Objective: To quantify the degree of perceived age change after aesthetic facial surgical procedures to provide an objective measure of surgical success.

Methods: Sixty patients undergoing various aging face surgical procedures were randomly chosen for analysis. Preoperative and postoperative photographs were evaluated. Raters were presented with photographs in a random assortment and were asked to estimate the age of the patient. Perceived age difference was defined as the difference between the chronological age and the estimated age, and the change in this value after surgery was the chief outcome of interest. Statistical models were designed to account for any effects of interrater differences, preoperative chronological age, rater group, photograph order, or surgical procedure performed.

Results: Our patient population was divided into the following 3 groups based on the surgical procedure performed: group 1 (face- and neck-lift [22 patients]), group 2 (face- and neck-lift and upper and lower blepharoplasty [17 patients]), and group 3 (face- and neck-lift, upper and lower blepharoplasty, and forehead-lift [21 patients]). Adjusted means demonstrated that patient ages were estimated to be 1.7 years younger than their chronological age before surgery and 8.9 years younger than their chronological age after surgery. The effect was less substantial for group 1 patients and was most dramatic for group 3 patients, who had undergone all 3 aging face surgical procedures.

Conclusions: Our study is novel in that it quantifies the degree of perceived age change after aging face surgical procedures and demonstrates a significant and consistent reduction in perceived age after aesthetic facial surgery. This effect is more substantial when the number of surgical procedures is increased, an effect unrelated to the preoperative age of a patient and unaffected by other variables that we investigated. The ability to perceive age correctly is accurate and consistent.
aesthetic surgery, these studies largely concentrate on patient-reported satisfaction. This is understandable given the fact that it is challenging to gauge the success of interventions whose outcomes are largely subjective in nature. However, if one of the chief motivations for cosmetic facial procedures is to restore a youthful appearance and minimize the effects of aging, then efforts directed at investigating the success of such interventions are desirable. Research has demonstrated significant enhancement in patient satisfaction with appearance and quality of life after aesthetic surgery; furthermore, this can have a demonstrably broader effect in the context of physical, emotional, and social well-being.2

Whether rejuvenating facial appearance specifically leads to perceived younger age or increased beauty, most would concur that it certainly leads to an improvement in the perception of one’s overall facial appearance. Some research has substantiated more positive perceived ratings in younger faces compared with older faces, with raters specifically regarding older faces as less attractive, likeable, or energetic.3 We can likely reason that aging face surgery has a positive effect in improving perceived age and beauty. Our objective herein is to quantify the degree of perceived age change after undergoing aesthetic facial surgical procedures, with this serving as an indicator of success in our role as facial plastic surgeons.

We assert that perceived age and perceived age change after surgery are the most direct indexes of success in facial rejuvenation procedures. Few data exist that quantify changes to these variables and consider factors such as patient sex, preoperative chronological age, and surgical procedure performed.

### Methods

Patients undergoing aesthetic facial surgery by one of us (P.A.A.) between January 2005 and December 2008 were eligible for inclusion in the study. Sixty patients were randomly selected among those who had given consent for their photographs to be used for the purpose of scientific study. Each patient had 2 frontal view photographs available for rater review, one before surgery and the other 6 months after surgery. The patients had various aging face surgical procedures performed and comprised the following groups: group 1 (face- and neck-lift [22 patients]), group 2 (face- and neck-lift and upper and lower blepharoplasty [17 patients]), and group 3 (face- and neck-lift, upper and lower blepharoplasty, and forehead-lift [21 patients]).

Our study design incorporated 40 raters, each randomly assigned to 1 of 4 rater groups (groups 1 through 4), with each group comprising 10 different raters. The raters were randomly chosen among volunteers from a class of first-year medical students. The 60 patients contributed 120 total photographs (preoperative and postoperative frontal views for each), and these photographs were randomly assigned among each of the 4 rater groups. Therefore, each group was responsible for rating 30 photographs, which were a random assortment of preoperative and postoperative photographs from the patient population, given in random order.

Raters were presented with a collection of photographs in the same random order for each group depending on their rater group number (1 through 4). They were asked to estimate and record the age of the patient appearing in each photograph. These data were recorded and kept in a confidential log. Before distribution, the photographs were numbered, and each number correlated with a number in a separate logbook containing actual age data, which could then be examined for statistical purposes.

Statistical analysis was performed using commercially available software (SAS, version 9.2; SAS Institute, Inc). Perceived age difference was defined as the difference between the chronological age and the estimated age of the patients. This allowed us to control for differences in the patients’ actual ages.

Pilot data suggested some degree of variability in rater ability to guess patient ages using photographs. Therefore, we initially used a somewhat complex model to compare perceived ages before and after surgery, while accounting for possible consistent differences within raters (ie, some raters might always guess younger, and other raters might always guess older). We used a mixed model (PROC MIXED in SAS), which allowed us to use all the age estimates of all the patients, with rater incorporated as a random predictor variable. At this stage, we also tested for possible effects of preoperative chronological age, rater group, and photograph order on the outcome. None of these effects were significant predictors of the outcome, and they were removed from subsequent models. Most important, no consistent differences were noted between raters in the ability to perceive age correctly (P=.13), and age estimates of the same patients were consistent between raters.

These results suggested that we could construct a simpler model. Because raters were consistent, we were able to use the age estimates before and after surgery to calculate a precise mean estimate of perceived age difference for each patient. We then constructed a repeated-measures model to compare the estimates of perceived age difference before and after surgery. The patient identification number was also included because there were differences between patients in the raters’ perception of their age (ie, some patients consistently appeared older and others consistently younger than their real age). This patient identification number effect was the same in the photographs before and after surgery, which means that the degree to which patients looked younger or older was about the same before and after surgery.

Perceived age difference (mean Δ) was defined as the following: Perceived age difference = chronological age – mean estimated age. To assess the effect of surgical intervention on perceived age, we calculated a variable referred to as Δ difference as follows: Δ Difference = mean Δ postoperative – mean Δ preoperative. The Δ difference was the outcome variable used in a general linear model to assess the effects of preoperative chronological age and surgical procedure performed on this outcome. Initial models included rater group and photograph order, but because these variables were found to be nonsignificant, they were removed from the final model. In addition, we tested the interaction between preoperative chronological age and surgical procedure performed, but this was also removed because of lack of significance. The final model indicated significant differences between the 3 surgical procedures performed. Tukey post hoc comparisons of all the possible pairs were performed to assess the effect of surgical procedure performed.

### Results

Patients in the study ranged in age from 45.0 to 72.0 years at the time of surgery, with a mean age of 59.7 years (Table 1). Fifty-four patients were female, with no significant difference in the mean age of men compared with women. Because there were so few men (n = 6), sex could
After surgery

Table 1. Patient Demographics

<table>
<thead>
<tr>
<th>Demographic</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preoperative chronological age, mean, y</td>
<td></td>
</tr>
<tr>
<td>Overall (range)</td>
<td>59.7 (45.0-72.0)</td>
</tr>
<tr>
<td>Men</td>
<td>61.8</td>
</tr>
<tr>
<td>Women</td>
<td>59.4</td>
</tr>
<tr>
<td>Sex, No.</td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>6</td>
</tr>
<tr>
<td>Female</td>
<td>54</td>
</tr>
<tr>
<td>Surgical procedure performed, No.</td>
<td></td>
</tr>
<tr>
<td>Face- and neck-lift (group 1)</td>
<td>22</td>
</tr>
<tr>
<td>Face- and neck-lift and upper and lower blepharoplasty (group 2)</td>
<td>17</td>
</tr>
<tr>
<td>Face- and neck-lift, upper and lower blepharoplasty, and forehead-lift (group 3)</td>
<td>21</td>
</tr>
</tbody>
</table>

Table 2. Perceived Age Difference Between the Chronological Age and the Estimated Age by Surgical Procedure Performed

<table>
<thead>
<tr>
<th>Groupa</th>
<th>Mean Δ Preoperative</th>
<th>Mean Δ Postoperative</th>
<th>Δ Differenceb</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (n=22)</td>
<td>1.88 (3.28)</td>
<td>7.62 (4.20)</td>
<td>5.74 (2.32)</td>
</tr>
<tr>
<td>2 (n=17)</td>
<td>3.91 (5.43)</td>
<td>11.42 (5.73)</td>
<td>7.51 (2.93)</td>
</tr>
<tr>
<td>3 (n=21)</td>
<td>-0.20 (2.63)</td>
<td>8.21 (3.31)</td>
<td>8.41 (3.02)</td>
</tr>
<tr>
<td>Total (N=60)</td>
<td>1.73 (4.11)</td>
<td>8.90 (4.64)</td>
<td>7.18 (2.95)</td>
</tr>
</tbody>
</table>

aGroup 1 underwent face- and neck-lift; group 2, face- and neck-lift and upper and lower blepharoplasty; and group 3, face- and neck-lift, upper and lower blepharoplasty, and forehead-lift.
bMean Δ postoperative minus mean Δ preoperative.

not be included in any of the statistical analyses as a predictive variable.

Adjusted means (least squares means) demonstrated that, on average, raters estimated patient ages to be about 1.7 years younger than their chronological age before surgery but 8.9 years younger than their chronological age after surgery (Table 2 and Figure 1). P values next to the least squares mean estimates are significant, indicating that the least squares means are both significantly different from zero. This demonstrates that raters generally rated patients as younger than their actual age, although this tendency was much more pronounced after surgery. Table 2 summarizes perceived age difference before and after surgery, when the separate surgical procedures performed are considered.

The general linear model indicated significant differences between the 3 surgical procedures performed (P=.007). Tukey post hoc comparisons of all the possible pairs were performed to assess the effect of surgical procedure performed. Differences between group 1 and group 3 were statistically significant but not differences between group 2 and group 1 or group 3. Post hoc comparisons showed that the Δ difference differed only between group 1 and group 3.

This is consistent with Figure 2, which shows that the gap between the preoperative and postoperative box plots is clearly wider among group 3 patients than among group 1 patients, with the gap being intermediate for group 2 patients. Rater group and photograph order (data not shown), in addition to preoperative chronological age (P=.18), were shown to be nonsignificant variables.

The desire to improve one’s physical presentation and to maintain a youthful appearance is intrinsic to our evolution.4 Even in times of hardship and famine, this drive takes precedence as the biological collective strives to entice one another. Although aesthetic surgical interventions may not fall under the realm of medically necessary procedures, there stems an innate desire to be as young and attractive as possible, which has been documented throughout much of the history of our species.5 Physical appearance and how we are perceived by others have implications for social and psychological func-
tioning, as well as our sense of well-being, self-esteem, and self-confidence. Unfortunately, biological and environmental aging is a relentless process, one that continues to encourage turnover of a species as it moves forward.

Our drive to achieve a youthful appearance has spawned innovation in medical advances, producing numerous options to slow the aging process and toreverse it. Our options include a spectrum ranging from skin care therapeutics to injectable soft-tissue fillers to surgical intervention and procedures. We can offer each patient a targeted approach to achieve his or her desired aesthetic results. That being said, patients and facial plastic surgeons are aware that our abilities are not limitless in the effort to combat age-related changes, despite increased sophistication and diversity in our rejuvenation techniques. The combined effects of hair and skin changes, soft-tissue atrophy, bony remodeling, and photoaging mount an aging offensive, presenting a complex and formidable challenge to the facial plastic surgeon. Experienced facial plastic surgeons know to temper their optimism in patient encounters because of the limitations in our abilities to reverse the complex aging process. Some tend to use the terms more youthful and more refreshed, but precise quantification of these attributes has remained elusive.

A fundamental issue in conducting a study like this is determining our effectiveness at estimating chronological age by simply reviewing photographs. Our data show that raters are consistent in how they rate age, with minimal interference from nonsignificant variables, such as preoperative chronological age, rater group, photograph order, and surgical procedure performed. Investigations have indirectly demonstrated our ability to discern, with surprising accuracy, the biological age of an individual based on appearance. One such study revealed a significant positive correlation between estimated age and biological age of individuals based solely on visible color distribution, even in isolated noncontextual skin images. The results of this study also indicated that the appearance of a woman’s skin significantly influences the estimation of her biological age and judgment of attractiveness, health, and youth, with the skin of younger women being rated more positively, highlighting the complexity of how our brain processes the image of another human being. There are other factors in the complex psychological aspect of age perception. Perceived age has been described as personal evaluation of age and consists of factors like recognition of chronological age, role involvement, health, and physical limitations, as well as awareness of societal age norms. To perform the present study, we first ran a pilot study to address the issue of age-perceiving accuracy. Notably, variables like rater group, photograph order, and patient identification number were found to be nonsignificant, and we further reduced variability by designing our model around a multitude of raters, rather than just a few, to eliminate the bias of having a limited number of “poor guessers.”

In this study, patients appeared 1.7 years younger than their chronological age before surgery, but the same patients appeared 8.9 years younger after undergoing facelift surgery. The change in perceived age difference varied depending on the specific rejuvenating procedures performed. In group 1 patients, the mean change was 5.7 years. The mean change was greater in group 2 patients, at 7.5 years, and still greater in group 3 patients, at 8.4 years. Overall, the mean change in perceived age difference was 7.2 years, which is significant. Raters did not differ significantly between each other in their age estimates of the same patients, although some patients were consistently estimated to be younger and others consistently older than their actual ages in the photographs before and after surgery. Our research represents some of the initial efforts aimed at quantifying the actual number of years that can be restored after facial rejuvenation surgery.

Our findings offer some objective sense as to our success with surgical intervention as facial plastic surgeons and provide us with more evidence to give patients when formulating their preoperative expectations. However, we acknowledge that this is a single-surgeon study looking at a limited spectrum of techniques. Future research would potentially seek to compare such results among patients undergoing different face-lifting techniques in addition to exploring the effect of laser resurfacing techniques, among other interventions. Regardless of the limitations, our results show a modest but significant reduction in perceived age after aesthetic facial surgery. Anecdotally, we have found in our practice that patients respond favorably to this finding when discussed because they want to look rejuvenated and more energetic while avoiding unnatural changes and drastic alterations in their appearance. Although motivations for aesthetic surgery may vary, a prevailing concept includes the desire to achieve a more youthful refreshed appearance while maintaining one’s unique attributes and identifying characteristics. Given these expectations, a mean 7.2-year reduction in perceived age difference is indeed consistent with this goal.

Further efforts might be directed toward elucidating why we are unable to further alter perceived age beyond the values delineated in our study. The facial aging process is complex, dependent on soft-tissue descent, skin wrinkling, volume depletion, collagen loss, and ligation laxity, in addition to bone loss and remodeling. We have the ability to resuspend, excise, tuck, inject, and augment. In recent years, volume restoration has come to be recognized as a critical component of facial rejuvenation. Further studies on the effect of aggressive volume augmentation will undoubtedly spur further innovation in products and techniques.

Many other related questions warrant exploration. For example, are there other factors yet unrecognized that have a role in perceived aging? How many years’ reduction in perceived aging can we achieve while retaining a natural untreated look? Many patients state that they “want to look good for their age.” What does this really mean? Is it a qualitative measure, or can it be quantified? In addition, ongoing research is exploring the mechanism of facial recognition and facial emotional identification, and further work will certainly be directed toward interplays between this recognition and perception of age and beauty. Unlocking these complex processing com-
CONCLUSIONS

Gauging success in the realm of facial plastic surgery is an often difficult task because of the subjective nature of outcomes and the varying levels of patient expectations. Our study represents some initial efforts at quantifying the degree of perceived age change after aging face surgery, providing an objective measure of surgical success. Our data demonstrate a significant and consistent reduction in perceived age after aesthetic facial surgery. This effect is made more substantial when the number of surgical procedures is increased, an effect unrelated to the preoperative age of a patient and unaffected by other variables that we investigated. Furthermore, we have shown that the ability to perceive age correctly is accurate and remarkably consistent. These quantitative results can be used to facilitate informed preoperative discussions and to provide patients with a better sense of outcomes, creating realistic expectations. Although the findings in the study are encouraging, there are many components to perceptions of youth and beauty, the study findings in the study are encouraging, there are many components may allow us to focus on new angles toward facial aging research.

For now, it is imperative that the preoperative counseling between the facial plastic surgeon and a potential patient should involve wise advice and informed consent, fostering a trustful therapeutic bond and the formation of realistic expectations. Our findings allow us to provide some objective evidence of the success in our surgical interventions. This information can help us in our decision making and in patient counseling. This ability to better identify the expected outcome for our patients enhances the probability of their satisfaction, which is the ultimate goal of all our interventions.

REFERENCES