple upper facial sites: patient-reported outcomes. *Dermatol Surg*. 2007;33:S10-S17.
19. Klassen AF, Cano SJ, Scott AM, Snell L, Pusic AL. Measuring patient-reported outcomes in facial aesthetic patients: development of the FACE-Q. *Facial Plast Surg*. 2010;26:303-309.
20. Pusic AL, Klassen AF, Scott AM, Cano SJ. Development and psychometric evaluation of the FACE-Q satisfaction with appearance scale. *Clin Plast Surg*. 2013;40:249-260.
21. Panchapakesan V, Klassen AF, Cano SJ, Scott AM, Pusic AL. Development and psychometric evaluation of the FACE-Q aging appraisal scale and patient-perceived age visual analog scale. *Aesthet Surg J*. 2013;33:1099-1109.
22. Pusic AL, Reavey PL, Klassen AF, Scott A, McCarthy C, Cano SJ. Measuring patient outcomes in breast augmentation: introducing the BREAST-Q Augmentation module. *Clin Plast Surg*. 2009;36:23-32.
23. Chen CM, Cano SJ, Klassen AF, et al. Measuring quality of life in oncologic breast surgery: a systematic review of patient-reported outcome measures. *Breast J*. 2010;16:587-597.
24. Cano SJ, Klassen AF, Scott AM, Cordeiro PG, Pusic AL. The BREAST-Q: further validation in independent clinical samples. *Plast Reconstr Surg*. 2012;129:293-302.
25. Schwitzer JA, Sher SR, Fan KL, Scott AM, Gamble L, Baker SB. Assessing patient-reported satisfaction with appearance and quality of life following rhinoplasty using the FACE-Q appraisal scales. *Plast Reconstr Surg*. 2015;135:830e-17e.
26. Sinno S, Schwitzer J, Anzai L, Thorne CH. Face-lift satisfaction using the FACE-Q. *Plast Reconstr Surg*. 2015;136:239-242.
27. Wilson AJ, Taglienti AJ, Chang BL, et al. A quantitative analysis of botulinum toxin type A (BoNTA) formulations: a randomized double blind prospective clinical trial of comparative dynamic strain reduction. Poster presented at the American Association of Plastic Surgeons' 2015 Annual Meeting, Scottsdale, AZ., April 11-14, 2015.
28. Flynn TC. Botox in Men. *Dermatol Ther*. 2007;20:407-413.
29. Flynn TC. Update on botulinum toxin. *Semin Cutan Med Surg*. 2006;25:115-121.
30. Hsu VM, Wes AM, Tahiri Y, Cornman-Homonoff J, Percec I. Quantified facial soft-tissue strain in animation measured by real-time dynamic 3-dimensional imaging. *Plast Reconstr Surg Glob Open*. 2014;2:e211.
31. Wilson AJ, Chin BC, Hsu VM, Mirzabeigi MN, Percec I. Digital image correlation: a novel dynamic three-dimensional imaging technique for precise quantification of the dynamic rhytid and botulinum toxin type A efficacy. *Plast Reconstr Surg*. 2015;135:869e-876e.
32. Rappl T, Parvizi D, Friedl H, et al. Onset and duration of effect of incobotulinumtoxinA, onabotulinumtoxinA, and abobotulinumtoxinA in the treatment of glabellar frown lines: a randomized, double-blind study. *Clin Cosmet Investig Dermatol*. 2013;6:211-219.
33. Davis JI, Senghas A, Brandt F, Ochsner KN. The effects of BOTOX injections on emotional experience. *Emotion*. 2010;10:433-440.
34. Hexsel D, Brum C, Siega C, et al. Evaluation of self-esteem and depression symptoms in depressed and non-depressed subjects treated with onabotulinumtoxinA for glabellar lines. *Dermatol Surg*. 2013;39:1088-1096.
35. Singh GC, Hankins MC, Dulku A, Kelly MB. Psychosocial aspects of botox in aesthetic surgery. *Aesthetic Plast Surg*. 2006;30:71-76.