Nasal Measurements in Asians and High-Density Porous Polyethylene Implants in Rhinoplasty

Dongwoo Jang, MD; Li Yu, MD, PhD; Yimin Wang, MD; Dejun Cao, MD, PhD; Zheyuan Yu, MD, PhD; Xiongzheng Mu, MD, PhD

Objectives: To understand Asian noses, set goals for rhinoplasty, and find the best alternative columellar strut.

Methods: Six values were used to evaluate the morphology of the nose: tip projection, alar-tip-columellar base angle, alar–columellar base–philtrum angle, nasolabial angle, nasofacial angle, and tip angle. One hundred average Chinese people (50 males and 50 females) were compared with 36 preoperative Chinese patients (13 males and 23 females). We presented an application of high-density porous polyethylene (Medpor) implant as a columellar strut for use in lengthening. We performed 3 surgical techniques: a single-plate strut, a double-plate strut, and a butterfly-shaped strut. Open rhinoplasty (transcolumella incision) was performed on 21 patients; closed rhinoplasty (marginal incision) was performed on 15 patients.

Results: Prominent changes in the 6 values were found in both male and female patients after rhinoplasty.

Conclusions: An analysis of the Asian nose will help surgeons achieve better results. High-density porous polyethylene columellar strut grafts provide adequate support for refined tip definition and the shaping of the columellar-lobular angle.


THE NOSE HAS A SIGNIFICANT role in defining beauty. Ideal beauty has generally been viewed through the standards of Caucasian, specifically Northern European, features. These standards are defined as a straight, narrow bridge; a well-defined projecting nasal tip; and refined alae, with a 90° to 95° nasolabial angle in men or a 95° to 100° nasolabial angle in women. The morphology of the average Asian nose is remarkably different from these standards. Asian noses have a bulbous tip, a short columella, round nostrils, an acute nasolabial angle, and a low dorsum, in general. These characteristics explain why most Asians require augmentation and columellar lengthening, rather than reduction as in Caucasian rhinoplasty.

Previous studies described autologous grafts, including cartilage, bone fascia, and dermis, that were commonly applied to nasal augmentation and columellar lengthening, although autologous grafts are difficult to contour and also have donor site morbidity, wrapping, and limited availability. In addition, autologous grafts of Asians are in short supply and of insufficient strength. Allogenic implants, such as silicone, polytef, and high-density porous polyethylene, have been chosen to substitute for autologous grafts in rhinoplasty. However, allogenic implants may cause complications, such as extrusion and infection.

This study describes the measurement of Asian noses and the use of high-density porous polyethylene (Medpor; Porex Surgical, Inc) as a columellar strut in columellar lengthening. We compared patients who underwent columellar lengthening with average Asians and also analyzed the results of columellar lengthening rhinoplasty. Measurements of the average group and the preoperative/postoperative patients will explain how the noses of patients are different from those of the average group and how the noses of those who were operated on were improved. We also describe the advantages of applying a high-density porous polyethylene implant in rhinoplasty.

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METHODS

In this study, Asians were defined as people from eastern China, including the Shanghai, Zhejiang, and Jiangsu provinces. All of them were of the Han ethnic group. From January 1, 2008, through December 31, 2010, high-density porous polyethylene implants were applied in 36 patients (13 males and 23 females). The mean (range) age was 24.0 (17-35) years for male patients and 22.2 (14-28) years for female patients. Five of the male pa-
Patients had secondary cleft lip nasal deformities; the other patients were undergoing the operation for aesthetic purposes. Seven of the female patients also had secondary cleft lip nasal deformities; the others sought aesthetic improvement.

A combination of lidocaine hydrochloride, 1%, with 1:100,000 epinephrine was infiltrated transcutaneously. We performed open rhinoplasty (transcolumella incision) on 21 patients and closed rhinoplasty (marginal incision) on 15 patients.

To evaluate the results of the procedures, preoperative/postoperative photographs were measured. To minimize variation in the data, all images of patients were taken with a single camera, a D70s (Nikon), and were measured by the same person. A frontal view, submental view (also called a worm’s-eye view), and lateral view were taken. To evaluate how the patients differed from the average population, we also measured 100 Asians (50 males and 50 females) who had no demand for rhinoplasty.

Six values were used to evaluate the morphology of the nose (Figure 1). The images in Figure 1 were illustrated using Rapidform 2006 software (INUS Technology, Inc.), after each image was scanned with a noncontact 3-dimensional digitizer (Vivid 910; Konica Minolta). ATC indicates alar-tip-columellar base; N-B, nasion to nasal base; N-T, nasion to nasal tip; and T-B, nasal tip to nasal base.

The ATC angle is the alar-tip-columellar base angle. The ACP angle is the alar–columellar base–philtrum angle. The nasolabial angle is the angular inclination of the columellar as it blends with the upper lip. The nasofacial angle is the angle of the tip-nasion to the nasion–progonion line. The tip angle is the angular inclination of the columellar with the pronasale. We set the values of ratios and angles that ratios and angles are relative magnitudes. Lengths of nasal areas are easily affected by other conditions, such as facial length and width. The values of ratios and angles are a more accurate way to analyze both average people and patients who underwent rhinoplasty.

**SURGICAL TECHNIQUES**

We performed the following 3 surgical techniques on our 36 patients.

**Single-Plate Columellar Strut**

We used a closed approach (marginal incision). Dissection was made from the nasal tip and columella to the nasal spine through a unilateral marginal incision. A high-density porous polyethylene plate (model No. 9536; length × width × thickness, 40 × 9 × 1.1 mm) was used in this technique; the plate was shaped according to the patient’s anatomical and aesthetic demands. The inferior crus of the high-density porous polyethylene columellar strut was fixed to the periosteum of the nasal spine with 1-0 silk braided nonabsorbable suture (Mersilk; Ethicon). The implant was placed in the center of the medial crus of the lower lateral cartilage. An auricular dermis graft was applied to the high-density porous polyethylene plate to release tension in 4 patients. If the patients had an underprojecting dorsum, augmentation rhinoplasty was performed concurrently. We performed augmentation using expanded polytetrafluoroethylene (ePTFE) (Shanghai Suokang Biomedical Co, Ltd) or silicone (Shanghai Xinheng Biomedical Co, Ltd, and Surgiform) for dorsal onlay. After shaping the onlay implant, a hole for the columellar strut was made in the onlay implant. The high-density porous polyethylene columellar strut was stuck on the ePTFE implant (Figure 2). Depending on the patient’s nasal tip tension, an auricular dermis tip graft was applied to relax tension in 8 patients.

**Figure 1.** Illustrations of nasal measurement for comprehension (tip projection, nasolabial angle, nasofacial angle, tip angle, and alar-tip-columellar base angle), illustrated by Rapidform 2006 software, after being scanned with a noncontact 3-dimensional digitizer (Vivid 910; Konica Minolta). ATC indicates alar-tip-columellar base; N-B, nasion to nasal base; N-T, nasion to nasal tip; and T-B, nasal tip to nasal base.

**Figure 2.** Single-plate columellar strut combined with expanded polytetrafluoroethylene (ePTFE) dorsal onlay implant.

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Double-Plate Columellar Strut

All the procedures for the patients with cleft lip nasal deformity were performed using double-plate columellar struts. We performed both open and closed rhinoplasties. In the double-plate technique, the same model of high-density porous polyethylene implant was used as in the single-plate technique. In aesthetic patients, dissection was performed through the nasal tip and columellar to the nasal spine. Extensive dissection of the lower lateral cartilage and the resection of the lateral crus on the cleft side's lower lateral cartilage was performed in patients with cleft lip. Two high-density porous polyethylene plates were shaped on the basis of anatomical and aesthetic demands. The plates were shaped as follows: length × width × thickness, 32 × 9 × 1.1 mm. The inferior crus of the implant was also fixed to the nasal spine periosteum with 1-0 silk sutures in 3 patients. Titanium screws (6 mm; Ningbo Cibei Medical Treatment Appliance Co, Ltd) were applied to columellar struts and the nasal spine for rigid fixation in 3 patients. The implant was placed in the center of the medial crus, as in the single-plate implant placement. The lower lateral cartilage on the cleft side was sutured on the high-density porous polyethylene plates to provide sufficient holding power and to release tension in 8 patients with cleft lip. An interdormal suture was performed to cover the columellar strut for the prevention of direct contact between the implant and the skin. In some cases, augmentation rhinoplasty was performed also. Two high-density porous polyethylene plates were fixed with dorsal onlay implants using 3-0 silk (Figure 3A-C).

Butterfly-Shaped Strut

The butterfly-shaped strut is a uniquely shaped high-density porous polyethylene implant (model No. 84010; length × width × thickness, 37 × 229 × 0.5 mm). A butterfly-shaped strut was implanted in 2 patients with cleft lip nasal deformity who had already received implants of double-plate struts in their columellae. After the implantation of the columellar strut, the patient still presented a poor projection of the lower lateral cartilage. Dissection was made in the anterior lower lateral cartilage to create a pocket in which to place the strut. The medial crus of the butterfly-shaped implant was fixed in the center of the double-plate implant using 5-0 polyglactin 910 (Vicryl; Ethicon) suture. The lateral crus of the butterfly-shaped strut was placed on the anterior surface of the lower lateral cartilage (Figure 4).

RESULTS

One hundred average Asians (50 males and 50 females, all Chinese) were compared with 36 preoperative pa-
patients (13 males and 23 females, all Chinese) (Table 1). Every patient who underwent a procedure was analyzed preoperatively and postoperatively (Table 2). The mean (range) follow-up period was 45.2 (18-110) weeks in male patients and 40.3 (20-82) weeks in female patients. The statistical analysis was performed using SPSS for Windows (SPSS Inc). Data were presented as mean (SD). The comparison of the 2 groups was analyzed using an unpaired *t* test. *P* < .05 was statistically significant.

### Table 1. Average Female and Male Groups vs Preoperative Female and Male Patients

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean (SD)</th>
<th>Preoperative Patients (n = 23)</th>
<th><em>P</em> Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Female</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age, y</td>
<td>28.2 (7.5)</td>
<td>22.2 (3.4)</td>
<td>.001</td>
</tr>
<tr>
<td>Tip projection, mm</td>
<td>0.52 (0.07)</td>
<td>0.45 (0.03)</td>
<td>.001</td>
</tr>
<tr>
<td>ATC angle</td>
<td>39.18 (4.79)</td>
<td>39.74 (3.51)</td>
<td>.62</td>
</tr>
<tr>
<td>ACP angle</td>
<td>-1.28 (5.92)</td>
<td>2.60 (6.51)</td>
<td>.02</td>
</tr>
<tr>
<td>Tip angle</td>
<td>39.60 (3.69)</td>
<td>38.26 (4.62)</td>
<td>.19</td>
</tr>
<tr>
<td>Nasolabial angle</td>
<td>99.64 (5.26)</td>
<td>106.57 (5.37)</td>
<td>.001</td>
</tr>
<tr>
<td>Nasofacial angle</td>
<td>25.94 (2.71)</td>
<td>26.43 (2.17)</td>
<td>.001</td>
</tr>
<tr>
<td><strong>Male</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age, y</td>
<td>27.4 (6.4)</td>
<td>24.0 (5.1)</td>
<td>.08</td>
</tr>
<tr>
<td>Tip projection, mm</td>
<td>0.54 (0.06)</td>
<td>0.49 (0.03)</td>
<td>.003</td>
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<tr>
<td>ATC angle</td>
<td>39.84 (3.08)</td>
<td>41.31 (3.50)</td>
<td>.14</td>
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<tr>
<td>ACP angle</td>
<td>-1.26 (4.19)</td>
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<td>Tip angle</td>
<td>39.16 (3.54)</td>
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<td>.009</td>
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<tr>
<td>Nasolabial angle</td>
<td>99.18 (5.25)</td>
<td>90.38 (4.56)</td>
<td>.001</td>
</tr>
<tr>
<td>Nasofacial angle</td>
<td>31.68 (3.09)</td>
<td>28.85 (1.82)</td>
<td>.002</td>
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</tbody>
</table>

Abbreviations: ACP, alar–columellar base–philtrum; ATC, alar-tip-columellar base.

aData are given in degrees unless otherwise stated.

b*n = 13 for preoperative male patients.

Studies have reported that the ideal standards for the nose are a tip projection of 0.67, an ATC angle of 30° to 35°, an ACP angle of 0° to 5°, a tip angle of 30° to 35° in males and 35° to 40° in females, a nasolabial angle of 90° to 95° in males and 95° to 105° in females, and a nasofacial angle of 30° to 40°. The standard for tip projection, however, needs to be adjusted to 0.60 in Asians, from our experience. Since globalization, the standard of beauty has become identical all over the world. As a result, these ideal standards of the nose have become widely accepted as beautiful among Asians.

There was certain evidence regarding how patients differed from the average group and why they needed rhinoplasties that was gathered by analyzing the 6 values. We found significant differences in the data of the average female group and the preoperative female patients. Four values of the average female group were closer to the ideal standards than those of preoperative patients: a tip projection of 0.52, an ATC angle of 39.18°, an ACP angle of −1.28°, a nasolabial angle of 99.64°, and a nasofacial angle of 29.54°. Three values of the average male group more closely approximated the ideal standards of the nose than those of the preoperative male patients: a tip projection of 0.54, an ATC angle of 39.84°, and a nasofacial angle of 31.68°. These results present the reasons why the patients demanded rhinoplasty: their differences from average people.

The goal of surgery was to improve the 6 values of patients that deviated from the ideal standards. After rhinoplasty, prominent changes in the 6 values were found in both male and female patients. In postoperative female patients, 4 values were improved: the mean change in tip projection was 0.45 to 0.50. The mean change in the ATC angle was 39.74° to 37.47°. The mean change in the nasolabial angle was 106.57° to 102.65°. The mean change in the nasofacial angle was 26.43° to 28.78°. Four of 6 values had been moved closer to the ideal standards in postoperative male patients. The mean change in tip projection was 0.49 to 0.53. The mean change in the ATC angle was 41.31° to 37.69°. The mean change of the tip

### Table 2. Preoperative Female and Male Patients vs Postoperative Female and Male Patients

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean (SD)</th>
<th>Preoperative</th>
<th>Postoperative</th>
<th><em>P</em> Value</th>
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<td><strong>Female</strong></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tip projection, mm</td>
<td>0.45 (0.03)</td>
<td>0.50 (0.04)</td>
<td>.001</td>
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</tr>
<tr>
<td>ATC angle</td>
<td>39.74 (3.51)</td>
<td>37.47 (2.59)</td>
<td>.02</td>
<td></td>
</tr>
<tr>
<td>ACP angle</td>
<td>2.60 (6.51)</td>
<td>1.61 (5.60)</td>
<td>.58</td>
<td></td>
</tr>
<tr>
<td>Tip angle</td>
<td>38.26 (4.62)</td>
<td>35.26 (3.58)</td>
<td>.03</td>
<td></td>
</tr>
<tr>
<td>Nasolabial angle</td>
<td>106.57 (5.37)</td>
<td>102.65 (5.40)</td>
<td>.02</td>
<td></td>
</tr>
<tr>
<td>Nasofacial angle</td>
<td>26.43 (2.17)</td>
<td>28.78 (2.52)</td>
<td>.002</td>
<td></td>
</tr>
<tr>
<td><strong>Male</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tip projection, mm</td>
<td>0.49 (0.03)</td>
<td>0.53 (0.03)</td>
<td>.001</td>
<td></td>
</tr>
<tr>
<td>ATC angle</td>
<td>41.31 (3.50)</td>
<td>37.69 (3.33)</td>
<td>.01</td>
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<tr>
<td>ACP angle</td>
<td>4.54 (3.60)</td>
<td>0.77 (2.31)</td>
<td>.004</td>
<td></td>
</tr>
<tr>
<td>Tip angle</td>
<td>36.31 (2.63)</td>
<td>33.54 (3.38)</td>
<td>.03</td>
<td></td>
</tr>
<tr>
<td>Nasolabial angle</td>
<td>90.38 (4.56)</td>
<td>85.77 (2.74)</td>
<td>.005</td>
<td></td>
</tr>
<tr>
<td>Nasofacial angle</td>
<td>28.85 (1.82)</td>
<td>31.23 (1.83)</td>
<td>.003</td>
<td></td>
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</table>

Abbreviations: ACP, alar–columellar base–philtrum; ATC, alar-tip-columellar base.

data are given in degrees unless otherwise stated.

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angle was 36.31° to 33.54°. The mean change in the nasofacial angle was 28.85° to 31.23°. These improvements prove that high-density porous polyethylene columnellar struts provide adequate support for refined tip definition and the shaping of the columnellar-lobular angle.

Case 1 involved an 18-year-old female patient who reported poor tip definition and a shortened nose. The patient was implanted with a single-plate columnellar strut and ePTFE dorsal onlay using a closed approach (Figure 2). Thirty-six weeks after surgery, prominent changes were found in this case: improved tip definition and a higher radix (Figure 5). The changes can be summarized as follows: tip projection 0.43 to 0.43, ATC angle 45.00° to 38.00°, ACP angle 6.00° to 2.00°, tip angle 32.00° to 34.00°, nasolabial angle 108° to 102°, and nasofacial angle 27.00° to 28.00°. Five values became closer to the ideal standards, although the tip projection ratio did not. The patient expressed satisfaction with the outcome.

Case 2 involved a 21-year-old female patient who reported a low radix, poor tip definition, and a shortened nose. We implanted a double-plate columnellar strut with ePTFE dorsal onlay using an open approach. Upper blepharoplasty was performed concurrently (Figure 3B). Forty-eight weeks after surgery, we could see significant improvement in this patient: refined tip definition, oval nostrils, and a higher radix (Figure 6). The changes

Figure 5. Views before (A) and 36 weeks after (B) the surgical procedure of an 18-year-old female patient who reported poor tip definition and a shortened nose. A single-plate strut with expanded polytetrafluoroethylene dorsal onlay was applied using a closed approach.

Figure 6. Views before (A) and 48 weeks after (B) the surgical procedure of a 21-year-old female patient who reported a low radix, poor tip definition, and a shortened nose. A double-plate columnellar strut was applied with expanded polytetrafluoroethylene dorsal onlay using an open approach. Upper blepharoplasty was performed concurrently.
can be summarized as follows: tip projection 0.40 to 0.43, ATC angle 42.00° to 39.00°, ACP angle 13.00° to 6.00°, tip angle 43.00° to 30.00°, nasolabial angle 102° to 101°, and nasofacial angle 24.00° to 28.00°. Improvement was seen in 3 values: tip projection, the ATC angle, and the ACP angle. The scar on the nasal column was not distinct, and the patient was satisfied with the outcome.

Average Asians have bulbous and inadequate nasal tip definition. In patients with cleft lip nasal deformity, the collapse of the medial and intermediate crura of the lower lateral cartilage seemed more common and severe, which leads to poor tip definition. Kim et al11 found that the reason for the collapse of the medial crus in cleft patients was not hypoplasia but dislocation. In previous studies,12-16 various techniques have been performed to improve tip support. We resected the lateral crus of the deformed side to release it from the pyriform. Resection of the lower lateral crus allows the lower lateral cartilage better movement and correct dislocation. However, we often faced the fact that lower lateral cartilage plasty can provide only limited correction of collapsed noses in Asian cleft lip patients. A high-density porous polyethylene columellar strut can disperse pressure on the nasal column, which causes the collapsed tip, and also can provide sufficient strength to uphold the nasal column. We advocate that a columellar strut be used with lower lateral cartilage correction to provide adequate tip support in patients with cleft lip. Two of the patients with cleft lip also had cleft alveolar. Iliac cancellous bone graft was suggested to the patients before rhinoplasty. However, because of financial issues, the patients did not agree to that surgery. We believe that bone grafts will make the nasal bases plump, resulting in better outcomes in cleft alveolus patients.

Gunter et al17 stated that a columellar strut can be used to maintain tip support, improve tip projection, and help in shaping the columellar-lobular angle. Septal and rib cartilage are preferred for use as a columellar strut. In Asian patients, because sepal cartilage has limited availability and inadequate holding power, surgeons tend to avoid choosing septal cartilage. Rib cartilage has prominent disadvantages, such as scarring, pneumothorax, hematoma, chest wall depression, and pain.5.10 Most important, Asian patients are more prone to severe scarring than other ethnicities. This leads patients to avoid choosing rib cartilage. Resorption is also a common disadvantage in autologous grafts. All these disadvantages have led surgeons to seek allogenic implants.

Even though other allogenic implants (ePTFE and silicone) have been commonly used in rhinoplasty, those implants have inadequate rigidity to provide tip support when used as a columellar strut. High-density porous polyethylene has enough rigidity to provide strength, unlike other allogenic implants, and has a low resorption rate, unlike autologous implants.18 In addition, high-density porous polyethylene has good biocompatibility. Vascular material and tissue can grow into its pores, and it provides stabilized fixation, unlike silicone. Allogenic implants have well-known disadvantages, such as extrusion, displacement, and infection. The infection rate of silicone and ePTFE is higher than that of high-density porous polyethylene implants.19,20 Applying high-density porous polyethylene can also cause disadvantages. However, these can be prevented by applying an auricular dermis tip graft, by using an interdormal suture to cover up the columellar strut to prevent extrusion, or by using sutures or titanium-screw rigid fixation to the nasal spine for displacement and antibiotic-solution (chloramphenicol) irrigation to prevent infection. High-density porous polyethylene has been widely applied in the reconstruction of craniofacial features, such as orbital, zygoma, and mandible augmentation, and has proven its stability and usefulness.21,22 High-density porous polyethylene implants could be an ideal alternative method for Asian rhinoplasty. Redness of the nasal tip was found in only 1 patient who received a single-plate strut with ePTFE onlay graft, without a cartilage tip graft. We believe that this complication derived from hair follicle infection near the incision. The implant was removed in that case. A previous study reported 5 cases of infection in 121 cases of high-density porous polyethylene implant rhinoplasty, and no other complications, such as extrusion or exposure, were found.23,24 As in previous studies, no other complications were found in our other patients. Romano et al22 and Merritt et al25 have reported that vascularized tissue ingrowth reduces the infection of high-density porous polyethylene implants and also prevents dislocation and extrusion. These results could suggest that the overall complication rate of high-density porous polyethylene is lower than that of other alloplastic materials.

To understand Asian noses and set goals for rhinoplasty, the measurement of the nose is required. An accurate analysis of the nose will help surgeons achieve better results. Traditionally, rib cartilage and septal cartilage have been widely used for columellar struts. However, many patients are unwilling to use rib cartilage because of its morbidity. Septal cartilage is not always the best option in Asian patients because of limited supply and inadequate support. L-shaped alloplasts, such as ePTFE and silicone, have inadequate tip support when used as columellar struts. High-density porous polyethylene implants not only can avoid the disadvantages of autologous implants but also can overcome the defects of other allogenic implants. The application of high-density porous polyethylene may provide the best alternative columellar strut.

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