Photogrammetric Facial Analysis of Attractive Celebrities Using the Glabella for Planning Rhinoplasty and Analyzing Surgical Outcomes

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Background Identifying problems and making a surgical plan through a preoperative analysis is important in facial aesthetic surgery. Thus, popular conceptions of an attractive face must be analyzed beforehand. The landmarks used as reference points may change after rhinoplasty, resulting in errors in the prediction and assessment of outcomes. To reduce such errors, it is advantageous to use reference points and landmarks that are subject to minimal variation. This study measured and analyzed landmarks with little preoperative and postoperative variation in rhinoplasty, and established appropriate standards for landmarks indicative of ideal profiles.

Methods A photogrammetric analysis was performed of 80 famous and attractive celebrities from Korea, Southeast Asia, Japan, China, and America. The nasofrontal angle, nasal angle, nasolabial angle, angle of facial convexity, and angle of total facial convexity were measured.

Results The angle of total facial convexity differed significantly among countries (P=0.013). No significant difference in nasal angle, facial convexity, or total facial convexity was observed between Western and Eastern countries. A significant difference in the nasofrontal angle (Asian: 138.66°, Western: 134.35°; P=0.006) was observed. The nasolabial angle (Asian: 97.09°, Western: 104.59° degrees; P=0.007) was significantly more acute in Asian than in Western subjects.

Conclusions In this study, we performed a more accurate analysis using the glabella instead of the nasion to measure the facial profiles of patients planning to undergo rhinoplasty and proposed standard values through an analysis of ideal and attractive facial profiles.

Keywords Anthropometry, Photogrammetry, Rhinoplasty

INTRODUCTION

The nose plays an important role in facial beauty; thus, rhinoplasty is currently one of the most frequently performed aesthetic surgical procedures in the world. Previously, rhinoplasty focused on improving certain parts of the nose, such as via the augmentation of the dorsum or tip plasty; however, it is now considered more important for rhinoplasty results to be harmonious and balanced with the face overall.

East Asians, unlike Caucasians, tend to have a short retruded columella, wide and flaring nostrils, a broad and ill-defined nose tip, low dorsal profile, obtuse nasofrontal angle, acute nasolabial angle, and greater forward placement of the upper lip with midface retrusion [1-3]. In a previous study, Western subjects tended to have a protruding forehead, while Asians had a retruded midface and less chin prominence [4,5]. The Asian concept of facial beauty has changed over the years, largely due to the influence of Western
culture [6].

In order to make a surgical plan that would yield harmonious rhinoplasty results for patients of various ethnicities, whose demands have been undergoing dynamic changes, it is necessary to perform a detailed analysis of the patients’ angular and proportional profiles prior to surgery. Thus, many authors have suggested utilizing soft tissue analysis as a reliable guide for aesthetic rhinoplasty. To establish standards of attractive faces that are broadly acceptable, studies on various facial angles and proportions using cephalometry, anthropometry, and photogrammetry have been performed [7-11]. Various angular profiles exhibit interrelationships with one another, and as a result, critical errors may occur in the assessment of preoperative and postoperative profiles. Reference points and landmarks that can minimize these interrelationships are necessary to reduce errors during surgical planning and the assessment of surgical outcomes.

We developed a system for assessing rhinoplasty results by measuring facial angular profiles using reference points with little variation before and after surgery. The goal of this study was to propose standards for attractive profiles in association with those reference points.

METHODS

Study subjects
To establish standards for various ethnicities and countries, a photogrammetric analysis was performed of famous and attractive celebrities, not only from Korea, but also from Southeast Asia, Japan, China, and the United States, to obtain mean measurements. Pictures were obtained from the Internet as JPG files. Attractive celebrities were chosen as subjects regardless of whether they had previous cosmetic surgery. The criteria for the selection of celebrities and pictures used in the analysis are presented below.

1. Celebrities whose nose shape and facial balance were considered attractive based on questionnaires completed by patients admitted to a hospital in the corresponding country.
2. Pictures in which the angle of the chin (pogonion) was uniformly measured during the photogrammetric analysis, and thus, had little variation due to occlusion or hypergnathism/hypognathism of the maxilla or mandible.
3. Pictures in which the glabella, nasion, pronasale, columella, subnasale, labium superius, and pogonion, which were the reference points for angle measurement, could be clearly seen. These points were defined as follows:
   • Glabella: The most prominent point of the forehead in the midline between the eyebrows.
   • Nasion: The midline point of the junction of the frontonasal suture and the superior nasal bones. Externally, the nasion often corresponds to the point of greatest concavity of the nasal dorsum near a line level with the upper lid lash line.
   • Pronasale: The most prominent point of the nasal tip.
   • Columella: The point of the base of the nose.
   • Subnasale: The deepest point at the junction of the base of the columella and the upper lip in the midline.
   • Labium superius: The midpoint on the vermilion line of the upper lip.
   • Pogonion: The most prominent point of the chin in the midline.
4. Pictures in which both eyelashes were positioned parallel to one another, and the opposite side of the midline was invisible or barely visible; in other words, the rotation about the cervical/axial axis was close to the true lateral profile. The opposite pupil, eyebrow, or eyelash was not visible.
5. Pictures in which there was no facial expression and the lips were normally closed.

A total of 80 subjects, consisting of 37 Koreans, 10 Chinese, 8 Japanese, 14 Southeast Asians (8 Thais, 2 Malaysians, 2 Filipinos, 1 Indonesian, and 1 Vietnamese), and 11 Americans, were included in this study.

Measurements
All profile photograph views were analyzed by one of the authors (C.W.P.). Seven soft tissue surface landmarks, including the glabella (g), nasion (n), pronasale (prn), columella (cm), subnasale (sn), labium superius (ls), and pogonion (pg) were marked on the profile photographs using Adobe Photoshop CS5 (Adobe Systems Inc., San Jose, CA, USA) (Fig. 1). Thereafter, each dot was connected for angle measurement. To measure the nasofrontal angle, nasal angle, and nasolabial angle, glabella-nasion-pronasale, nasion-pronasale-
columella, and columella-subnasale-labium superius were connected in a line, respectively. To measure facial convexity, glabella-subnasale-pogonion was connected in a line. For the measurement of total facial convexity, glabella-pronasale-pogonion was connected. The angles formed by these lines were measured using the ruler tool in Adobe Photoshop CS5 (Fig. 2 and Table 1).

Statistical analysis
The Kruskal-Wallis test was used to compare angle measurements for each country. The Mann-Whitney U-test was used to compare the measurements between Asian and Western countries. The data were analyzed using SPSS version 15.0 (SPSS Inc., Chicago, IL, USA). P-values < 0.05 were considered to indicate statistical significance.

RESULTS
Measurements by country and region are shown in Table 2. The angle of total facial convexity differed significantly among the countries/regions (P = 0.013). A comparison of Asian and Western countries is shown in Table 3. No significant differences in nasal angle

![Diagram of profile landmarks and angles](image)

**Fig. 2.** The 5 angles that were measured. g, glabella; n, nasion; prn, pronasale; cm, columella; sn, subnasale; ls, labium superius; pg, pogonion.

**Table 1.** Definition of the seven profile landmarks and five angles of measurement

<table>
<thead>
<tr>
<th>Landmark</th>
<th>Definition</th>
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<tbody>
<tr>
<td>Glabella (g)</td>
<td>The most prominent point of the forehead in the midline between the eyebrows.</td>
</tr>
<tr>
<td>Nasion (n)</td>
<td>The midline point of the junction of the frontonasal suture and the superior nasal bones. Externally, the nasion often corresponds to the point of greatest concavity of the nasal dorsum near a line level with the upper lid lash line.</td>
</tr>
<tr>
<td>Pronasale (prn)</td>
<td>The most prominent point of the nasal tip.</td>
</tr>
<tr>
<td>Columella (cm)</td>
<td>The point of the base of the nose.</td>
</tr>
<tr>
<td>Subnasale (sn)</td>
<td>The deepest point at the junction of the base of the columella and the upper lip in the midline.</td>
</tr>
<tr>
<td>Labiale superius (ls)</td>
<td>The midpoint on the vermilion line of the upper lip.</td>
</tr>
<tr>
<td>Pogonion (pg)</td>
<td>The most prominent point of the chin in the midline.</td>
</tr>
<tr>
<td>NFA</td>
<td>The angle of the nasal tip, radix, and most prominent point of the forehead; g-n-prn.</td>
</tr>
<tr>
<td>NA</td>
<td>The angle between the line from the glabella to the pronasale and the line from the pronasale to the columella; n-prn-cm.</td>
</tr>
<tr>
<td>NLA</td>
<td>The angle between the line from the anterior columella to the subnasale and the line from the subnasale to the labiale superius; cm-sn-ls.</td>
</tr>
<tr>
<td>FC</td>
<td>The angle between the line from the glabella to the subnasale and the line from the subnasale to the pogonion; g-sn-pg.</td>
</tr>
<tr>
<td>TFC</td>
<td>The angle between the line from the glabella to the pronasale and the line from the pronasale to the pogonion; g-prn-pg.</td>
</tr>
</tbody>
</table>

NFA, nasofrontal angle; NA, nasal angle; NLA, nasolabial angle; FC, facial convexity; TFC, total facial convexity; g, glabella; n, nasion; prn, pronasale; cm, columella; sn, subnasale; ls, labium superius; pg, pogonion.
(nasion-pronasale-columella; Asian: 111.97° ± 5.65°, Western: 112.55° ± 3.49°), facial convexity (glabella-subnasale-pogonion; Asian: 169.11° ± 2.67°, Western: 170.67° ± 3.12°), or total facial convexity (glabella-pronasale-pogonion; Asian: 142.88° ± 2.95°, Western: 142.17° ± 3.73°) were found between the Western and Asian countries. A significant difference in the nasofrontal angle (glabella-nasion-pronasale; Asian: 138.66° ± 4.09°, Western: 134.35° ± 4.93°; P = 0.006) was found between the Western and Asian countries, with Asians having more obtuse angles than Western subjects. The nasolabial angle (columella-subnasale-labium superius; Asian: 97.09° ± 7.22°, Western: 104.59° ± 9.19°; P = 0.007) was significantly more acute in Asian than in Western subjects.

**DISCUSSION**

Anthropometric analysis is important for guiding the rhinoplastic surgeon to achieve satisfactory results for a harmonious face. Data available from various studies are difficult to compare directly because of the different settings required to obtain a profile view and because of racial variations. However, the natural head position is relatively constant and reliable [12]. Legan and Burstone [13] described the angle of convexity, which is formed by the glabella, subnasale, and pogonion. The Powell analysis, involving the nasofrontal, nasofacial, nasomental, and mentocervical angles, was developed to provide insights into the ideal facial profile. Arnett and Bergman defined frontal and lateral analysis procedures using photographic records taken in the natural head position [14,15]. They used the nasolabial angle and the angle of the contour of the maxillary and mandibular sulcus. They also described the facial profile in different types of malocclusion according to the angle of facial convexity (glabella-subnasale-pogonion) [14,15].

Auger and Turley [16] attempted to determine significant changes in the female soft tissue profile as presented in fashion magazines of the 1990s. Rhee et al. [7] also conducted angular profile analysis using profile photographs of famous female models obtained from...
The methods we employed enabled measurements to be made easily, with only a lateral profile and Adobe Photoshop or a protractor. Because this method required simply marking a few soft tissue landmarks and measuring a few angles, it avoided challenges caused by overlapping reference points. Although it would be ideal to accurately fit the natural head position, an objective comparison using photogrammetric analysis was sufficient since the angles between soft tissue landmarks were compared without marking the Frankfort plane. In addition, since total facial convexity and facial convexity were measured relative to the glabella—a fixed point—the comparison between preoperative and postoperative results was more objective.

Although 80 subjects (37 Koreans, 10 Chinese, 8 Japanese, 14 Southeast Asians, and 11 Americans) were included in this study, this number seemed too small to make a definitive comparison between Asian and Western subjects. Furthermore, pictures of the subjects were obtained from the Internet, since we could not directly take pictures of them. Moreover, as we could not obtain their accurate lateral profiles and the obtained pictures had differences in angles and lighting, there may have been errors in our findings. These limitations should be considered when interpreting our results and should be addressed in future research. Better rhinoplasty planning and ideal surgery outcomes can be achieved by setting reference points suitable for producing an attractive nose that would be satisfactory for patients.

Although the sample size was small, our results indicate that the facial lateral profile angles that were considered attractive were similar among the countries analyzed.

We proposed standards for beautiful faces through an analysis of ideal and attractive celebrity facial profiles in association with suitable reference points. This can serve as a guide for the treatment goals of aesthetic rhinoplasty.

REFERENCES

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