Measurement of Preoperative and Postoperative Nasal Tip Projection and Rotation

Koen Ingels, MD, PhD; Kadir S. Orhan, MD

Objective: To measure the effect of columellar struts and cephalic trim on tip projection and tip rotation using digitized photographs.

Methods: Using photographs of 62 patients who underwent external rhinoplasty, we retrospectively analyzed nasal tip projection (the Goode method) and rotation (nasolabial angle) before and after surgery. A cartilaginous strut was used in 36 patients, whereas 26 patients did not receive a strut. Patients were categorized into 4 subgroups, depending on the placement of a strut (placement, strut+/H11001 vs nonplacement, strut−) and the removal of the cephalic margin (removal, cephalic+/H11001 vs nonremoval, cephalic−) of the lateral crus: strut−/cephalic−, n=17; strut+/cephalic−, n=23; strut−/cephalic+, n=9; strut+/cephalic+, n=12.

Results: Nasal tip projection, measured with the Goode method, increased from 0.58 to 0.60 (P=.02) in the strut+/H11001 group; in the strut− group, nasal tip projection did not change significantly. Nasolabial angle increased from 93.96° to 100.92° in the strut+/cephalic− group and from 88.30° to 95.06° in the strut+/cephalic+ group. Removal of the cephalic margin alone (strut−/cephalic−/H11001) hardly affected tip rotation (P=.05).

Conclusions: The external rhinoplasty approach did not lead to a decrease in nasal tip projection. A cartilaginous strut slightly increased nasal tip projection and also increased nasal tip rotation. This effect was accentuated by the removal of the cephalic margin of the lateral crus.

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To our knowledge, very few studies have made objective evaluations of postoperative changes in nasal tip projection (NTP) and nasal tip rotation (NTR) after rhinoplasty. It is difficult to measure facial morphometry based on photographs. Absolute parameters cannot be used if the position of the head is not identical when the preoperative and postoperative photographs are taken. Relative measurements are more reliable, but they are time consuming and have not been validated.

In the literature, several methods have been described to evaluate the NTP. The greater the distance between the tip and the face, the larger the NTP. As a measure of NTP, the distance between the alar root and the tip of the nose can be divided by the distance between the nasion and tip. This relative measurement is also known as the Goode method. Nasal tip position can also vary in a superoinferior direction (cranio-caudal), which is called the NTR. It is expressed as the nasolabial angle. The nasolabial angle in men ranges from 90° to 105°, and in women from 105° to 120°. When the angle is larger than the given value, it is referred to as overrotation of the nasal tip. When it is smaller, the term underrotation is used, also known as a dropping tip.

Larrabee has ascribed the tripod concept of the nasal tip to Jack R. Anderson, MD. In this concept, the nasal tip is represented as a tripod. Two legs are made up by the lateral crura, while the third leg is composed of the united medial crura in the columella (Figure 1). If one or more legs of the tripod is changed, this will have repercussions on the position of the nasal tip. When, for example, a cartilaginous strut is sutured between the medial crura, which will reinforce the medial inferior leg of the tripod, then the tip rotates upward. The same effect can be achieved by removing the cephalic margin of the lateral crus, which will weaken the 2 upper legs of the tripod.

In the present study, we measured NTP and NTR with a commercially available computer image processing program. We also attempted to correlate the tripod concept with the data obtained by this computer-assisted method.
A retrospective study was performed on the photographs of 62 patients who underwent primary external septorhinoplasty to modify the nasal tip tripod. Fifty-three patients (85%) needed a septum correction where the caudal end of the cartilage was resected and sutured to the anterior nasal spine. Surgery of the tip tripod involved placement of a columellar strut and/or partial removal of the cephalic margin of the lateral crus. No further major or minor tip support mechanisms were changed; neither tongue-and-groove techniques nor shield grafts were used. All the operations were performed by one of us (K.I.) in the period between 1998 and 2002. Preoperative and postoperative (6 months) digital photographs were taken in a standardized way. When a strut was placed, it was sutured between the medial crura and never surpassed the level of the domes.

Preoperative and postoperative photographs were taken with a 35-mm Nikon FM2 camera (Melville, NY) and a studio-grade electronic flash unit. We used a 105-mm macro portrait lens with a focal length of 1:2.8, and an aperture number (f-stop) of 16. In the lateral view, the viewfinder was focused on the Frankfort line at the lateral canthus at a fixed distance of 1.3 m. To ensure proper and uniform photographic size, focusing was achieved by moving the camera, not by adjusting the lens. Despite this professional equipment, negligible variances may have occurred from picture to picture. To rule out these deviations, we did not measure absolute millimeters but only used relative measures like the Goode method and nasolabial angle.

The 35-mm film slides were then digitized with a Hewlett-Packard Photo Smart photographic scanner (Palo Alto, Calif) at a resolution of 300 dots per inch. The NTP and NTR were computed with Adobe Photoshop, version 5 (Adobe Systems Inc, San Jose, Calif) according to the Goode method and by measuring the nasolabial angle, respectively. The measurements were performed by an independent researcher who was not aware of the preoperative or postoperative situation.

**METHODS**

A right profile view was chosen, and a line was drawn between the alar root (Al) and the nasal tip (NTi) (perpendicular to a line between the nasion [Na] and Al). Photoshop allows measurement of the distance between 2 selected points. This absolute length was divided by the distance between the Na and NTi, which resulted in the following equation for the relative measure: \[ NTP = \frac{\text{distance between Al and NTi}}{\text{distance between Na and NTi}} \] (Figure 2).

Adobe Photoshop was used to measure the nasolabial angle between 2 lines drawn parallel to the upper lip and columella (Figure 3 and Figure 4). The Wilcoxon signed rank test was applied for statistical analysis of the data, using SPSS software, version 12.0.1 (SPSS Inc, Chicago, Ill).

**RESULTS**

We were able to collect data from 62 patients whose preoperative and postoperative photographs were well documented.

**NASAL TIP PROJECTION**

The NTP results are detailed in Table 1. Patients were divided into 2 groups according to whether a nasal strut had been placed: 36 patients received a strut, whereas 26 patients did not. Preoperatively, mean NTP was 0.58 in the 2 groups by the Goode method. Postoperatively, there were minor increases in projection to 0.60 and 0.59 in the 2 groups with and without strut placement, respectively. The difference between preoperative and postoperative NTP was only significant in the group with strut placement (P = .02).

In 6 patients, a second measurement was performed 12 months postoperatively. No significant change in NTP could be detected between 6 and 12 months (P = .75).

**NASAL TIP ROTATION**

The NTR results are detailed in Table 2. One patient underwent strut placement in combination with unilateral marginal resection of the lateral crus because of asymmetry. Therefore, he was excluded, which left a total of 61 patients for our analysis.

According to the tripod concept, the patients could be divided into 4 groups depending on the placement of a strut (placement, strut + vs nonplacement, strut −) and the removal of the cephalic margin (removal, cephalic + vs removal, cephalic −). The 35-mm film slides were then digitized with a Hewlett-Packard Photo Smart photographic scanner (Palo Alto, Calif) at a resolution of 300 dots per inch. The NTP and NTR were computed with Adobe Photoshop, version 5 (Adobe Systems Inc, San Jose, Calif) according to the Goode method and by measuring the nasolabial angle, respectively. The measurements were performed by an independent researcher who was not aware of the preoperative or postoperative situation.

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Figure 2. Measurement of preoperative (A) and postoperative (B) nasal tip projection (NTP) using Adobe Photoshop (Adobe Systems Inc, San Jose, Calif) and the following equation: NTP = the distance between Al and NTi divided by the distance between Na and NTi, where Al indicates alar length; NTi, nasal tip; and Na, nasion length. A, Preoperative NTP = 0.40. B, Postoperative NTP = 0.58.

Figure 3. Measurement of a woman’s nasal tip rotation with Adobe Photoshop (Adobe Systems Inc, San Jose, Calif). The angle between the 2 lines drawn parallel to the upper lip and the columella represents the nasolabial angle. A, Preoperative nasolabial angle, 89°. B, Postoperative nasolabial angle after hump reduction and strut placement, 96°.
The angle between the 2 lines drawn parallel to the upper lip and the columella represents the nasolabial angle. A, Preoperative nasolabial angle, 85°. B, Postoperative nasolabial angle after minor hump reduction, strut placement, and resection of cephalic margin, 93°.

**Figure 4.** Measurement of a man’s nasal tip rotation with Adobe Photoshop (Adobe Systems Inc, San Jose, Calif). The angle between the 2 lines drawn parallel to the upper lip and the columella represents the nasolabial angle. A, Preoperative nasolabial angle, 85°. B, Postoperative nasolabial angle after minor hump reduction, strut placement, and resection of cephalic margin, 93°.

**Table 1. Goode Method Tip Projection Measures in Patients Who Underwent Rhinoplasties**

<table>
<thead>
<tr>
<th>Measurement Time</th>
<th>Strut (n = 36)</th>
<th></th>
<th>No Strut (n = 26)</th>
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<tbody>
<tr>
<td></td>
<td>P Value†</td>
<td></td>
<td>P Value†</td>
<td></td>
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<tr>
<td>Preoperative</td>
<td>0.58 (0.05)</td>
<td>.02</td>
<td>0.58 (0.05)</td>
<td>0.59 (0.06)</td>
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<tr>
<td>Postoperative</td>
<td>0.60 (0.06)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Unless otherwise indicated, data are reported as mean (SD).
†Wilcoxon signed rank test.

**Table 2. Nasolabial Angle Measures From 4 Different Surgical Procedures**

<table>
<thead>
<tr>
<th>Measurement Time</th>
<th>Strut-/Cephalic− (n = 17)</th>
<th>P Value†</th>
<th>Strut+/Cephalic− (n = 23)</th>
<th>P Value†</th>
<th>Strut-/Cephalic+ (n = 9)</th>
<th>P Value†</th>
<th>Strut+/Cephalic+ (n = 12)</th>
<th>P Value†</th>
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<tbody>
<tr>
<td>Preoperative</td>
<td>96.75 (18.63)</td>
<td>.46</td>
<td>93.96 (14.45)</td>
<td>.006</td>
<td>94.22 (12.44)</td>
<td>.05</td>
<td>88.30 (10.26)</td>
<td>.006</td>
</tr>
<tr>
<td>Postoperative</td>
<td>97.25 (11.10)</td>
<td></td>
<td>100.92 (10.10)</td>
<td></td>
<td>102.03 (11.04)</td>
<td></td>
<td>95.06 (9.46)</td>
<td></td>
</tr>
</tbody>
</table>

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Nonremoval, cephalic−) of the lateral crus: strut−/cephalic−, n = 17; strut+/cephalic−, n = 23; strut−/cephalic+, n = 9; strut+/cephalic+, n = 12. In the strut−/cephalic− group, there was no difference between the preoperative and postoperative situation. In the strut+ groups, the preoperative and postoperative results differed significantly (P = .006). The nasolabial angle was larger in the strut+/cephalic− group (93.96°-100.92°) than in the strut+/cephalic+ group (88.30°-95.06°). Removal of the cephalic margin alone (strut−/cephalic+) changed the NTR from 94.22° to 102.03°, which was marginally significant (P = .05).
According to many authors, rhinoplasty is an art in which the craftsmanship can only be developed by means of thorough diagnostic observation and training. The tripod concept offers a good method to make preoperative tip alteration plans, and even experienced surgeons need these plans as a guideline to predict the new position and form of the nasal tip based on the surgical technique under consideration. Therefore, our results need to be analyzed continuously to better understand nasal tip physiology.

NASAL TIP PROJECTION

An external rhinoplasty approach destroys some of the minor nasal tip support mechanisms that subsequently need to be repaired. A strut is said to be a versatile method to avoid collapse of the tip by preventing it from “falling off the cartilaginous nasal pyramid.” In the present study, we found that strut placement led to only a slight increase in NTP. This is in agreement with the conclusion drawn by Vuyk et al that a columellar strut maintains NTP. However, all of our patients underwent an external rhinoplasty approach that damaged the minor tip support mechanisms, but we could not demonstrate any deprojection in the strut− group. These effects seem to be long lasting, since there was no difference in a subgroup of 6 patients in tip projection between 6 and 12 months.

NASAL TIP ROTATION

Our results showed clearly that NTR was not influenced when no changes had been made to the tripod (strut−/cephalic−). In contrast, in the strut+ group, there was a significant increase of the nasolabial angle of almost 7°, an increase similar to that found in the strut+/cephalic+ group. However, the strut+/cephalic− group had a more pronounced initial situation with a sharper nasolabial angle of 88.3° compared with 93.96° in the strut+/cephalic− group. Therefore, it appeared that the more pronounced cases needed not only a strut to obtain a similar increase in NTR but also cephalic lateral crus resection.

Most of our results were in accordance with the tripod concept. A strut strengthened the medial leg of the tripod and resulted in upward NTR. Removal of the cephalic margin of the lateral crus alone, however, seemed unable to achieve similar rotation. In combination with strut placement, removal of the cephalic margin led to considerable NTR in the cases with the smallest nasolabial angle. All in all, our results validated the tripod concept and indicated that it is a useful instrument in preoperative rhinoplasty planning.

Working with Adobe Photoshop proved to be a valuable method to evaluate operative results. The relative way of expressing parameters in ratios seemed reliable and formed a good alternative to measuring photographs with a ruler. It is important for each individual surgeon to continuously analyze the postoperative results to be able to predict morphologic changes associated with specific techniques.

In conclusion, the external rhinoplasty approach evaluated in the present study did not cause any decrease in NTP. The Goode method showed that a strut alone hardly increased NTP. However, a strut increased NTR, which was accentuated by removal of the cephalic margin.

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