Analysis of Patient-Determined Preoperative Computer Imaging

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Objective: To compare patients' goals in aesthetic rhinoplasty with aesthetic ideals by analyzing changes requested through computer imaging during the initial consultation.

Methods: The frontal and lateral views of 20 consecutive female rhinoplasty patients were analyzed retrospectively before and after using image manipulation software. Indexes from the frontal view included the ratio of alar base width to dorsal length and the ratio of alar base width to interpupillary distance. On the lateral view, parameters included the nasolabial angle, nasofacial angle, and tip projection (Goode ratio). Ideal parameters were based on descriptions by Powell and Humphreys.

Results: The ideal and patient-determined proportions were compared using a paired 2-tailed t test. The mean nasolabial angle falls within the ideal range before and after image manipulation. However, the Goode ratio and the ratio of alar base width to interpupillary distance were statistically similar to ideal values only after image manipulation. The nasofacial angle and the ratio of alar base width to dorsal length showed a trend toward the ideal ratio.

Conclusions: Patients' preferences were similar to the ideal in 3 of 5 parameters, and the remaining parameters approached the ideal. These parameters are useful in creating satisfying proportions in aesthetic rhinoplasty and reconstructive surgery within our population. Rather than population-based normative data or ideals based on fashion models or Greek statuary, these are proportions requested by patients. Computer imaging software, used by a growing number of aesthetic surgeons, holds a wealth of data regarding common patient preferences.

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Beauty is an experience, nothing else. It is not a fixed pattern or arrangement of features. It is something felt, a glow or a communicated sense of fineness.

D.H. Lawrence

The preoperative discussion before aesthetic surgery has changed dramatically since the development of inexpensive, rapid, and high-resolution digital photography combined with accessible image manipulation software. This recent technology makes visualization of patients' expectations practical, facilitating communication with the patient and surgical decision making. A growing body of literature during the past 2 decades addresses the various facets of computer imaging in rhinoplasty, including patient satisfaction, confidence, and expectations; the accuracy of preoperative manipulations compared with postoperative results; medical implications; equipment; and cost. As with other anatomically complex procedures, computer-based simulations have been developed to allow residents to practice on a "virtual nose" without risk. This list of developments is by no means exhaustive.

Similarly, advances in microprocessor and software design have enabled physicians, psychologists, and philosophers to test increasingly sophisticated models of facial beauty and attractiveness. The faces of fashion models are cut from magazines, distilled to their essence, and scoured for clues to their desirability. "Average" faces are sampled from a population and compared with neoclassic ideals. The many benefits conferred on attractive persons in public and private life have been extensively cataloged. The quest for an objective measure of beauty is of course ancient, as evidenced by the persistence of classic ideals (such as the golden ratio) in modern models like the phi mask by Marquardt. However, the wealth of ongoing research into beauty and attrac-
Given this premise, we ask whether patients’ goals in rhinoplasty conform to aesthetic ideals as evidenced by patient-driven image manipulation during the preoperative consultation. If patients’ tastes are similar to a published standard, the standard remains useful as a teaching tool and reconstructive foundation, even while imaging continues to supplant imagining in preoperative discussion and planning. Knowing where patients’ desires fall within the range of desirable proportions would also help a surgeon select patients with acceptable expectations.

METHODS

The facial plastic surgery practice of one of us (B.C.M.) is in suburban Wisconsin, includes aesthetic and functional rhinoplasty, and is associated with an academic medical center. The standard preoperative consultation before aesthetic rhinoplasty involves an initial introduction and history, a discussion by the patient of specific concerns using a handheld mirror, a physical examination, standard 6-view digital photography (frontal, left and right lateral, left and right oblique, and basal views) using a photographic suite (Canon D70 digital slave flash; Canon, Inc, Lake Success, NY), and then digital image manipulation by the surgeon that is directed by the patient (Mirror Suite; Canfield Scientific, Fairfield, New Jersey) to simulate proposed operative changes in the frontal and lateral views.

After obtaining institutional review board approval, data were extracted retrospectively using the image manipulation software package from the frontal and lateral views (original and simulated) of 20 consecutive female patients who were seen for rhinoplasty. The number of participants was based on the modest objective of the study to compare our patients’ goals in rhinoplasty with an established aesthetic standard rather than to create a new standard. Eighteen women were white, 1 woman was African American, and 1 woman was of South Asian origin. On the frontal view, the interpupillary distance, alar base width, and dorsal length (from nasion to tip) were measured in standardized units (per software protocol) (Figure 1). On the lateral view, the nasolabial angle, distance from tragus to lateral canthus, dorsal length (from nasion to tip), distance from nasion to alar groove, and tip projection were measured (Figure 2). The data were entered into a spreadsheet (Microsoft Excel; Microsoft Corporation, Redmond, Washington) without identifying information. Therefore, informed consent was not required.

The proportions of the nose described by Powell and Humphreys15 were chosen as an aesthetic standard for their simplicity and generality. Variables of interest from the lateral view included the nasolabial angle (measured directly), nasofacial angle (derived from the triangle described by the dorsal length, tip projection, and nasion to alar groove distance using the law of cosines), and tip projection (Goode ratio, derived from the aforementioned triangle as the sine of the nasofacial angle) (Figure 3). Indexes from the frontal view included the ratio of alar base width to dorsal length and the ratio of alar base width to interpupillary distance (Figure 4). When a range of ideal values was provided, such as a nasolabial angle of 90° to 120°, the midpoint was chosen (105°). A nasofacial angle of 36° was chosen based on work chosen (105°). A nasofacial angle of 36° was chosen based on work by several authors.16 The Goode ratio, ideally between 0.55 and 0.60, was set at 0.59, although Powell and Humphreys15 recommend a lower value for female noses. A nasofacial angle of 36° corresponds to a Goode ratio of 0.59. Finally, the distance from tragus to lateral canthus was compared in matched lateral images from each patient to ensure that the images were of the same quality.
scale. The process was repeated with paired frontal views using the interpupillary distance.

**RESULTS**

Statistical analysis included calculation of the mean (SD) and 95% confidence interval of each index (Table). Two-tailed t test was then performed for each parameter, comparing means from the original and manipulated images with a fixed ideal. The null hypothesis in each instance is that no difference exists between patients’ actual or desired proportions and the published ideal.

A correlation coefficient of 0.9999 was calculated for the tragus to lateral canthus distance in paired lateral images, and a correlation coefficient of 0.9991 was calculated for the interpupillary distance in paired frontal images. This indicated that the images are indeed the same size and that the process of measuring distances using a mouse and the image manipulation software is reliable.

The nasolabial angle in the original and manipulated images is statistically indistinguishable from the ideal value of 105°. Indeed, the ideal is a range, usually given as 95° to 110° in women. The means of the original and manipulated images fall within this range. Similarly, the mean manipulated ratio of alar base width to interpupillary distance (52.6%) is statistically indistinguishable from the ideal value of 50%, as is the mean manipulated Goode ratio (0.61, ideally 0.59). The remaining parameters, the
mean manipulated nasofacial angle (37.9°, ideally 36°) and the ratio of alar base width to dorsal length (77.3%, ideally 70%), showed a trend toward the ideal value but did not attain significance at α = .05.

**COMMENT**

This study is a small piece of an enormous body of literature exploring the concepts of beauty and attractiveness. The pursuit of an absolute standard of beauty is an age-old undertaking common to many cultures. Surprisingly, it seems from recent research that men and women from different cultures may share common ideas of attractiveness. However, controversies in the field are boundless, and it is beyond the scope of this article to review the current state of affairs. Rather, we confine ourselves to a practical question: Are the ideal proportions of the nose as outlined by Powell and Humphreys applicable to the population of patients seeking rhinoplasty? That is, do patients seek to mimic the published “ideal” nose in their own features, given the chance to plasty? That is, do patients seek to mimic the published

<table>
<thead>
<tr>
<th>Variable</th>
<th>Ideal Value</th>
<th>Mean (SD)</th>
<th>95% Confidence Interval</th>
<th>P Value</th>
<th>Mean (SD)</th>
<th>95% Confidence Interval</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nasolabial angle,*</td>
<td>105</td>
<td>106.6 (8.1)</td>
<td>102.6-110.6</td>
<td>.45</td>
<td>104.0 (8.1)</td>
<td>100.4-107.6</td>
<td>.58</td>
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<td>Nasofacial angle,*</td>
<td>36</td>
<td>40.9 (3.8)</td>
<td>39.2-42.6</td>
<td>&lt;.001</td>
<td>37.9 (4.0)</td>
<td>36.2-39.6</td>
<td>.048</td>
</tr>
<tr>
<td>Goode ratio</td>
<td>0.59</td>
<td>0.65 (0.05)</td>
<td>0.63-0.67</td>
<td>&lt;.001</td>
<td>0.61 (0.05)</td>
<td>0.59-0.63</td>
<td>.08</td>
</tr>
<tr>
<td>Ratio of alar base width to dorsal length, %</td>
<td>70</td>
<td>82.6 (17.0)</td>
<td>75.2-90.0</td>
<td>.004</td>
<td>77.3 (15.3)</td>
<td>70.6-84.0</td>
<td>.045</td>
</tr>
<tr>
<td>Ratio of alar base width to interpupillary distance, %</td>
<td>50</td>
<td>55.7 (5.3)</td>
<td>53.4-58.0</td>
<td>&lt;.001</td>
<td>52.6 (6.2)</td>
<td>49.9-55.3</td>
<td>.08</td>
</tr>
</tbody>
</table>

*Acceptance of the null hypothesis at α = .05.

Our data also suggest that the mean nasolabial angle of patients falls within the ideal range even without manipulation. Furthermore, the mean manipulated Goode ratio (0.61) and the mean manipulated ratio of alar base width to dorsal length (52.6%) are statistically indistinguishable from the ideal values of 0.59 and 50%, respectively, congruent with frequent requests for tip and alar base width reduction in rhinoplasty. The mean manipulated nasofacial angle (38.0°) and the mean manipulated ratio of alar base width to dorsal length (77.3%) approached the ideal values of 36° and 70%, respectively. Overall, 3 of our 5 chosen parameters were statistically similar to ideal values after image manipulation, while only 1 was similar in the original images. It seems that these ideals are indeed applicable to our population.

Potential limitations in the methods of this study should be discussed, as they may undermine our conclusions. One of us (B.C.M.) performed the photographic manipulations while being directed by the patient, which is an indirect way of ascertaining the patients’ preferences. As Pearson and Adamson mention, a more patient-centered process would be ideal.

Also, 20 participants may be too small a sample, and the inclusion of nonwhite participants may have confounded the data. An entirely different analysis might be possible with a larger, more diverse study population. Rather than comparing patient preferences with the published ideal, which is treated as a control, the preferences of individual groups could be compared with each other. For example, the preferences of the South Asian or African American patient in this study could be compared with those of the larger group. These patients are assumed to be confounders in the present analysis, but their inclusion in larger numbers presents an opportunity to study the role of race/ethnicity in rhinoplasty. Parameters that are unlikely to be modified in specific groups (such as alar base width among whites) could be used as negative controls during subgroup analysis. Specifically, the changes in alar base width, tip projection, and nasolabial angle requested by an Asian or African American patient likely differ from the requests of our mostly white population. Augmentation and alar base width

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reduction might be preferred rather than tip reduc-
tion. A more extensive study is warranted.

A larger, more homogeneous sample might also
strengthen our limited conclusions by reducing the stan-
dard deviation. However, the t test is a robust statistical
test for a sample of 20 participants even with a nongaus-
sian distribution. When the calculations were re-
peated using a Wilcoxon matched-pairs signed rank test,
which makes no assumptions about sample distribu-
tion, our findings did not change significantly.

Another limitation lies in our choice of parameters.
We purposely chose a few of the measures outlined by
Powell and Humphreys15 because of their frequent ref-
ence. We treated these measures as though they are
independent variables, but they clearly are not. For
example, calculation of the Goode ratio for estimating
tip projection is mathematically identical to the sine of
the nasofacial angle. In practice, however, the nasofa-
cial angle is usually measured at the nasion directly
from a lateral view, while the Goode ratio relies on
measurement of the dorsal length and tip projection.
Therefore, the 2 parameters are independently useful.
Rather than a few parameters, a set of mathematical
curves might better describe a nose. Curves come
closer to creating a complete image than linear mea-
surements, but these would be difficult to define and
would limit any clinical usefulness. A more likely
limitation is our choice of the ideal value for each
parameter. The ideal is often given as a range of val-
ues, but we chose a single value within this range to
facilitate hypothesis testing. We attempted to
choose this value well, as described in the "Methods"
section.

A common problem among studies similar to ours is
that the nose is examined in isolation from the face, al-
though an actual patient or surgeon always considers
the feature in context. Therefore, the patients who prefer a
projecting nose because they have a projecting chin can-
not be discerned from our data. As the number of vari-
ables increases, so too does the complexity of the as-
sumptions and conclusions. Examining only the nose
provides at least a first-order approximation of what pa-
tients are seeking in aesthetic rhinoplasty.

In this study, the most useful information may be the
mean (SD) of each manipulated parameter because these
data show what patients want their noses to look like.
Following the reasoning by Pearson and Adamson,14 pa-
tients and the public share a common ideal, so our para-
meters might also apply to the public at large. A set of
smooth distribution curves could be created describing
what the average person wants, ideally with a larger sample
of patients. Such probability curves would allow a young
surgeon to identify outliers.

A final concern is that the ideal proportions of the
nose are irrelevant to surgeons for several reasons. Most
surgeons at work rely on their eyes and "esthetic sense" rather than on a ruler, compass, and protractor.
Surgeons rely on the eyes of those around them in the
operating room (for example, the anesthesiologist and
nurses) as a proxy for the public eye. When meeting the
patient for the first time and listening to his or her
desired changes, the aesthetic surgeon relies on a devel-
oped sense of whether the patient is making reasonable
requests. More recently, although many surgeons are
not yet using these tools,21 the patient and surgeon can
take a picture and then simulate the desired changes
directly, further diminishing the need for measure-
ments. However, the search for a universal metric of
beauty will continue regardless of a surgeon's use for it,
because the search itself illuminates fundamental
aspects of human thought and behavior.22 Furthermore,
there is always a use for measurements to quantify what
we may know or perceive qualitatively.23

The derivation of the ideal proportions by Powell
and Humphreys13 deserves discussion as well. First,
whether they are derived randomly or from Greek
statuary, if the ideal proportions of aesthetic texts
included not only a range but also a justified mean
(SD), we could support them unreservedly. These propor-
tions would then be rooted in population-based
data and could be more easily tested. Second, knowing
the mean desirable proportions of a nose in a popula-
tion is more useful than knowing the ideal proportions
of the beautiful nose, if one desires to please patients.
Patients might not be interested in beauty at all but
simply want their noses to be unremarkable, and one
cannot discern individual patient motivations from
measurements taken out of context, less so from the
mean of measurements taken out of context. Our
mean desired proportions do indeed approximate the
ideal proportions, partially validating the application
of the ideal proportions to our population. It would be
a logical next step to mine the wealth of data con-
tained in the digital photographic files of surgeons
who use image manipulation software to continue to
clarify quantitatively what rhinoplasty patients want
from their surgeons.

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script for important intellectual content: Mahajan, Shafiei,
and Marcus. Statistical analysis: Mahajan. Administra-
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