

Title: Nasofrontal angle and nasal dorsal aesthetics: A quantitative investigation of idealized and normative values

ABSTRACT

Background: A quantitative evaluation of the influence of the lower component of the nasofrontal angle on perceived attractiveness and threshold values of desire for rhinoplasty.

Methods: The nasofrontal angle of an idealized silhouette male Caucasian profile image was altered incrementally between 106° to 148°. Images were rated on a Likert scale by pre-treatment patients (n=75), laypeople (n=75), and clinicians (n=35).

Results: The results demonstrate that a nasofrontal angle of approximately 130° is ideal, corresponding to a lower component of 60°, with a range of 127° to 142° deemed acceptable. Angles above or below this range are perceived as unattractive, and anything outside the range of 118° to 145° is deemed very unattractive. Reduced nasofrontal angles, simulating a nasal hump deformity, of less than 115° were deemed the least attractive.

In terms of threshold values of desire for surgery, for all groups a threshold value of 148° indicated a preference for surgery; for patients 121° or less, for lay people the threshold value was 124° or less and similarly 118° or less for clinicians.

Clinicians were the least critical, and patients appeared to be less critical than lay people. This stresses the importance of using patients as observers, as well as laypeople and clinicians, in facial attractiveness research.

Conclusions: From the results of this study, it is recommended that in rhinoplasty planning, the range of normal variability of the nasofrontal angle, in terms of observer acceptance, is taken into account as well as the threshold values of desire for surgery.

Keywords: Rhinoplasty, Nasofrontal angle, Surgical planning, Diagnosis, Nasal dorsal hump

INTRODUCTION

The nose inhabits the central position of the face and is often the most dominant part of the facial profile, and nasal profile aesthetics may have profound emotional and socio-cultural significance for patients.¹ The nasofrontal angle is a potentially important factor in the perception of facial profile attractiveness.² It is the anterior angle formed by drawing a line from nasion tangent to glabella, and another line tangent to the nasal dorsum, intersecting at nasion. The angle may be used to analyse the relationship between the glabellar region and the nasal dorsum in profile view. The magnitude of this angle will depend on the morphology of the glabellar region *and* the nasal bridge. To more accurately evaluate the nasal dorsal aesthetics, the nasofrontal angle may be separated into upper and lower component parts using a true horizontal line through nasion, allowing them to be assessed separately, as they vary independently (Figure 1).³ The rest of this article will focus on the lower component of the nasofrontal angle and the perceived aesthetics of nasal dorsal morphology.

The principal aim of this investigation was to evaluate quantitatively the influence of nasal dorsal morphology as represented by the nasofrontal angle on perceived attractiveness. The relationship between the nasofrontal angle and attractiveness was recorded to ascertain the range of normal variability, in terms of observer acceptance, and to determine the clinically significant threshold value or cut-off point, beyond which the angle is perceived as unattractive and surgical correction is desired. The perceptions of patients, clinicians and laypeople were compared for these different variables.

MATERIALS AND METHODS

Ethical approval was sought and granted for the study by the National Research Ethics Service; NRES (UK); REC reference: 06/Q0806/46.

Two-dimensional profile silhouettes are used routinely to assess the perceptions of facial attractiveness.^{4,5} A profile silhouette image was created with computer software (Adobe[®] Photoshop[®] CS2 software). The image was manipulated using the same software to construct an “ideal” profile image with proportions,³ and linear and angular soft tissue measurements,^{3,6-8} based on currently accepted criteria for an idealized Caucasian male profile, as previously described.⁴

The nasofrontal angle of the idealized image (image BK: 130°) was altered in 3-degree increments from 148 to 106 degrees, in order to represent variations in the angle and morphology of the nasofrontal region, ranging from an excessive nasal dorsal hump to a ski slope dorsal morphology (Figure 2).

Based on the results of a pilot study and power calculation, 185 observers took part in the study, separated into three groups (pre-treatment orthognathic patients, laypeople and clinicians; Table 1), with the following selection criteria:

- Patients: pretreatment (only 1 consultation appointment); primary concern was facial appearance; no previous facial surgical treatment; no history of facial trauma; no severe psychological issues (based on patient interview by FBN).
- Laypeople: no previous facial surgery, deformities or history of facial trauma.
- Clinicians: involved in the management of patients with facial deformities; included 19 maxillofacial surgeons and 16 orthodontists, with 1-16 years of experience in the clinical management of patients requiring orthognathic and facial reconstructive surgery.

Each observer was given a questionnaire and asked to provide the following information: age, gender, ethnic origin (White or non-White), how would you rate the attractiveness of your facial appearance, and how important do you think it is to have an attractive facial

appearance. An instruction sheet accompanied the questionnaire, asking the observers to rate each image in terms of facial attractiveness using the following rating scale:

1. Extremely unattractive.
2. Very unattractive.
3. Slightly unattractive.
4. Neither attractive nor unattractive.
5. Slightly attractive.
6. Very attractive.
7. Extremely attractive.

Observers were also asked whether they would consider surgery to correct the appearance if this was their facial appearance (yes or no).

The images were placed in random order into the software application Microsoft PowerPoint® (Microsoft Corporation, USA). Each image was identified by a randomly assigned double letter in the top right corner of the screen (e.g. BK, PF etc.; Figure 3). A duplicate image assessed intra-examiner reliability (images DM and EL). Each observer sat undisturbed in the same room in front of the same computer and 17-inch flat screen monitor. The presentation and the images were created in such a way that each of the profile silhouette images, when viewed on the monitor, had the same dimensions as a normal human head, based on an average lower facial height, reducing the potential effect of image size on observer perception. Each observer examined the images in the PowerPoint® presentation by pressing the “Page Down” button on the keyboard, in their own time.

The Likert-type rating scale used is largely accepted in the psychology literature as the most useful rating method.⁹ The seven-point Likert scale described above was used by each observer to rate each image in terms of attractiveness.

Statistical analysis

The median and interquartile observer ratings were calculated for each angle and for each observer group; these descriptive statistics were calculated using software that we developed using MATLAB (The MathWorks Inc, Natick, MA, USA). Additionally, data were modelled by curve fitting performed using MATLAB. Similarly, the software calculated the proportions in each group suggesting a desire for surgery. Additional paired t-tests were performed using Minitab version 16 (Minitab Inc, State College, PA, USA). This was following applying the Ryan-Joiner test in Minitab, used to examine if the data were consistent with a normal distribution.

RESULTS

Reliability Analysis

Table 2 shows the first and third quartile rankings of the Likert score. The results indicate that there was generally good agreement in the three observer groups. The interquartile range for all three groups was 0 with a maximum difference of 2 in the patient group, and 1 in the lay and clinician groups.

Perceived attractiveness of images

In Table 3 the median attractiveness rating of the observers on a Likert scale from 1 to 7 is shown, where 1 indicates “extremely unattractive” and 7 indicates “extremely attractive”. Nasofrontal angles outside the range of 127° to 145° were associated with a reduction in the median attractiveness scores in all three groups of observers. The patient, lay and clinician groups had the same median attractiveness score for the identical images (DM and EL) thus again indicating good inter-examiner repeatability.

Most attractive and least attractive images

Table 4 demonstrates the data in rank order from most to least attractive, arranged on the basis of responses from the clinician group then the lay group.

Table 5 and 6 demonstrate the proportion expressed as a percentage of each observer group suggesting that surgery is required. The results indicate that clinicians were generally least likely to suggest surgery for varying degrees of nasofrontal angle. Images DM and EL were identical, and so repeatability of the 35 patients' and clinicians' assessment was excellent, for the patient group 56% and the clinician group 40% suggesting surgery. For the 75 lay people the assessment of the two repeated images was also similar (56 and 59 %). For many of the images there was generally good agreement among clinicians as to whether surgery is required. There was more variability in the assessment for the patient and lay groups as indicated by fewer very low (< 25%) and very high percentage (> 75%) of the groups suggesting surgery. Taking 50% (i.e. majority) of each observer group as a cut-off where the majority suggested surgery, for patients the threshold value of desire for surgery was 121° and below, for lay people the threshold value was 124° and below and similarly 118° and below for clinicians; in addition for the patients and lay people groups an angle of 148° indicated a preference for surgery.

For observers who considered attractiveness to be important (>2), table 7 indicates the proportion suggesting surgery. For patients 68/75, for laypeople 71/75, and all clinicians considered attractiveness to be important. Thus nasofrontal angle deviations of 148° and ≤118° were again associated with a higher proportion desiring surgery.

For those who did not consider attractiveness to be important (7 patients and 4 laypeople), table 8 summarises the proportion desiring surgery. The table has no column for clinicians as all considered attractiveness to be important.

DISCUSSION

Planning aesthetic rhinoplasty requires the determination and validation of correct nasofacial morphological relationships, which requires two sources of information.¹⁰ Age, gender and ethnicity specific population averages based on anthropometric data allow comparison of a patient's nasofacial measurements and proportions to the population norms. No longitudinal data is available for the nasofrontal angle, but there is some cross-sectional data available.⁸ Additionally, the perceived attractiveness of the proportions and morphological relationships should be confirmed by the judgement of patients and the lay public, and ideally compared to the judgement of treating clinicians. This was the main purpose of this investigation.

The results of this investigation demonstrated that increasing the nasofrontal angle deviation in either direction from an angle of 130 degrees (Image BK) was associated with a reduction in the median attractiveness scores in all three groups of observers. The highest attractiveness scores were for image BK (130°), closely followed by image MH (133°), image OT (136°) and PF (139°). An angle of 142° (image RX) and 127° (image CK) were deemed to be neither attractive nor unattractive, i.e. essentially acceptable, even if not attractive. However, from a nasofrontal angle of 124° and below and 148° (and presumably above), the images were viewed as unattractive by all observer groups. The further the angle reduced below 124°, the more unattractive it was perceived to be, with 115° and below being perceived as very and extremely unattractive by all observer groups. It thereby appears that a nasofrontal angle of 130° is perceived as the most attractive, and between 127 to 142° is deemed acceptable. Angles outside this range are perceived as unattractive by all groups, with greater deviations leading to progressively reduced perceptions of attractiveness.

In terms of desire for surgical correction, the results indicate that clinicians were generally somewhat less likely to suggest surgery for varying degrees of nasofrontal angle. Although there was generally good agreement in the three observer groups, there appears to be a high

degree of agreement amongst clinicians, and the reason for this may be the potentially higher critical capabilities of clinicians resulting from their training. As clinicians appear to be the least critical, this stresses the importance of using patients as observers in facial attractiveness research. Interestingly, table 8 demonstrates that even those not considering attractiveness to be important still desired surgical correction of obvious deviations from the idealized image.

As with other facial parameters it is generally acknowledged that the nasofrontal angle has a range of normal individual variability. As a starting point, for comparative purposes and by way of contrast, it is useful to look at the nasofrontal angle in idealized images from classical and Renaissance art and sculpture (Table 9). The first known treatise on ideal human proportions was written by the Greek sculptor Polycleitos of Argos. Unfortunately, no copies of this book exist. However, it is known, based on evidence from the physician Galen, that Polycleitos based his most important statue, the Doryphorus, on his treatise.³ The lower component of the nasofrontal angle in these statues is approximately 60 to 65 degrees. From a number of idealized male and female profile images painted in the Renaissance, the lower component of the nasofrontal angle is again within the range of 60 to 70 degrees. The upper component of the nasofrontal angle demonstrates a wider range, between 130 to 165 degrees, due to greater variability in the drawings of the glabellar regions (Table 9). A common denominator in the morphology of the nasal dorsum in these images is that it is relatively straight in all the images.

Additionally, a number of modern surgical authorities have provided “ideal” values for the nasofrontal angle, based on anecdotal evidence and the “good eye” of the respective surgeon. For example, in their “aesthetic triangle”, Powell and Humphreys¹³ described an ideal range of 115-130 degrees, with an ideal value of 115 degrees in males and 120 degrees in females. Their diagrams appear to illustrate that the slightly greater nasofrontal angle in females appears to be due to their often less prominent brow ridge. Orten and Hilger¹⁴ and Papel and

Capone¹⁵ corroborated the values provided by Powell and Humphreys¹³. Lehocky¹⁶ provided the ideal values as 130 degrees in men and 134 degrees in women, based on anecdotal opinion. Sheen¹⁷ and Rees¹⁸ stressed the importance of the nasofrontal angle in achieving a pleasing facial contour, without providing any specific ranges for the angle.

Average values, based on anthropometric studies by Farkas et al.,⁶ for adult North American whites are $130 \pm 7^\circ$ in males and $134 \pm 7^\circ$ in females. There is ethnic variability, and average values for a Chinese population have been provided as $135 \pm 7^\circ$ in males and $135 \pm 4^\circ$ in females, and in an African-American population as $127 \pm 12^\circ$ in males and $128 \pm 8^\circ$ in females.⁸ None of the authorities in any study or published article provided separate values for the upper and lower components of the nasofrontal angle.

It is important to bear in mind that the profile silhouette image created was based on North American white adult male proportions and normative values. As such, it is not generalizable to different ethnic groups and the data may not be directly relevant to other ethnic groups, through it does provide an insight into how different ethnic groups view Caucasian faces. It would be interesting to repeat the study using images from different ethnic groups.

CONCLUSIONS

The results demonstrate that a nasofrontal angle of 130° is ideal, corresponding to a lower component of 60° , with a range of 127° to 142° deemed acceptable. Angles above or below this range are perceived as slightly unattractive, and anything outside the range of 118° to 145° is deemed very unattractive.

For all groups the threshold value of desire for surgery was 148° and above. For patients the threshold value of desire for surgery was 121° and below, for lay people 124° and below, and for clinicians 118° and below.

There is a difference in the perception of patients, laypeople and clinicians, which stresses the importance of using patients as observers, as well as laypeople and clinicians, in facial attractiveness research.

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FIGURE CAPTIONS

- Figure 1 Nasofrontal angle, NFA; UC, upper component of the nasofrontal angle; LC, lower component of the nasofrontal angle; TrH, true horizontal line.
- Figure 2 Lower component of the nasofrontal angle of the idealized profile image was altered incrementally, creating a series of images.
- Figure 3 An example of an image viewed by study observers on the monitor during data collection.

TABLE CAPTIONS

- Table 1 Observer demographics.
- Table 2 First and third quartile rankings of the Likert score.
- Table 3 Median attractiveness observer ratings on the Likert scale.
- Table 4 Data in rank order from most to least attractive (clinician ranking first).
- Table 5 Proportion expressed as a percentage of each observer group suggesting a desire for surgery.
- Table 6 Proportion expressed as a percentage of each observer group suggesting a desire for surgery in rank order.
- Table 7 Proportion of observers desiring surgery who considered attractiveness to be important.
- Table 8 Proportion of observers suggesting surgery who did not consider attractiveness to be important.
- Table 9 The nasofrontal angle in idealized images from classical and Renaissance art and sculpture.

Author's role/participation in the authorship of the manuscript

FBN conceived the premise and carried out data collection. DW and FBN undertook the statistical analysis. All authors (FBN, MTC, UG, FM, DW) were involved in data analysis and completion of all other aspects of the article.