The Two Essential Elements for Planning Tip Surgery in Primary and Secondary Rhinoplasty: Observations Based on Review of 100 Consecutive Patients

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Nasal tip surgery has become significantly more complex since the introduction of tip grafting and the many suture designs that followed the resurgence of open rhinoplasty. Independent of the surgeon’s technical approach, however, is the need to identify the critical anatomical characteristics that will make nasal tip surgery successful. It is the author’s contention that only two such features require mandatory preoperative identification: (1) whether the tip is adequately projecting and (2) whether the alar cartilage lateral crura are orthotopic or cephalically rotated (“malpositioned”). Data were generated from a review of 100 consecutive primary rhinoplasty patients on whom the author had operated. The results indicate that only 33 percent of the entire group had adequate preoperative tip projection and only 54 percent had orthotopic lateral crura (axes toward the lateral canthi). Forty-six percent of the patients had lateral crura that were cephalically rotated (axes toward the medial canthi). Both inadequate tip projection and convex lateral crura were more common among patients with malpositioned lateral crura (78 percent and 61 percent) than in patients with orthotopic lateral crura (57 percent and 20 percent, respectively). Tip projection can be reliably assessed by the relationship of the tip lobule to the septal angle. Malposition is characterized by abnormal lateral crural axes, long alar creases that extend to the nostril rims, alar wall hollows, frequent nostril deformities, and associated external valvular incompetence.

The data suggest that the surgeon treating the average spectrum of primary rhinoplasty patients will see a majority (61 percent) who need increased tip support and a significant number (46 percent) with an anatomical variant (alar cartilage malposition) that places these patients at special risk for postoperative functional impairment. Correction of external valvular incompetence doubles nasal airflow in most patients. As few as 23 percent of primary rhinoplasty patients (the number with orthotopic, projecting alar cartilages in this series) may be proper candidates for reduction-only tip procedures. When tip projection and lateral crural orientation are accurately determined before surgery, nasal tip surgery can proceed successfully and secondary deformities can be avoided.

those surgeons who prefer the days when the only alar cartilage technique was reduction.

Independent of the surgeon’s technical approach, however, is the need to identify the critical anatomical characteristics that make nasal tip surgery successful. It is the author’s contention that only two tip features need mandatory preoperative identification, regardless of the surgeon’s technical plan: (1) whether the tip is adequately projecting and (2) whether the alar cartilage lateral crura are orthotopic or cephalically rotated (“malpositioned”).1

The degree of tip projection must be accurately assessed because a straight postoperative profile cannot be obtained without adequate projection. The lateral crural axis must be identified because cephalically rotated lateral crura not only produce characteristic tip configurations that may modify the surgical plan but also provide insufficient structural support to the external nasal valves. The degree of external valvular competence must be assessed preoperatively to avoid inadvertent injury to the nasal airway.

The purpose of this article is to describe the incidence of these two alar cartilage characteristics in 100 consecutive primary rhinoplasty patients on whom the author operated, and to detail the practical implications of tip projection and lateral crural orientation for planning and performing primary and secondary rhinoplasty.

PATIENTS AND METHODS

Patient Population

A chart review was performed of 100 consecutive primary rhinoplasty patients (81 women, 19 men) on whom the author had operated before February of 2002 and in whom postoperative follow-up had been at least 12 months. The mean patient age was 36 years (range, 14 to 72 years).

Surgical Technique

All reconstructive rhinoplasties were performed endonasally. Inferior turbinectomy was not performed. I use Sheen and Sheen’s methods with very few modifications.2–5 Only autogenous materials were used for the nasal reconstructions; unless specifically stated otherwise, all grafts were created from septal cartilage and bone. A brand of expanded polytetrafluoroethylene (1-mm Gore-Tex SAM facial implant; W. L. Gore and Associates, Flagstaff, Ariz.) provided maxillary augmentation in some cases.

Cephalically rotated lateral crura that were sufficiently convex or malformed were exposed through incisions 2 to 3 mm above each alar rim and therefore caudal to the malpositioned lateral crural edges. Each crus was separated by sharp dissection from its external and vestibular skin attachments, resected at the lateral genu, lightly

Fig. 1. Technique of resection and replacement of malpositioned lateral crura used in most patients. (Left) Resected lateral crus, divided at the lateral genu. (Right) Crus flattened, trimmed, and placed along the alar rim.
crushed, trimmed to the appropriate size, and replaced along the alar rim, where it was immobilized by catching the edge of the graft in the wound closure with 6-0 chromic suture (Fig. 1).

**Definition of Anatomic Terms**

The anatomic characteristics being tabulated were defined as follows: “adequate tip projection” defined any tip that projected to or beyond the level of the anterior septal angle, whereas “inadequate tip projection” defined any tip that did not project to the level of the anterior septal angle.\(^6\) Lateral crural orientation was defined by the axis of the crus lateral to the lateral genu. In patients with orthotopic lateral crura, each axis ran toward the lateral canthus of the ipsilateral eye (Fig. 2).

**Fig. 2.** (Above) Patient with orthotopic lateral crura and (below) patient with malpositioned lateral crura. Both patients have adequate tip projection. (Left) Preoperative views and (right) 2-year postoperative views. Note the surface contour conferred by the different lateral crural positions.
In patients with cephalically rotated lateral crura, the axis ran toward the ipsilateral medial canthus (Fig. 2, below and inset). For brevity and because the original term 1 is familiar to most readers, “malpositioned” will be used in this article to describe cephalically rotated lateral crura.

Rhinomanometric Measurements and Statistical Methods

Inspired nasal airflow was measured preoperatively and at postoperative intervals according to a protocol described previously, using anterior mask rhinomanometry in airways decongested by topical 1% phenylephrine hydrochloride to minimize the effects of mucosal factors and nasal cycling. Independent measurements were made of each nasal passage during a standard 14-second test. Geometric mean nasal airflow was calculated as the square root of the product of the volumes inspired through each airway. The development and rationale of our methods have been documented previously.

RESULTS

In this group of 100 consecutive primary rhinoplasty patients, only 33 percent had adequate preoperative tip projection; 67 percent had inadequate tip projection. Fifty-four percent had orthotopic alar cartilage lateral crura, whereas 46 percent had malpositioned lateral crura (Table I). There was no overlap between this group and previous series reported by the author. Even for the experienced surgeon, it is easy to get overwhelmed by the options and become distracted from the primary issue in planning tip surgery, that of making the correct diagnosis.

If the goals of any rhinoplasty are reduced to their simplest elements (creating a straight dorsum and maintaining or increasing the size of the airway), the alar cartilages participate in both objectives by controlling tip projection and external valvular support. Even without considering the nuances of tip angularity, lobular size, nostril proportion, and other factors, the surgeon who can accurately assess tip projection and external valvular support is already prepared to devise an operative plan that will safely achieve the two goals of a straight dorsum and optimal airway. Conversely, if tip strength and anatomy are not accurately identified before surgery, other details become less relevant because an unfavorable outcome is likely.

Each segment of the alar cartilage crura serves a different primary purpose: the medial crura support the columella; the middle crura determine tip projection and contour; and the lateral crura support external valvular function. Although it could reasonably be argued that the medial crura, intranasal ligaments, and dorsal height also provide tip support, the majority of tip projection and external valvular support derive from middle and lateral crural volume, substance, and position.

“Tip projection” has been used to connote different things by different authors, but for the purposes of this article and in my own practice I have found that the most valuable indicator of middle crural strength is the position of the tip relative to the septal angle. Other surgeons have assessed tip projection by measuring the distance of the most projecting point of the tip from some facial parameter, but such criteria do not provide equivalent information.

<table>
<thead>
<tr>
<th>Lateral crural position</th>
<th>Patients</th>
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<tbody>
<tr>
<td>Orthotopic</td>
<td>54%</td>
</tr>
<tr>
<td>Malpositioned (cephalically rotated)</td>
<td>46%</td>
</tr>
<tr>
<td>Tip projection</td>
<td></td>
</tr>
<tr>
<td>Adequate (tip supported to septal angle)</td>
<td>33%</td>
</tr>
<tr>
<td>Inadequate (tip not supported to septal angle)</td>
<td>67%</td>
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</tbody>
</table>
Table II. Relationship of Lateral Crural Orientation to Tip Projection/Configuration in 100 Consecutive Primary Rhinoplasty Patients

<table>
<thead>
<tr>
<th>Lateral Crural Orientation</th>
<th>Comparative Relative Frequency of Occurrence</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Adequate Projection</td>
</tr>
<tr>
<td>Orthotopic (n = 54)</td>
<td>43%</td>
</tr>
<tr>
<td>Malpositioned (cephalically rotated) (n = 46)</td>
<td>22%</td>
</tr>
</tbody>
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Fig. 3. Patient with convoluted, malpositioned lateral crura and adequate tip projection. (Left) Preoperative views. (Right) Twenty-four-month postoperative views after lateral crural resection and replacement, nasal shortening, and radix, spreader, and tip grafts. Geometric mean nasal airflow increased 12 times over preoperative measurements.
not easily apply to patients with large nasal bases (Figs. 3, 4, 6, and 7). In such patients, tip projection may be inaccurately assessed as “adequate” by the relative distribution of lower nasal skin, but that judgment is not the same as determining that the alar cartilages can support the tip independent of dorsal height, one critical prerequisite for a straight profile line. The patients in Figures 4 and 5 have short, poorly projecting middle crura; the patient in Figures 6 and 7 has had the majority of her alar cartilages removed. In all three women, skin surface measurements would indicate adequate tip projection, though that is clearly not the case. The data generated from this study indicate

**Fig. 4.** Patient with bilateral, flat, malpositioned lateral crura and inadequate tip projection.  
*(Left)* Preoperative views. *(Right)* One-year postoperative views after resection and relocation of the lateral crura, minimal dorsal reduction, nasal shortening, and radix, spreader, and tip grafts. Note the apparent diminution in nasal base size achieved by tip rotation and elevation of the radix. Postoperative airflow doubled over preoperative measurements.
that 67 percent of 100 consecutive primary rhinoplasty patients had inadequate tip projection. Inadequate projection was similarly present in 80 percent of the patients in my previous series of 150 consecutive secondary and tertiary rhinoplasties\(^8\) and in 78 percent of a current review of such patients seen in consultation\(^8\); therefore, unrecognized inadequate tip projection is one of the most common reasons for an unfavorable postoperative result.\(^8\)

Fig. 5. Patient with malpositioned, convex lateral crura and inadequate tip projection (the most commonly observed phenotype in this 100-patient series). (Left) Preoperative views. (Right) Twenty-month postoperative views after resection and relocation of the lateral crura, dorsal reduction, and radix, spreader, and tip grafts. Note the ablation of the alar wall hollows and the alteration in alar rim contour following lateral crural relocation. Postoperative nasal airflow increased four times over preoperative measurements.
Fig. 6. Secondary rhinoplasty patient in whom lateral crural malposition was present (inset, left) preoperatively; the patient was treated before the entity was described. (Left) Preoperative views. Note the deepening of the alar grooves and nostril distortion after loss of external valvular support. The middle vault collapse and maxillary retrusion are the consequence of a coexistent septal collapse. (Right) Fifteen-month postoperative views after resection and relocation of the alar cartilage lateral crura, Gore-Tex maxillary augmentation, and dorsal, spreader, and tip grafts. Coronally oriented composite grafts were placed to complete the nostril reconstruction. Airflow increased 11 times over preoperative measurements.
When Sheen described alar cartilage malposition in 1979, he considered this anatomical variation to be an uncommon phenotype that imparted a broad shape to the nasal tip and created characteristic “parentheses” on frontal view. Sheen’s observations and my own since then, however, indicate that malposition is not rare. Nearly half (46 percent) of the patients in the current series of primary patients had lateral crural malposition. The high incidence of secondary deformities and airway obstructions attributable to this normal anatomical variant (84 percent in a current review of 50 consecutive secondary and tertiary patients seen in consultation) suggests that the majority of surgeons are not diagnosing malposition preoperatively.

Malposition is not only an aesthetic problem but also a technical and functional one. The abnormal position of the lateral crura places them at special risk for intracartilaginous incisions, which transect the malpositioned lateral crura instead of only splitting the intended cephalic portions. When the lateral crura are removed or weakened, the alar wall deformities are characteristic (Figs. 6 and 7). It is important to recognize that these same identifying characteristics also exist in the primary patient: long alar creases that extend to the alar rims (Figs. 2, above, right, and below, left, 3, and 5), alar wall hollows (Figs. 3 through 5), and/or eversion of the nostril rims (Fig. 3). Many patients with external valvular incompetence unconsciously flare their nostrils to avoid inspiratory collapse and airway obstruction (Fig. 3), an observation that I made in earlier publications and that remains one of the most frequent characteristics of secondary rhinoplasty patients. Not every malposition patient has obvious “parentheses” (Fig. 2, below, left, and 5 through 7), but all have abnormal alar cartilage axes and long alar creases and most share the other common phenotypical traits just enumerated.

The axes of malpositioned lateral crura cannot provide adequate external valvular support. Our previous reports have indicated that approximately 50 percent of patients presenting with airway obstruction at the external nasal valves have alar cartilage malposition. Adequate treatment of this anatomical variant requires resection and replacement of the lateral crura or, at the very least, augmentation of external valvular support with autogenous grafts. In secondary cases and in most primary patients, I have found that resection, light crushing, and replacement of an appropriately sized graft (Fig. 1) is the most dependable method of relocating the lateral crus. I have tried simple mobilization, caudal or cephalic trimming, and scoring of the concave surface, and each method works sometimes, but secondary deformities are common. In secondary patients, lateral crural replacement with conchal cartilage or...
even composite grafts may be necessary (Figs. 6 and 7), depending on the degree of scarring and the extent of soft-tissue contraction following the previous surgeries. In fact, a preexisting malposition is one of the most common indications for composite grafting in my practice. Even in primary cases, however, the salutary effect of repositioning the lateral crus upon alar rim contour is obvious (Figs. 3, 5, and 7).

Geometric mean nasal airflow typically doubles after external valvular reconstruction. The higher airflow improvements seen in the patients reported here are not unusual, however. The majority of these patients had severely compromised airways preoperatively, which allows dramatic postsurgical changes. Furthermore, many patients with external valvular incompetence have coexistent internal and/or septal obstructions, and the improvements from corrections at each site are additive. Note also that the secondary patient in Figures 6 and 7, who had undergone a previous septoplasty, had an airflow improvement similar in magnitude to that of the primary patients, once again underscoring the relative importance of valvular function in the hierarchy of possible causes of nasal airway obstruction.

The data also indicate an association between lateral crural position and tip projection (Table II). Although the incidence of inadequate tip projection was higher than that for adequate projection in either lateral crural configuration, 78 percent of patients with cephalically rotated lateral crura had inadequate projection, in contrast to 57 percent of those with orthotopic lateral crura. The effect of lateral crural position on middle crural length (and therefore tip projection) is characteristic and evidenced by a comparison of the patients shown in Figures 4 and 5 (who have inadequate projection) with the patient in Figure 3 (who has adequate projection).

Lateral crural axis was also associated with an apparent difference in lateral crural contour: 61 percent of the cephalically rotated lateral crura were excessively convex (as shown in the patient in Figure 5), as opposed to only 20 percent of the orthotopic lateral crura. Although malpositioned lateral crura are characteristically identified by the “parentheses” that they confer on tip lobular shape, their relationship to the “ball” and “box” tip is also strong and is the subject of a forthcoming publication.

In view of the popularity of open rhinoplasty, the reader should recognize that both tip projection and lateral crural position must be diagnosed preoperatively rather than intraoperatively once surgery has begun. The creation of an infracartilaginous incision and separation of the dense soft-tissue attachments to the medial crura each create artifacts that make it easy for the surgeon to lose his or her landmarks. Unless the position of the lateral crus relative to the alar rim and to the medial and lateral canthi is determined beforehand, cephalic rotation may look erroneously orthotopic once the nose has been opened. Not all malpositioned lateral crura need repositioning, but almost all have functional ramifications: Either the external valves are already incompetent or valvular support is potentially threatened by the surgeon’s intraoperative maneuvers.

Despite the referral nature of my rhinoplasty practice, which is currently 80 percent secondary and tertiary cases, it is likely that the primary cases surveyed in this report represent a spectrum that is characteristic of most plastic surgeons’ practices. If that assumption is true, the data presented indicate that a relatively small percentage of primary rhinoplasty patients (Fig. 2, above) are suitable candidates for straightforward alar cartilage resection techniques. Only 54 percent of patients in this study had orthotopic lateral crura, of which only 43 percent (23 of the 100 patients in the entire study) also had adequate tip projection. The data suggest that the surgeon treating the average spectrum of primary rhinoplasty patients will see a majority (67 percent) who need increased tip support, a significant number (46 percent) of patients with an anatomical variation (cephalic rotation of the lateral crura) that puts them at special risk for postoperative functional impairment, and a minority (23 percent) who can be treated by alar cartilage reduction alone. Aside from the technical approach and the specifics of any individual case, accurate assessment of tip projection and recognition of alar cartilage malposition are the two essential elements in successful preoperative tip rhinoplasty planning.

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REFERENCES