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Validation of a Method for Estimation of Facial Age by Plastic Surgeons

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IMPORTANCE Within cosmetic facial plastic surgery, there is considerable difficulty in producing high-quality scientific publications because of the lack of scientific tools that serve to transform sensations, such as more beautiful or rejuvenated, into numbers capable of being used in statistical analysis.

OBJECTIVE To validate an objective evaluation method that can be used to define the perception of facial age in scientific studies.

DESIGN, SETTING, AND PARTICIPANTS This is a cross-sectional, observational study of evaluation by plastic surgeons of 70 photographs of patients from a private care hospital performed from March 1, 2015, through April 30, 2016. When evaluating the photographs, 7 plastic surgeons wrote down the perceived age of each patient. The photographs of each patient were randomly presented twice to each evaluator (photograph 1 and photograph 2) and analyzed singly using a trimmed mean. Three evaluators were randomly chosen for further statistical analysis in an attempt to make the assessment technique more practical.

EXPOSURES Usual aging process.

MAIN OUTCOMES AND MEASURES Estimated mean age and chronological age.

RESULTS Photographs of 70 patients were evaluated (mean [SD] age, 41.5 [13.8] years; 48 women [68.6%]; and mean [SD] body mass index, 22.5 [2.7]). No significant differences were observed between photographs 1 and 2 for any of the evaluators. A significant difference in the mean ages was not observed when comparing evaluators. For photograph 1 (evaluated by only 3 evaluators), the difference was 0.16 years (P = .52). For photograph 2, the difference was 0.05 years (P = .86). The difference between the mean perceived age for the 3 evaluators and the chronological age was only 0.8 years (<10 months).

CONCLUSIONS AND RELEVANCE The intraevaluator and interevaluator agreement suggests that 3 plastic surgeons can estimate the age of a person with a margin of error of 10 months by analyzing a photograph. This article is important to facial plastic surgeons because it reveals how the results of rejuvenation procedures can be assessed.

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In the field of cosmetic facial plastic surgery, producing high-quality scientific publications is difficult because of the lack of scientific tools that serve to transform sensations, such as more beautiful or rejuvenated, into numbers capable of being used in statistical analysis.[1] A previous study[2] that aimed to specifically assess the results of facial rejuvenation procedures lacked an objective definition, which serves to assess whether the treatment actually caused the facial appearance to seem younger.

A variety of equipment, software, and wrinkle scales have been developed in an attempt to provide this assessment.[3-5] Currently, a criterion standard does not exist to estimate the facial age of a person, considering that previously described techniques have difficulties, such as lack of validation, excessive cost, and interevaluator subjectivity.[6] We believe that a plastic surgeon, as a result of training and clinical practice, acquires the knowledge and skills necessary to precisely gauge the apparent facial age of people. The main objective of this study is to validate an objective evaluation method that can be used to define the perception of facial age in future scientific studies, evaluate the intraevaluator and interevaluator agreement among evaluators in the estimation of facial age by plastic surgeons, and define the number of evaluating plastic surgeons needed for this assessment.

Key Points

Question Are plastic surgeons able to accurately estimate facial age by photographs?

Findings In this cross-sectional, observational study of 70 patient photographs, the difference between the mean perceived age by 3 evaluators and the chronological age was only 0.8 years.

Meaning Intraevaluator and interevaluator agreement suggests that 3 plastic surgeons can estimate the age of a person by analyzing a picture with a margin of error of 10 months.

Methods

This cross-sectional, observational study was performed from March 1, 2015, through April 30, 2016. The entire population who was voluntarily assessed gave written informed consent, allowing the scientific use of their facial images and personal data; the patients also consented to the use of their unaltered full facial photographs for publication. All the evaluators had access only to the images and, after agreeing to participate in the study, signed a nondisclosure agreement in respect to the photographs of the people who would be assessed. The evaluators signed written informed consent forms and nondisclosure forms to participate in the study. The principles outlined in the Declaration of Helsinki were followed.[7] This study protocol was approved by the Research Ethics Committee of Pontificia Universidade Católica do Rio Grande do Sul and is registered with the Brazilian National Council of Ethics in Research.

Inclusion criteria were age of 18 to 70 years and body mass index (calculated as the weight in kilograms divided by square of height in meters) of 18 to 25. Exclusion criteria were a prior history of any facial reconstructive or cosmetic plastic surgery, use of any facial dermatologic formulation in the last 6 months, possessing dental implants, men with beard hair longer than 1 cm, having used any permanent dermal filler on the face, and having performed in the last 12 months a facial aesthetic treatment that involved temporary fillers, botulinum toxin, or skin exfoliation procedures, such as chemical and/or laser peels.

Patients posed for photographs in the frontal plane. The distance between the camera and the photographed individual was standardized at 2.5 m. For the evaluation of the photographs, 7 plastic surgeons with 3 years of training in facial plastic surgery were invited to participate. The photographs obtained were numbered and presented to the board-certified plastic surgeons acting as the evaluators on a 43-cm laptop with a high-definition screen (Apple Inc) with a 10-second display interval for each picture. During the evaluation, a spreadsheet was provided with the sequence of appearance numbered on the screen for each patient in the study with a space left blank for the evaluator to write down the perceived age of each patient. The photographs of each patient were randomly presented twice for each evaluator, without the evaluators being warned of this repetition so that they could evaluate the concordance of the evaluator between the respective observations. The evaluators were not allowed to go back in the presentation or to analyze each image for a longer time. The first presentation of the photograph of each person was referred to as photograph 1 and the second as photograph 2.

The results obtained for each photograph by each evaluator were compared to assess intraevaluator variability (photograph 1 vs photograph 2) and were also compared with the chronological age of each patient. The data were compared among the evaluators to perform an interevaluator assessment.

The initially proposed method for objective assessment, which can be used for evaluation of facial age in future scientific studies, was based on the judgment used in certain modalities of the Olympic games. This method, also known as trimmed mean, uses the results of the first assessment of facial age indicated by all 7 evaluators. For each photograph, the lowest and highest values suggested by the evaluators were discarded, and the mean of the 5 remaining values was kept. The tests were conducted initially using only photograph 1 and then only photograph 2. The results obtained by the 7 evaluators were compared with those obtained after discarding the extremes (lowest and highest values given for each photograph) to verify whether there were differences between the data obtained from all the evaluators when compared with the data obtained after the discarding. After this analysis, 3 evaluators were drawn at random, and the mean of the results of these 3 were compared with the mean obtained by the 7 evaluators after the discarding of the extremes (mean of the 5 remaining evaluators).

The intraevaluator analysis was performed with these 3 evaluators, with the means provided for photograph 1 compared with those of photograph 2. For the assessment of the

interevaluator agreement, the results obtained by each were compared. This analysis evaluated only photograph 1. The mean obtained for photograph 1 by the 3 evaluators was compared with the chronological age of each patient to verify the level of agreement.

A sample of 70 patients was calculated to detect a 50% difference in the SD in the age considering an α = .05 and a power of 90%. This sample served also as a control group to compare the chronological age of the patient with the perceived age. The data obtained were entered into the software program Excel (Microsoft Inc) and subsequently exported to the SPSS statistical software program, version 18.0 (IBM Inc) for statistical analysis. WINPEPI, version 11.63 (Hebrew University) was also used for statistical correction.

The categorical variables are provided as frequencies (percentages) and the quantitative variables as mean (SD). The comparisons of the means of each observer were performed by applying the *t* test for paired samples, with Bonferroni correction modified by Finner. $P < .05$ was considered statistically significant.

Results

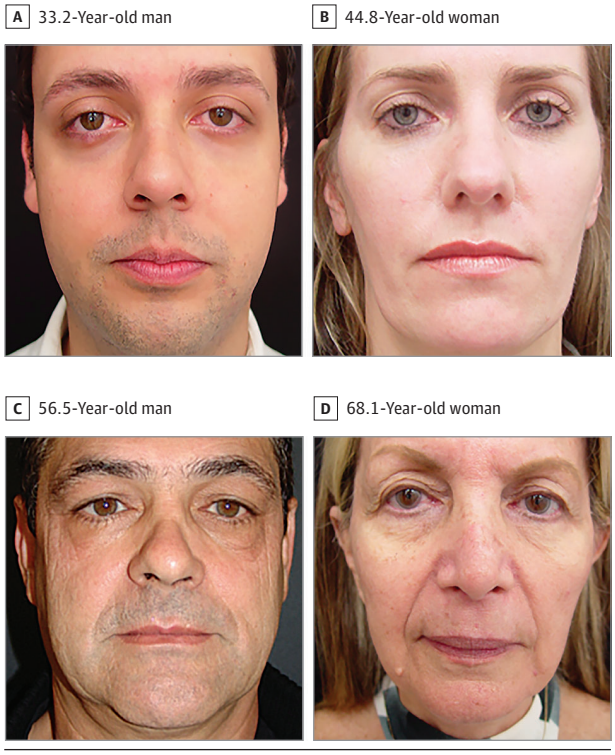
Photographs of 70 patients were evaluated (mean [SD] age, 41.5 [13.8] years; 48 women [68.6%]; and mean [SD] body mass index, 22.5 [2.7]). According to the Fitzpatrick phototyping scale, the enrolled patients have the following distribution: phototype I, 13 (18.6%); phototype II, 23 (32.9%); phototype III, 20 (28.6%); phototype IV, 7 (10.0%); phototype V, 5 (7.1%); and phototype VI, 2 (2.9%). The **Figure** shows the photographs of 4 patients in this study.

All the evaluators were plastic surgeons with 3 years of training in facial plastic surgery. Their mean (SD) age was 41.3 (4.1) years. The mean (SD) time they have been working in facial plastic surgery was 9.4 (3.8) years. The mean (SD) number of facial plastic surgery procedures each one performed during the past year of this research was 158.5 (22.6).

Initially, we assessed the results obtained by the 7 evaluators by comparing the mean (SD) age suggested by all the evaluators with the mean obtained after discarding the lowest and the highest values attributed by the evaluators, thereby providing the mean of the 5 evaluators. For photograph 1, the difference was 0.04 years (15 days), with no significant difference between the mean values obtained by the 7 and the 5 after discarding ($P = .50$). For photograph 2, the difference was 0.03 years (11 days), with no significant difference ($P = .69$) between the data provided by the 7 evaluators compared with the data obtained after the discarding. **Table 1** gives the age of the enrolled patients and the interquintile accuracy of the evaluators.

With the objective of making the assessment technique more practical, 3 evaluators were randomly chosen (lottery) (evaluators A, B, and C). The results obtained for photograph 1, which was evaluated by only 3 evaluators, revealed a difference of 0.16 years (58 days), with no significant difference between the means obtained by the 5 evaluators ($P = .52$). The same evaluation was performed using photograph 2. With 3 evaluators for photograph 2, the difference was 0.05 years (18 days), also with no significant difference in the means obtained by the 5 evaluators ($P = .86$).

Figure. Patient Photographs and Their Chronological Ages and Mean Perceived Ages



A, Chronological age of 33.2 years and mean perceived age of 32.7 years; B, chronological age of 44.8 years and mean perceived age of 44.7 years; C, chronological age of 56.5 years and mean perceived age of 57.1 years; and D, chronological age of 68.1 years and mean perceived age of 66.9 years.

For photograph 1 vs photograph 2 evaluations, the mean (SD) intraevaluator results (evaluator-perceived ages) were as follows: 41.3 (1.3) vs 41.5 (1.5) years for evaluator A ($P = .63$, paired *t* test), 40.2 (0.2) vs 41.1 (1.1) years for evaluator B ($P = .21$, *t* test), and 40.8 (0.8) vs 41.2 (1.2) years for evaluator C ($P = .45$, *t* test). When only photograph 1 was evaluated, the mean (SD) interobserver results (evaluator-perceived ages) were 41.3 (12.9) vs 40.2 (16.1) years for evaluator A vs B ($P = .17$), 41.3 (12.9) vs 40.8 (16.5) years for evaluator A vs C ($P = .55$), and 40.2 (16.1) vs 40.8 (16.5) years for evaluator B vs C ($P = .49$).

Table 2 gives the differences between the chronological age and the evaluator-perceived age for photograph 1. A significant difference between the means of photograph 1 were not observed for any of the 3 observers when compared with the chronological age of the people evaluated. The same was observed after calculating the mean of the data obtained by the 3 evaluators. The difference between the mean obtained by the 3 evaluators and the chronological age was only 0.8 years (<10 months), with all suggesting values that were slightly lower than the chronological age.

Table 1. Patient Age and Interquintile Evaluator Accuracy[a]

No. of Observers	Interquintile Accuracy by Patient Age, %				
	18-30 y (n = 17)	31-40 y (n = 18)	41-50 y (n = 12)	51-60 y (n = 13)	61-70 y (n = 10)
7	98.1	97.7	98.3	98.6	99.2
5	98.8	98.0	98.5	98.8	99.4
3	98.5	98.3	98.2	99.1	99.5

[a] Significant differences in the interquintiles suggested for photograph 1 were not observed when comparing 7, 5, or 3 evaluators, revealing interobserver agreement.

Table 2. Comparison of Evaluator-Perceived Age for Photograph 1 With Chronological Age

Evaluator	Evaluator-Perceived Age for Photograph 1, Mean (SD), y	Chronological Age, Mean (SD), y	95% CI of the Difference	*P* Value[a]
A	41.3 (12.9)	41.5 (13.8)	−1.42 to 0.91	.66
B	40.2 (16.1)	41.5 (13.8)	−2.75 to 0.10	.24
C	40.8 (16.5)	41.5 (13.8)	−2.24 to 0.73	.39
Mean	40.7 (14.7)	41.5 (13.8)	−1.77 to 0.21	.24

[a] Paired *t* test with Bonferroni adjustment. A significant difference between the means for photograph 1 were not observed for any of the 3 observers when compared with the chronological age of the people evaluated.

Discussion

Aesthetic procedures are difficult to assess in an evidence-based manner because of subjective outcomes.[8] The validated criterion standard scale for facial aging measurement and response to rejuvenation procedures is still lacking.[2,6] Numerous rating systems, including photographic aging signs, wrinkles, pigmented spots, and telangiectasia, have been described; nevertheless, almost all of them remain nonvalidated and their heterogeneity difficult to analyze across different studies, and most of them permit only intrastudy comparisons.[9] Our study found that by applying a simple, cheap, and easily reproducible method, it is possible to make an accurate estimate of the apparent age by a person's face. This finding is important when seeking to improve the level of evidence for scientific articles on plastic surgery, in particular when conducting meta-analyses to adequately evaluate the results of different studies.

Perceived age can be defined as the age that a person is visually estimated to be based only on physical appearance. A youthful appearance is a valuable characteristic in our society. In addition, perceived age is also an indicator of overall health status in elderly people because old-looking people tend to have higher rates of morbidity and mortality.[10] To satisfy the need for objective approaches when estimating perceived age, a novel protocol was described in our article. Our protocol was originally designed with the participation of 7 evaluating plastic surgeons. On obtaining these 7 evaluations, we discarded the highest and lowest ages indicated for each of the 140 photographs evaluated. We found that, even when considering the evaluation of 5 surgeons, the mean obtained was not significantly different in statistical terms when compared with the evaluation of the initial 7 evaluators. We then compared the data from 3 evaluating plastic surgeons, which were randomly chosen from our database, and we found no statistically significant difference (3 random; mean, 40.89; 7 evaluators; mean, 40.74; $P = .78$) between the mean age perceived by them when compared with the mean of the 7 initial evaluators. Thus, we observed that, from a statistical perspective, the evaluation given by 3 plastic surgeons is sufficient to have a high level of efficiency in the estimation of perceived age, which will allow us to make rational use of financial resources for medical research, reducing costs that result from the use of more professionals for the evaluation.

Previous studies[2,6,11-17] have found that the ability to perceive age correctly is accurate and consistent; however, in most studies, reliability between photographs used for intraindividual and interindividual comparisons is not detailed. However, several of these studies[10,11] used groups with up to 50 nonmedical observers as evaluators in each publication, which is inappropriate when the intention is to perform an assessment in private clinic patients who ideally should not have their identities revealed. Replacing those 50 nonmedical evaluators with 3 plastic surgeons will provide greater protection of the confidentiality of each patient by upholding the Hippocratic oath.

Our study used statistical analysis to validate data and measurements in addition to standardizing the evaluation protocol. We chose to repeat each of the 70 photographs used in our protocol to verify the agreement of the perceived age of each observer. When analyzing the results, we noticed that there was no statistically significant difference between the first and the second time each photograph was shown to each plastic surgeon. Therefore, our findings indicate that the internal validity of our method is extremely reliable.

The appearance of faces can be strongly affected by the characteristics of faces viewed previously; these perceptual aftereffects reflect processes of sensory adaptation.[18] In a specific study,[19] after adapting to younger or older faces, faces of all ages appeared 2 to 3 years older or younger to nonmedical observers, respectively. By using plastic surgeons as evaluators, we chose to have an assessment by professionals with extensive experience in observing facial age, thus reducing the possibility of such perceptual aftereffects.

Each decade in life is associated with progressive facial changes. In the 40s, some early jowling, submental laxity,

and the presence of a nasolabial fold can be noted. After the fifth decade of life, jowling becomes pronounced, platysma bands start to appear, and nasolabial folds deepen. In the 60s, midface descent is pronounced, producing obvious jowling, platysma bands are evident, and deepened nasolabial folds can be observed.[20,21] Training in surgical facial rejuvenation procedures and minimally invasive techniques, such as fillers and botulinum toxin associated with daily practice, makes it possible for experts in plastic surgery to be able to identify the changes in facial appearance that occur over time. Our study suggests that plastic surgeons can estimate the age of a person by viewing a photograph with a mean accuracy of approximately 10 months. Notably, all evaluators suggested slightly younger chronological ages (agreeing with each other). The comparison with the control group (patients' real chronological age) found that plastic surgeon evaluation rates have reached an accuracy level sufficient to prove that they are able to perceive a person's facial age. Because the probability of identifying at least 1 significant result attributable to chance increases as more hypotheses are tested,[22] we used the Bonferroni correction to prove that our results were accurate.

Limitations

This study has numerous limitations. The method used in our study relies solely on subjectivity and the intuitions of these specific plastic surgeons. Additional studies must be performed to evaluate the external validity of our data. All volunteers agreed to have their photographs used for research purposes, which may create a selection bias. Although there was strong statistical significance to the data, a larger patient population would be desirable for more conclusive findings. Low Fitzpatrick phototype correlates with premature aging.[23] In our study, 56 (79.8%) of the enrolled patients had skin phototypes I to III; perhaps with another skin phototype distribution the results could be different. There may have been personality differences among the evaluating plastic surgeons, which could have influenced their perception of the photographs.[24]

The application of an outcomes research method to facial aesthetic surgery may allow plastic surgeons to better define the success or failure of each facial procedure.[25,26] In the future, the method of evaluation proposed in this study should be performed by other researchers to estimate the perceived age difference when comparing photographs before and after facial procedures. The perceived age difference can be defined as the difference between the chronological age and the perceived age.[13] The change in this value after facial rejuvenation procedures will be the main outcome of interest in future studies.

Conclusions

The results for the intraevaluator and interevaluator agreement suggest that 3 plastic surgeons can estimate the age of a person by analyzing a photograph with a margin of error of 10 months. It is not necessary to assess with additional observers or to discard the extreme values. This article addresses an issue that is important to facial plastic surgeons and reveals how the results of rejuvenation procedures can be assessed.

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Study concept and design: Valente, da Silva, Padoin.
Acquisition, analysis, or interpretation of data: All authors.
Drafting of the manuscript: All authors.
Critical revision of the manuscript for important intellectual content: Valente, da Silva.
Statistical analysis: Valente, da Silva, Lerias, Rossi.
Administrative, technical, or material support: da Silva.
Study supervision: da Silva.

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Additional Contributions: The plastic surgeon evaluators were as follows: Eduardo Chem, MD, MSC, Gustavo Pereira Filho, MD, MSC, Darwin Rech, MD, André Valiati, MD, Vinicius Ribeiro, MD, Angelo Pretto, MD, MSC, and Rodrigo Dreher, MD. None received financial compensation for their services. We thank the patients for granting permission to publish this information.

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