The Laryngoscope

Nasal Tip Projection and Facial Attractiveness

Zlatko Devcic, BS; Benjamin A. Rayikanti; Jesse P. Hevia; Natalie A. Popenko, BS; Koohyar Karimi, BS; Brian J.F. Wong, MD, PhD

Objectives/Hypothesis: Six nasal tip projection (NTP) ratios from Goode, Simons, Baum, Powell, and Crumley guide clinical and academic practice on quantifying NTP, but none have been empirically correlated with facial attractiveness. This study's objectives were to determine: 1) if there is a correlation between these ratios and facial attractiveness; and 2) which of the six ratios has the greatest linkage to overall facial attractiveness.

Study Design: Basic research study.

Methods: There were 300 digital portraits of women (ages 18–25 years) randomly paired and morphed to create 300 synthetic lateral facial images rated by 78 raters in the community. NTP ratios were measured in each portrait.

Results: None of the ratios correlated with facial attractiveness. For the Baum, Powell, and Simons ratio, facial attractiveness increased as NTP deviated 1 and 2 standard deviations from the ideal, whereas facial attractiveness decreased as NTP deviated from the Goode and Crumley ideal ratios. The most attractive faces had NTP ratios consistent with previous expert opinion findings.

Conclusions: To our knowledge, this is the first study to empirically correlate these six landmark NTP ratios with facial attractiveness. Although there was no correlation with any of the six ratios, the ideal ratios proposed by Goode and Crumley impacted facial aesthetics the most. Although the ideal ratios are useful in establishing rhinoplasty guidelines, they should only be used as a part of the management in achieving an aesthetic face on the whole, as they may not be robust enough to correlate with overall facial attractiveness.

Key Words: Facial beauty, nasal tip projection, focus groups, plastic surgery, attractiveness, facial beauty rating, lateral facial aesthetics.

Level of Evidence: 5.

***Laryngoscope,* 121:1388–1394, 2011**

INTRODUCTION

Rhinoplasty is still one of the most common and challenging surgical procedures performed in the field of plastic surgery, and developing rigorous quantitative methods to analyze nasal geometry continues to be a clinical challenge. In lateral profile analysis there are various numerical metrics used to describe the nose, such as the nasofrontal angle, nasofacial angle, and nasal tip projection (NTP). Evaluating NTP is extremely important because it aids in reconstructing or correcting the nasal tip, preoperative planning, postoperative evaluation of results, and guides report of results, documentation, and teaching. Inasmuch as NTP is intuitive to formulate on inspection, quantitative description is a challenge as there is no clear landmark to use as a stationary reference point, the projection of the chin and geometry of the lip figures into the calculus, and NTP and tip rotation are intimately related. The nose should also, as Dr. Toriumi described, have contours that draw attention toward the eyes and other facial features.[1] Although there is no established method to quantify NTP, six methods used to measure NTP, as described below, have gained traction in the literature.

The ideal NTP as described by Baum is a 2:1 ratio of a vertical line from the nasofrontal angle to the vertex of the nasolabial angle that ends at the perpendicular junction to a line passing through the tip defining point (Fig. 1A).[2] Similarly, Powell and Humphreys used the same perpendicular lines, but measured the entire vertical line from the nasofrontal angle to the nasolabial angle and stated that the ratio should be 2.8:1 (Fig. 1B).[3] A third method described by Simons includes the upper lip, stating that the ratio of the upper lip should be equal to the base length of the nose in a 1:1 ratio (Fig. 1C).[4] Incorporating the length of the upper lip into the measurement is an important element distinguishing his method from others. A fourth method attributed to Goode uses a 3-4-5 triangle. One side of the triangle is from the nasofrontal angle through the alar crease, the second a perpendicular line going through the tip defining point, and the third is a line drawn to complete the right triangle using the nasal dorsum (Fig. 1D).[3]

From the Division of Facial Plastic Surgery, Department of Otolaryngology–Head and Neck Surgery (Z.D., B.A.R., J.P.H., N.A.P., K.K., B.J.F.W.), University of California–Irvine, Orange, California; Beckman Laser Institute and Medical Clinic (B.J.F.W.), University of California–Irvine, Irvine, California, and Department of Biomedical Engineering (B.J.F.W.), University of California–Irvine, Irvine, California, U.S.A.

Editor's Note: This Manuscript was accepted for publication March 2, 2011.

Oral presentation at the Combined Sections Meeting of the Triological Society, Scottsdale, Arizona, U.S.A., January 28, 2011.

All work in this study was done at the Beckman Laser Institute, University of California–Irvine, Irvine, California, U.S.A.

Send correspondence to Brian J.F. Wong, MD, Beckman Laser Institute, University of California–Irvine, 1002 Health Sciences Rd., Irvine, CA 92612. E-mail: bjwong@uci.edu

DOI: 10.1002/lary.21804

Fig. 1. Each of the six nasal tip projection ratios as defined by Baum (A), Powell (B), Simons (C), Goode (D), Crumley 1 (E), and Crumley 2 (F).

Finally, in a study by Crumley two new NTP ratios were proposed.[5] The first method (Fig. 1E) included a line from the nasion to vermilion-cutaneous junction of the upper lip to the vertex of the nasofrontal angle, and a second line perpendicular to this through the tip defining point. The ratio of the vertical line to the perpendicular line should be 3.53. The second method (Fig. 1F) uses Goode's triangle but extends the posterior line through the mandibular profile. The ratio of the posterior line to the perpendicular line should be 4.23. The novelty of the Crumley ratios is that they relate the upper lip length and the nasal length (method 1) and overall facial height (method 2) to NTP.

Although these ratios were developed by expert surgeons and have proven to be of practical value in rhinoplasty, there is no empiric data on whether these ratios correlate well with overall facial attractiveness as determined by the general population rather than focus groups consisting of expert evaluators. Further, there has never been a head-to-head analysis of these six ratios using the same quantitative measuring system to determine which ratio has the most utility and linkage to overall facial attractiveness. As contemporary views on beauty change and society grows more ethnically diverse, it is important to continually re-evaluate these methods, and empirically challenge them with population-based studies. Modern studies have shown there are differences in facial anthropometrics between various ethnicities, including those of the nose,[6–8] and thus we narrowed our analysis to Caucasian woman to limit the impact of race on our analysis. The objectives of this study were twofold: 1) to determine if there is a correlation between these six ratios and facial attractiveness as determined by the general population, and 2) to determine which of the six ratios has the greatest utility and linkage to overall facial attractiveness.

MATERIALS AND METHODS

Photographs and Subjects

All facial portraits were used with the approval of the institutional review board at the University of California–Irvine. To obtain a wide range of NTP, 300 digital portraits were taken of Caucasian women between the ages of 18 and 25 years. Volunteers with craniofacial abnormalities such as cleft lip were not used in the study. Study participants were recruited from various student associations, sororities, medical student associations, and from the placement of a booth within the University of California–Irvine student center. A total of 300 female Caucasian volunteers were photographed under standard conditions with the face oriented along the Frankfort horizontal plane on a neutral background. When necessary, participants used a headband to fully expose their face including the ears and trichial line and a barber's cape around the neck to minimize clothing in the photograph. Subjects were asked to maintain a neutral facial expression and to remove all cosmetic make-up, earrings, and other piercings to appear as clean as possible. A digital camera (Rebel XT, 100 mm macro lens; Cannon USA, Lake Success, NY) with either flash or ambient artificial lighting was used to obtain all photographs at a standardized distance of approximately 6 feet from the subjects.

Creating Synthetic Photographs

The facial photographs used in this study are part of a larger photograph database managed by the lead author under approval of the institutional review board at the University of California–Irvine. This database is continually used for several ongoing facial analysis projects. Presenting the actual subject photographs in public venues would require an extensive written informed consent document as well as additions to the original institutional review board requiring approval. Both of these processes would severely limit the accrual of subjects, decrease the number of photographs within the overall database, and decrease the power of facial analysis studies. However, the University of California–Irvine institutional review board does permit the use of photographs that have been digitally modified, such as synthetic facial images created by morphing software.[9,10] Thus, we decided to use 300 synthetic lateral facial images for this study, which were created as described below. To ensure that the morphing process used to create these synthetic faces does not significantly change NTP from real photographs, all six NTP ratios were compared between 100 photographs of real subjects and the 300 synthetic morphed images, and there was no significant difference between any of the six ratios for these two groups ($P > .05$).

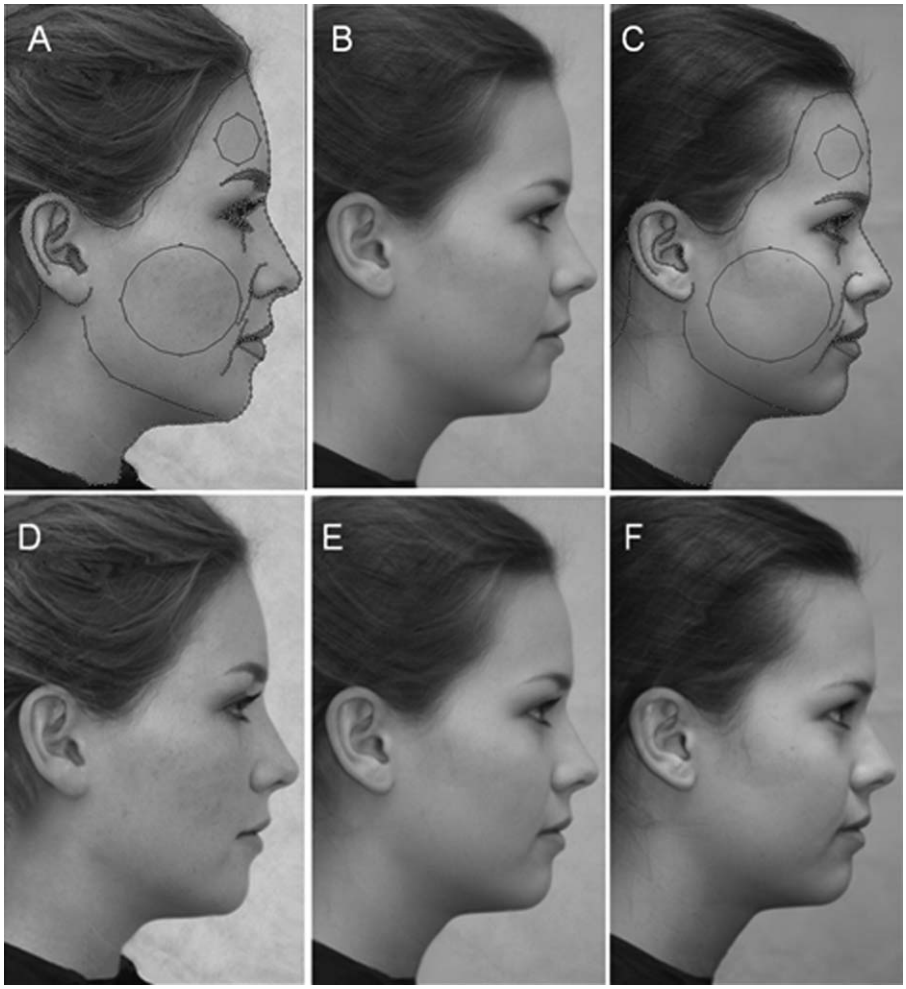

Fig. 2. Two facial images (D and F) are morphed together to create a synthetic face (E) that is a 50:50 average of the original two. (A, B, C) Pictures demonstrate the registry points necessary for this process.

Synthetic lateral facial images were created with a morphing process that transforms two lateral facial images into a third that is a 50:50 synthetic morph of the original two (Fig. 2D, 2E, 2F). These morphing algorithms are based on the user marking the prominent features of the face with registry points (Fig. 2A, 2B, 2C). The program then matches the corresponding registry points on each of the faces and morphs them to create a third image that is a 50:50 average of all corresponding registry points. Although the third image is a synthetic morph, it is a realistic and natural appearing face. We selected Morphman 2000 (STOIK Imaging LTD, Moscow, Russia) because it is a low-cost program, easy to use, and capable of intricately outlining all of the necessary nasal points of interest on a lateral facial photograph, along with other features such as the eyes, lips, and chin. More examples of morphing can be found in our original paper.[9] In this study, 300 original lateral photographs of Caucasian woman were randomly paired to create 300 synthetic lateral facial portraits through morphing.

Focus Group Evaluations

Each of the 300 photographs was scored from 1 (unattractive) to 10 (attractive) by 78 focus group raters in the local community. The raters were recruited from local hospitals, schools, and other community organizations. Prior to scoring the faces, the evaluators were shown a visual analogue scale for facial beauty with one face representing each score from 1 to 10. The aim of this visual analogue scale was to encourage a more consistent evaluation approach by the raters. The raters were not presented any other information on our research project. The scoring process used was the focus group approach. Each of the 300 synthetic lateral facial portraits was scaled in a PowerPoint (Microsoft, Redmond, WA) presentation to standardize the size of the images and presented in a random order, one at a time, on a projection screen using an LCD projector for approximately 8 seconds per portrait. Each individual in the focus group manually recorded their score on a sheet of paper. All 78 scores for each of the images were averaged so that each face had an average facial attractiveness score comprised of 78 raters.

NTP Measurements

All facial portraits were scaled to the same size using Microsoft Paint (Microsoft) and printed using a color laser printer. Each of the eleven nasal measurements: A-B, A-C, A-E, D-F, C-E, A-Y, A-Z, A-D, B-D, Y-D, and C-D, as shown in Figure 1, were measured on each of the 300 faces using a standardized ruler. Measurement A is the nasofrontal angle, B is the location where the perpendicular line AC intersects the line through the tip defining point, C is the vertex of the nasolabial angle, D is the tip defining point, E is the vermilion-cutaneous junction of the upper lip, F is the location where the perpendicular line AE intersects the line through the tip defining point, Y is the vertex

TABLE I.
Nasal Tip Projection Measurements and Facial Attractiveness Correlations for Each of the Six Ratios (N = 300 Facial Portraits).

	Baum	Powell	Simons	Goode	Crumley 1	Crumley 2
Ideal ratio	2	2.8	1	0.55–0.60	3.53	4.23
Average ratio	2.25	2.96	1.57	0.63	3.54	4.41
Standard deviation	0.23	0.25	0.25	0.065	0.32	0.30
Minimum	1.36	1.8	1	0.43	2.11	2.81
Maximum	3.07	4	2.87	1.33	4.61	6.25
Correlation	0.097	0.088	0.04	0.18	0.063	0.03

of the 90-degree angle of the right triangle in Goode's ratio, and Z is the point where the posterior line of Goode's triangle intersects the mandibular profile. One investigator (J.P.H) performed all of the measurements, and a second investigator (Z.D.) verified the measurements. These measurements were used to tabulate the six NTP ratios for each of the 300 faces.

Statistical Methods

Correlation analysis was used to compare NTP ratios as a function of overall facial attractiveness, and a correlation coefficient was determined for each of the six ratios. Linear regression and correlation analysis was also performed for each of the eleven nasal measurements with facial attractiveness. A significance level of .05 was used. For each of the six ratios the average NTP, standard deviation, minimum, and maximum were also determined for the entire cohort of 300 faces. The average NTP ratio was also determined for the top 11 most attractive faces and the bottom 10 most unattractive faces. Eleven attractive faces were used instead of 10 because two faces had the lowest of the top ten scores. Finally, attractiveness scores were calculated as a function of deviating 1, 2, and 3 standard deviations away from the ideal NTP for all 300 faces, as well as for the 10 faces closest to and 10 furthest away from the ideal NTP. Because the ideal NTP for the Goode method is a range (0.55–0.60), all 72 faces that fit within this range were included in the analysis of those faces closest to the ideal.

RESULTS

The NTP measurements for each of the six ratios, including the average, minimum, maximum and standard deviation for the 300 faces is listed in Table I. The last column in Table I lists the correlation coefficient between NTP and facial attractiveness. Although the Goode ratio has the strongest correlation with facial attractiveness, none of the six ratios correlate with facial attractiveness scores. Table II provides a correlation and regression analysis for each of the individual nasal measurements and facial attractiveness. Although A-Z and A-D have a statistically significant linear regression with facial attractiveness, none of the individual measurements correlate with attractiveness.

Table III tabulates NTP for the top 11 most attractive faces and bottom 10 most unattractive faces of the 300. Figure 3 demonstrates five of the 11 most attractive and five of the 10 most unattractive faces. The most attractive faces have an NTP that deviates further away from the ideal Baum and Powell ratios than the most unattractive faces, whereas NTP for both the most attractive and unattractive faces deviates away from the Simons' ideal a similar amount. On the other hand, the attractive faces have NTP that is closer to the ideal Goode and both Crumley ratios than the unattractive faces. Crumley's second ratio has the largest difference in NTP between the attractive and unattractive faces.

Table IV demonstrates facial attractiveness as a function of standard deviations away from the ideal NTP for each of the ratios. For the Baum and Powell ratios facial attractiveness increased as NTP deviates 1 and 2 standard deviations away from the ideal, and then decreases as faces deviate 3 standard deviations from the ideal. For the Simon's ratio facial attractiveness continues to increase as NTP deviates 1, 2, and 3 standard deviations away from the ideal. For the Goode and both of the Crumley methods, on the other hand, facial attractiveness continually decreases as faces deviate 1, 2, and 3 standard deviations from the ideal. If this analysis is limited to those 10 faces closest to and furthest away from the ideal ratios for the Goode and both Crumley methods, this trend is magnified, with the second Crumley method demonstrating this trend the most (Table V).

DISCUSSION

Successful rhinoplasty involves not only an enhancement of the individual features of the nose, but also a thorough understanding of how changing these features will enhance the proportions and achieve balance with the rest of the face. A rigorous quantitative foundation in nasal anthropometrics is key to this process, and although various methods have been proposed to measure NTP, there is no well-defined standard. The current methods available have not been empirically tested in population-based studies to assess their effect on overall facial attractiveness and to determine which has the greatest utility and linkage to overall facial beauty. In answering the first objective of this study, it is evident by the correlation coefficients that none of these six ratios correlated well with facial attractiveness. In fact, our data demonstrates that both attractive and

TABLE II.
Regression and Correlation Analysis for Each of the 11 Nasal Measurements (N = 300 Facial Portraits).

Measurements	A-B	A-C	A-E	C-E	A-Y	A-Z	A-D	B-D	F-D	Y-D	C-D
Regression (*P* value)	0.24	0.26	0.22	0.26	0.13	0.0016	0.034	0.74	0.35	0.44	0.18
Correlation coefficient	0.046	0.025	−0.035	−0.075	0.026	−0.13	0.065	−0.046	0.061	−0.08	−0.031

TABLE III.
Average Nasal Tip Projection Measurements for All 300 Faces, the Top 11 Most Attractive Faces, and the Bottom 10 Most Unattractive Faces.

	Baum	Powell	Simons	Goode	Crumley 1	Crumley 2
Ideal ratio	2	2.8	1	0.55–0.60	3.53	4.23
300 faces	2.25	2.96	1.57	0.63	3.54	4.41
Most attractive	2.28	2.94	1.70	0.61	3.51	4.27
Most unattractive	2.14	2.86	1.73	0.70	3.42	4.43

unattractive faces can have NTP that is over- and under-projected. The absence of a correlation between NTP and facial attractiveness is likely due to the importance of other facial proportions and features such as nasofrontal angle, nasolabial angle, chin and forehead angulation, and overall facial balance in achieving lateral aesthetics. For example, it has been shown that 15% of individuals who undergo rhinoplastic procedures could benefit from augmentation or reduction of the chin,[11,12] and a study by Kim demonstrated that the size of nasal width has an effect on determining the ideal size of the nasal tip.[13] In short, NTP as assessed by these methods may not integrate other key features of the face sufficiently to explain overall attractiveness. Although regression analysis of each individual nasal measurement with facial attractiveness demonstrates statistical significance between measurements A-Z (the line from the nasofrontal angle to the intersection with the mandibular profile) and A-D (the line from the nasofrontal angle to the tip defining point), both of these measurements had weak correlations with facial attractiveness. Again, although it is evident these two measurements are most predictive of facial attractiveness, there is a lack of correlation because there are other facial proportions that are important in determining overall facial attractiveness. With the methods currently available to assess NTP, it is possible to have over- and under-projected NTP in both unattractive and attractive faces, and these methods do not integrate other facial proportions sufficiently to achieve a correlation with overall facial attractiveness.

The core importance of ideal NTP as defined by these ratios is best demonstrated by subdividing the 300 faces into the most unattractive and attractive faces. This subdivision into the top 11 most attractive faces and bottom 10 most unattractive faces demonstrates that the average NTP of the attractive faces is similar to the ideal ratios proposed by Goode and Crumley, whereas the average NTP for the unattractive faces deviates from their ideal ratios (Table II). In this study the Goode ratio for the most attractive faces was 0.61, which is slightly above the ideal range proposed by Goode, but is in agreement with the only other study, by Crumley, that empirically evaluated all six ratios with

Fig. 3. Examples of five of the 10 most unattractive faces in the top row and five of the 11 most attractive faces in the bottom row. Average facial attractiveness scores are in the bottom right in each facial portrait.

TABLE IV.
Facial Attractiveness as a Function of Standard Deviations Away From the Ideal Nasal Tip Projection Ratio.

	Baum	Powell	Simons	Goode	Crumley 1	Crumley 2
1 StDev	4.06	4.10	3.96	4.16	4.12	4.11
2 StDev	4.21	4.14	4.10	3.90	4.11	4.09
3+ StDev	4.14	4.11	4.14	3.78	4.08	3.86

StDev = standard deviation.

the opinions of five experienced and well-known rhinoplasty surgeons, and suggested that Goode's ratio should be 0.60.[5] On the other hand, the most attractive faces in this study did not have NTP ratios similar to the ideal ratios proposed by the Powell and Baum methods. Instead, the unattractive faces have and NTP closer to the Baum and Powell ideal ratios than the attractive faces. Although this finding is initially surprising, it is also in agreement with the findings of Crumley, which suggested the ideal Powell ratio should be 3.02 instead of 2.80 and the Baum ratio should be 2.55 instead of 2.0. In our study the most attractive faces have ratios of 2.94 for the Powell method and 2.28 for the Baum method, and the unattractive faces have ratios of 2.86 and 2.14, respectively. These findings suggests that the tip should actually be more under-projected than originally proposed by the ratios of Baum and Powell. For the Simons' method, both the unattractive and attractive faces deviated from the ideal ratio similarly. The data in this study agrees with the Crumley finding that the base of the nose should be longer than the 1:1 ratio originally proposed by Simons; however, the ideal length of the base is inconsistent between this study and the study by Crumley. The most attractive faces in this study have a ratio of 1.70, whereas those in the Crumley study had a ratio of 1.58. Of the six methods used in this analysis, the second ratio proposed by Crumley increases facial attractiveness the most, suggesting this ratio may have the largest impact on overall lateral aesthetics. These population-based findings suggest that the ideal ratios proposed by Goode and Crumley are best at accurately defining ideal NTP in attractive faces, whereas the ratios proposed by Powell, Baum, and Simons may need modification, as suggested previously by expert-opinion findings.

When facial attractiveness is tabulated as a function of standard deviations away from the ideal, it is evident that as faces deviate away from the ideal ratios proposed by Goode and Crumley, overall facial attractiveness scores decrease for the entire cohort of 300 faces. This trend does not hold true for Baum, Powell, and the Simons' ratio, for which facial attractiveness scores actually increase as the faces deviate 1 standard deviation away from the ideal (Table IV). If this analysis is confined to the 10 faces that have an NTP closest to and furthest from the ideal as defined by Goode and Crumley, this trend is magnified, with the second Crumley method demonstrating this trend the most (Table V). This data analysis supports the finding that the ideal ratios as proposed by Goode and Crumley may be a core component to an attractive face, and that these ratios can impact lateral facial beauty the most. The Goode and Crumley methods may be better at defining lateral facial attractiveness because their ratios for ideal NTP incorporate total nose length, total face height, and the nasal alar crease. Because other features and facial proportions are important for determining facial beauty, it comes as no surprise that the ratios that include other key features of the face, such as total face height and alar crease, impart the greatest impact on overall facial attractiveness. In fact, it is evident from Table II that the length of the nasal dorsum and length of the line from the nasofrontal angle through the mandibular profile line are statistically significant measurements of facial attractiveness, and both of these are included in the ratios proposed by Goode and Crumley, respectively. Out of these six ratios, the second method proposed by Crumley increased facial attractiveness the most, suggesting that incorporating total face height into NTP is important in achieving overall facial attractiveness.

This study has included a very large sample size of a particular demographic, as well as maximized the number of focus group raters to increase its clinical practicality and the power of its results. In addition, although it has performed the first population-based approach to empirically testing all six ratios, it has limitations that merit discussion. First, although there was a broad range of NTP for each of the six ratios, the sample sizes of the more extreme ratios may need to be larger to detect even greater differences in attractiveness score. This is a particularly challenging hurdle to overcome because our cohort of faces was limited to Caucasian females, and large numbers of extreme NTP may need an even greater sample size. Second, our focus groups rated 300 faces within approximately 50 minutes, and with such repetition it is possible that their scores approach an average toward the end of the session, and thus a greater spread in facial attractiveness scores is not achieved. Similarly, because we limited our study to Caucasian females the faces may not have differed from each other enough to create a larger spread in facial attractiveness scores. The third limitation may explain why trends are magnified when the most attractive and unattractive faces are compared to each other. Fourth, this study endeavored to correlate NTP with overall facial attractiveness, and thus the focus group raters evaluated the entire face in assigning an attractiveness score, not only the nose. In the study by Crumley from 1988, the expert evaluators evaluated only the nose. Therefore, our study assesses NTP indirectly, and the findings of this study are not a direct assessment of the NTP preferences of the focus groups. Alternatively,

TABLE V.
Facial Attractiveness for the 10 Faces Closest to and 10 Furthest Away From the Ideal Ratio (Goode Ratio, N = 72).

	Goode	Crumley 1	Crumley 2
Closest	4.204	4.32	4.902
Furthest	3.733	4.139	3.79

the advantage of this indirect approach is that NTP is evaluated in the context of overall facial attractiveness, and the utility and linkage of these six ratios can also be assessed within this broader picture.

CONCLUSION

In an effort to improve the quantitative assessment of NTP, this study investigated two objectives: 1) to determine if there is a correlation between the six landmark ratios for measuring NTP and facial attractiveness, and 2) to determine which of the six ratios has the greatest utility and linkage to facial attractiveness. The results of this study have shown that NTP alone, as evaluated by these methods, does not correlate with overall lateral facial attractiveness. Although good NTP may be important in achieving an attractive face, there are other facial features and proportions in addition to NTP that are necessary to increase overall lateral facial beauty. In determining which of the six ratios has the greatest linkage to facial attractiveness, our results are similar to the only other study to evaluate these six ratios in a head-to-head analysis based on expert opinion, with the ratios proposed by Goode and Crumley most accurately defining good NTP in attractive faces. The original methods proposed by Powell, Baum, and Simons, as also suggested in the study by Crumley, may need further fine tuning to determine the ideal ratio. The methods proposed by Goode and Crumley may impart the greatest impact on overall facial attractiveness because they integrate other facial features such as alar crease and total facial height into their analysis. In clinical practice these findings stress the value of using a rigorous quantitative technique to evaluate the individual steps of rhinoplasty, such as altering NTP, but also reinforce the importance of achieving balance with all facial proportions to maximize beauty. In the academic practice of facial plastic surgery, these findings suggest that the methods proposed by Goode and Crumley are the most useful in teaching, as they have the best expert and population-based evidence. Similarly to the changing role of the neoclassical canons, as meticulous academic studies have questioned their accuracy and role in the contemporary practice of facial plastic surgery, it is important to empirically test the current methods used to quantifying facial beauty. This study demonstrates that the methods proposed by Goode and Crumley perform well in determining the NTP of attractive faces, but developing future methods of quantifying the face should use a three-dimensional approach that accounts for overall balance and proportion. This is the future direction of our research.

Acknowledgments

We would like to thank all of the students in Dr. Wong's facial beauty research group at University of California–Irvine, including Ashley Hamamoto, Tiffany Liu, and David Avila, as well as all of the individuals in the focus groups that participated in the study, and Dr. Mary Jane Niles at USF.

BIBLIOGRAPHY

1. Toriumi DM. New concepts in nasal tip contouring. *Arch Facial Plast Surg* 2006;8:156–185.
2. Baum, S. Introduction. *Ear Nose Throat J* 1982;61:426–428.
3. Powell N, Humphreys B. *Proportions of the Aesthetic Face*. New York, NY: Thieme-Stratton; 1984:21.
4. Simons R. Nasal tip projection, ptosis, and supratip thickening. *Ear Nose Throat J* 1982;61:452–455.
5. Crumley RL, Lanser M. Quantitative analysis of nasal tip projection. *Laryngoscope* 1988;98:202–208.
6. Sim RS, Smith JD, Chan AS. Comparison of the aesthetic facial proportions of southern Chinese and white women. *Arch Facial Plast Surg* 2000;2:113–120.
7. Choe KS, Yalamanchili HR, Litner JA, Sclafani AP, Quatela VC. The Korean American woman's nose: an in-depth nasal photogrammatric analysis. *Arch Facial Plast Surg* 2006;8:319–324.
8. Choe KS, Sclafani AP, Litner JA, Yu GP, Romo T III. The Korean American woman's face: anthropometric measurements and quantitative analysis of facial aesthetics. *Arch Facial Plast Surg* 2004;6:244–252.
9. Wong BJ, Karimi D, Devcic Z, McLaren CE, Chen WP. Evolving attractive faces using morphing technology and a genetic algorithm: a new approach to determining ideal facial aesthetics. *Laryngoscope* 2008;118: 962–974.
10. Devcic Z, Karimi K, Popenko N, Wong BJ. A web-based method for rating facial attractiveness. *Laryngoscope* 2010;120:902–906.
11. Millard DR. Adjuncts in augmentation mentoplasty and corrective rhinoplasty. *Plast Reconstr Surg* 1965;36:48–61.
12. Simons RL, Lawson W. Chin reduction in profileplasty. *Arch Otolaryngol* 1975;101:207–210.
13. Kim DW, Biller JA. A contemporary assessment of facial aesthetic preferences. *Arch Facial Plast Surg* 2009;11:91–97.