Elaboration of an Alternative, Segmental, Cartilage-Sparing Tip Graft Technique: Experience in 405 Cases

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Despite the value of tip grafting in many rhinoplasty patients, adequate donor cartilage may be unavailable in secondary and even primary patients whose donor sites have been harvested previously or whose septal cartilage is calcified. Furthermore, by enlarging the lobule, tip grafts can create undesirable postoperative disproportions in some patients. These two observations have stimulated the elaboration of a tip graft method (which evolved from the Sheen technique) that uses small amounts of autogenous donor material to augment only those lobular segments that require increased contour or support, without necessarily increasing overall lobular volume. This article reports experience with the technique in a 405-patient study group.

Segmental tip grafting is performed endonasally through access incisions along the caudal edge of one alar cartilage. Grafts augment each third of the tip lobule and anterior columella (corresponding to each of the alar cartilage crura) depending on the aesthetic objective; multiple grafts are always placed. Selective augmentation limits the overall increase in lobular size. The method is not suitable for those patients needing substantial augmentation (58 of 463 tip-grafted patients in the 6-year study period), in which case the author still prefers the Sheen technique.

The records of the 405-patient study group (40 percent primary rhinoplasty, 60 percent secondary rhinoplasty) indicate a total nasal revision rate of 14 percent; 6 percent were tip revisions. Tip revisions were more frequent in secondary patients but not in patients with thin skin. Reoperation percentages decreased during the study term, so that the tip revision rate was 12 percent in the first 12 months of study but only 4 percent in the last 12 months ($p < 0.0008$).

The primary indication for tip grafting has evolved since the author’s earlier practice experience: in the past 3 years of the study, 77 percent of primary patients and 80 percent of secondary patients underwent grafting principally to improve lobular contour, not tip projection ($p < 0.0005$).

A segmental, cartilage-sparing tip graft technique can provide both projection and contour for primary and secondary rhinoplasty patients. Nevertheless, tip imperfections remain the most common reason for revision in the author’s practice. (Plast. Reconstr. Surg. 103: 237, 1999.)

Cartilage grafting has become an increasingly important component of tip reconstruction for both primary and secondary rhinoplasty. As originally described,1-3 grafts were proposed as a method of increasing tip projection. However, the surgeon who uses tip grafts commonly will find that they can also alter tip lobular and nostril contour; increase lobular volume (reducing relative nostril size); impart a different ethnic character4,5; and enlarge the nasal base, therefore changing the balance between dorsal height and tip projection.4,6-8

The two most common graft designs are the “shield” graft popularized by Sheen and Sheen2,4,8 and the cephalic transverse onlay graft, with or without a columellar strut, popularized by Peck.3,9

In clinical practice, the successful application of either tip graft technique as classically described may be difficult. Aside from the commonly cited problems of graft visibility, absorption, or malposition,4,8,10,11 the great majority of which can be overcome by technical precision and experience, tip grafting presents two other potential problems. The first is that either tip graft technique, by definition, augments the tip lobule; therefore grafts large enough to produce the desired tip projection can enlarge the lobule and nasal base beyond proportions

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that may be desirable in some patients. Secondly, either tip graft technique requires cartilage pieces of a minimum appropriate size; small scraps will not do. Adequate autogenous donor cartilage may be unavailable not only in secondary rhinoplasty patients, where donor sites have been harvested previously, but even in primary patients whose septal cartilage may be brittle, calcified, or present in inadequate amounts.

In the author’s practice, where secondary rhinoplasty now comprises more than 66 percent of the nasal surgeries performed, the so-called graft-depleted patient has necessitated the elaboration of a tip graft method that uses lesser amounts of donor material while never-

Fig. 1. Patients with large preoperative tip lobules. Tip grafting undesirably increases lobular size in these patients.
TABLE I
Patients Studied from June of 1991 to June of 1997
(n = 405)

<table>
<thead>
<tr>
<th></th>
<th>Mean Age (ys) (range)</th>
<th>No. of Primary Rhinoplasties</th>
<th>No. of Secondary Rhinoplasties</th>
</tr>
</thead>
<tbody>
<tr>
<td>Men</td>
<td>96 34 (14-72)</td>
<td>24</td>
<td>72</td>
</tr>
<tr>
<td>Women</td>
<td>309 31 (14-73)</td>
<td>136</td>
<td>173</td>
</tr>
<tr>
<td>TOTAL</td>
<td>405</td>
<td>100</td>
<td>245</td>
</tr>
</tbody>
</table>

Follow-up (mos)
Mean = 17.0
Median = 12.0
Range = 6-66

Nevertheless, the technique has evolved empirically from the Sheen tip graft technique and has been used essentially without modifications since June of 1991. This modified method is not suitable for those patients needing substantial augmentation (58 of 463 tip-grafted patients in the study period reported herein); for such patients I have found that the Sheen method produces superior results.

The purpose of this article is to describe the technique, indications, applications, and limitations of an alternative, segmental, cartilage-sparing tip graft technique in 405 consecutive patients for whom the method was used.

METHODS

Patients Studied

Four hundred five consecutive patients (96 men, 309 women; 160 primary rhinoplasties, 245 secondary rhinoplasties) operated on between June 1, 1991, and June 30, 1997, according to the technique described in this article comprise this prospective series (Table I). These patients represent 87 percent of the 463 rhinoplasty patients who were tip-grafted during this period. All patients have been followed for a minimum of 6 months postoperatively (mean 17.0 months, median 12 months, range 6 to 66 months). All rhinoplasties were performed endonasally. Inferior turbinectomy was not performed. I used Sheen and Sheen's methods essentially without modifications. Only autogenous materials were used for the reconstructions [although Gore-Tex (Gore-Tex 1 mm SAM facial implant, brand of expanded polytetrafluoroethylene, W. L. Gore Associates Inc., Flagstaff, Ariz.) provided maxillary augmentation in some cases]. Patient data are summarized in Tables I through V. Where appropriate, the chi-square test was used; a level of \( p < 0.05 \) was considered significant. No correction for multiple testing was made.

Rhinomanometry

Anterior, active, mask rhinomanometry was performed with a Storz rhinomanometer (MCX Diagnostic Center, Storz Instrument Company, St. Louis, Mo.), employing the methods described by Kern and Mertz et al. according to the protocol previously described. Briefly, one nostril was occluded with a pressure transducer, which, except in cases of total unilateral nasal obstruction or septal perforation, reflects transnasal pressure through the opposite, unoccluded nostril. Airflow through the unoccluded nostril was measured by a face mask connected to a pneumotachograph. Measurements were obtained for each airway during quiet and forced inspiration over a uniform 14-second test period after 15 minutes of decongestion with 1% phenyl-

TABLE II
Segmental Tip Graft Method Experience from June of 1991 to June of 1997

<table>
<thead>
<tr>
<th>Study Year</th>
<th>No. of Patients</th>
<th>No. of Primary Rhinoplasties (%)</th>
<th>No. of Secondary Rhinoplasties (%)</th>
<th>No. of Tips Revised (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1991 (6 mos)***</td>
<td>43</td>
<td>18 (42)</td>
<td>25 (58)</td>
<td>—</td>
</tr>
<tr>
<td>1992</td>
<td>66</td>
<td>25 (38)</td>
<td>41 (62)</td>
<td>8 (12)</td>
</tr>
<tr>
<td>1993</td>
<td>75</td>
<td>33 (44)</td>
<td>42 (56)</td>
<td>5 (6)*</td>
</tr>
<tr>
<td>1994</td>
<td>70</td>
<td>27 (39)</td>
<td>43 (61)</td>
<td>4 (6)</td>
</tr>
<tr>
<td>1995</td>
<td>55</td>
<td>17 (31)</td>
<td>38 (69)</td>
<td>4 (7)**</td>
</tr>
<tr>
<td>1996</td>
<td>51</td>
<td>23 (45)</td>
<td>28 (55)</td>
<td>3 (6)†</td>
</tr>
<tr>
<td>1997 (6 mos)***</td>
<td>45</td>
<td>19 (42)</td>
<td>26 (58)</td>
<td>2 (4)†</td>
</tr>
<tr>
<td>TOTAL</td>
<td>405</td>
<td>162 (40)</td>
<td>243 (60)</td>
<td>26 (6)</td>
</tr>
</tbody>
</table>

* NS, \( p < 0.125 \), comparing 1990 and 1994 with 1992.
** \( p < 0.05 \), comparing 1990 with 1992.
*** Revision data do not reflect the method described in this article and therefore have been omitted.
† \( p < 0.01 \), comparing 1996 with 1992.
†† \( p < 0.006 \), comparing 1997 with 1992.
TABLE III
Tip Graft Revision

<table>
<thead>
<tr>
<th>No. of Revisions</th>
<th>Reason for Revision</th>
<th>Patient Skin Type</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>For Any Reason</td>
<td>For Tip Problem</td>
</tr>
<tr>
<td>1991</td>
<td>18*</td>
<td>10*</td>
</tr>
<tr>
<td>1992</td>
<td>12</td>
<td>8</td>
</tr>
<tr>
<td>1993</td>
<td>15</td>
<td>5</td>
</tr>
<tr>
<td>1994</td>
<td>8</td>
<td>4</td>
</tr>
<tr>
<td>1995</td>
<td>10</td>
<td>4</td>
</tr>
<tr>
<td>1996</td>
<td>7</td>
<td>3</td>
</tr>
<tr>
<td>1997</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>58</td>
<td>26</td>
</tr>
<tr>
<td><strong>PERCENT</strong></td>
<td>14**</td>
<td>6**</td>
</tr>
</tbody>
</table>

* 1991 Revision data do not reflect the revised method described in this article and therefore have been omitted from calculations.
† NS, p < 0.267, comparing total undercorrected revised patients with total overcorrected revised patients.
‡ NS, p < 0.781, comparing total revised thick-skinned patient with total revised thin-skinned patients.
§ p < 0.005, comparing total revised primary patients with total revised secondary patients.

ephelrine HCl nasal spray to minimize mucosal factors and nasal cycling. Rhinomanometry was performed for each patient preoperatively and from 1 to 66 months postoperatively; only the longest term measurements were used for analysis and were continually updated. Geometric mean nasal airflow was calculated from independent measurements of each airway (geometric mean equals the square root of the product of total flow through each airway during the 14-second test period).

Segmental Tip Grafting Technique (Fig. 2)

The method of grafting the superior, anterior, and inferior tip lobular segments has evolved empirically, and in anatomic terms represents augmentation of the lateral, middle, or medial crura as the clinical circumstances dictate. Accordingly, the technique affects only that tip lobular segment requiring increased contour or support, minimizing volume changes in the other two; the limited “pockets” developed for each augmented segment allow a maximal effect from donor cartilage pieces that would be inadequate for tip grafting as originally described. In many patients, even small amounts of graft material can produce substantial changes. Septal cartilage, the preferred donor material, is used when available. Conchal cartilage, although rubbery and brittle (often shattering when crushed), can be split tangentially before crushing and frequently yields excellent tip grafts (see case 7, Fig. 10). Thin slices of costal cartilage can be crushed in the same manner, but with less-predictable results.

TABLE IV
Primary Reason for Revision or Second Operation (n = 405 patients)

<table>
<thead>
<tr>
<th>Reason for Revision</th>
<th>Total</th>
<th>Tip</th>
<th>Dorsum</th>
<th>Airway</th>
<th>Other Graft</th>
<th>Deliberately Staged</th>
<th>Patient’s New Request</th>
</tr>
</thead>
<tbody>
<tr>
<td>1991*</td>
<td>18</td>
<td>10</td>
<td>6</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>1992</td>
<td>12**</td>
<td>8</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>1993</td>
<td>15</td>
<td>5</td>
<td>2</td>
<td>—</td>
<td>1</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>1994</td>
<td>8</td>
<td>4</td>
<td>1</td>
<td>—</td>
<td>0</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>1995</td>
<td>10</td>
<td>4</td>
<td>1</td>
<td>—</td>
<td>0</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>1996</td>
<td>7</td>
<td>3</td>
<td>2</td>
<td>—</td>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>1997</td>
<td>6</td>
<td>2</td>
<td>1</td>
<td>—</td>
<td>1</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td><strong>TOTAL (1992-1997)</strong></td>
<td>58</td>
<td>26</td>
<td>7</td>
<td>1*</td>
<td>4</td>
<td>13</td>
<td>5</td>
</tr>
<tr>
<td>% of total revisions (405 patients)</td>
<td>14</td>
<td>45</td>
<td>12</td>
<td>2</td>
<td>7</td>
<td>22</td>
<td>9</td>
</tr>
</tbody>
</table>

* 1991 revision data do not reflect the revised method described in this article and therefore have been omitted from calculations.
** Yearly revision rates are necessarily approximate because revisions include some patients operated on in years prior to the study period.
† p < 0.005, comparing airway revisions with other categories; null hypothesis = all revision types would be equally represented.
‡ p < 0.0005, comparing tip revisions with other categories; null hypothesis = all revision types would be equally represented.
TABLE V
Indications for Tip Grafting, 1995–1997

<table>
<thead>
<tr>
<th>Year</th>
<th>Primary Rhinoplasties</th>
<th></th>
<th></th>
<th>Secondary Rhinoplasties</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Projection</td>
<td>n (%)</td>
<td>Contour</td>
<td>n (%)</td>
<td>Projection</td>
<td>n (%)</td>
</tr>
<tr>
<td>1995</td>
<td>17</td>
<td>3 (18)</td>
<td>14 (82)</td>
<td>38</td>
<td>5 (15)</td>
<td>33 (87)</td>
</tr>
<tr>
<td>1996</td>
<td>23</td>
<td>6 (26)</td>
<td>17 (74)</td>
<td>28</td>
<td>7 (25)</td>
<td>21 (75)</td>
</tr>
<tr>
<td>1997</td>
<td>19</td>
<td>5 (26)</td>
<td>14 (74)</td>
<td>26</td>
<td>6 (25)</td>
<td>20 (77)</td>
</tr>
<tr>
<td>TOTAL</td>
<td>59</td>
<td>14 (24)*</td>
<td>45 (76)</td>
<td>92</td>
<td>18 (20)**</td>
<td>74 (80)</td>
</tr>
</tbody>
</table>

Total primary and secondary patients grafted for:
- Projection 32/151** (21%)
- Contour 119/151 (79%)

* p < 0.01, comparing projection versus contour; null hypothesis = equal representation by each group.
** p < 0.0005, comparing projection versus contour; null hypothesis = equal representation by each group.

Segmental tip grafting should be performed endonasally so that limited pockets can be developed and individual grafts do not need suture fixation, thereby minimizing the chance for graft slippage or wasting material in a larger pocket than is necessary. The tip lobule is augmented according to the aesthetic objective (Fig. 2). A single infracartilaginous incision provides access to the superior and anterior thirds (lateral and middle crura, respectively); a separate incision that splits or parallels the medial crus through the lateral columnella provides access to the inferior third (medial crus). The dissection should correspond only to those areas that need augmentation and should be wide enough for the soft tissues to drape without producing a lumpy or "button-like" effect. Grafts are fed into any of the three pockets using bayonet forceps, tamped, and smoothed into position by the blunt end of a Cottle periosteal elevator. Individual graft size and shape are not as important as the substance of the grafts (crushed only enough to be supple but not lacy or shredded), pocket limitation (which controls the resulting contour), and care taken by the surgeon to position the grafts symmetrically and without surface irregularities.

**Augmentation of the superior lobule** increases tip projection (see Figs. 6 and 7); **augmentation of the anterior lobule alters** the contour of the middle crura (see Figs. 7 and 9); **caudal grafts** cor-

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Fig. 2. Schematic of the segmental tip graft method. Multiple grafts are always placed, the number and substance depending on the soft-tissue cover and the effect desired. Note the change from poor tip aesthetics (left) to good aesthetics (right). See text for details.
rect concavities or retraction in the medial crura or anterior columella (see Figs. 6 and 10). Multiple grafts are always placed, usually two or three for a more angular result, four or five for a less angular or "softer" contour\(^4\)\(^,\)\(^8\), however, even multiple small scraps placed into a narrow pocket can produce an angular result (see Figs. 4 through 6 and 8). The stiffness of the grafts used depends on the quality of the donor cartilage, the character of the overlying soft tissues, and the aesthetic result that surgeon and patient seek to achieve.\(^4\) Thicker, scarred skin requires more substantial grafts than thin, unscarred skin to produce the same result.\(^4\)\(^,\)\(^8\) The segmental method is not suitable for those patients needing substantial augmentation [e.g., ptotic or contracted tips (58 of 463 tip-grafted patients during the 6-year study period, see Fig. 11 and Discussion)].

RESULTS

Clinical Data

During the 6-year study period, a total of 463 patients underwent rhinoplasty in which tip grafts were used. Of these, 58 were considered unsuitable for the segmental tip graft method because of the degree of augmentation required. Typical of this clinical situation are the secondary patients shown in Figure 11, in whom the alar cartilages had been resected, leaving contracted, scarred nasal tips. Small, segmental grafts cannot provide the degree of support and expansion needed here; in such cases I employ Sheen's methods\(^2\)\(^,\)\(^4\)\(^,\)\(^8\) as described by the author.

Four hundred five of the total 463 patients underwent the segmental tip graft method; 160 (40 percent) had primary rhinoplasties and 245 (60 percent) secondary rhinoplasties (Table I). Currently, the author’s rhinoplasty practice is 66 percent secondary and 33 percent primary rhinoplasties; the difference between these general practice figures and the patient mix in this study reflects the fact that the majority of those patients excluded from the current review were secondary rhinoplasty patients with substantial losses of tip support not suitable for the method described here.

Of the 405 patient cohort, a total of 26 patients (6 percent) underwent tip graft revision (Table II). As might be expected, the greatest number of reoperations occurred in the first 2 years of the study while experience was being gained with the limitations of the technique. After the third year, significantly fewer revisions were necessary. Although more patients required reoperation for undercorrection than overcorrection, this difference was not significant \((p < 0.267)\) (Table III). Of the patients revised during the 6-year period, 76 percent had originally had secondary rhinoplasties,
Fig. 4. Preoperative and 2½-year postoperative frontal, oblique, and lateral views.
and only 24 percent had originally had primary rhinoplasties \( (p < 0.005) \), probably reflecting the difficulty of achieving satisfactory tip contour in the scarred, secondary nose. Patients undergoing reoperation were divided evenly between those with thick skin and those with thin skin \( (NS, p < 0.781) \), a finding that is in contradistinction to the experience of many surgeons with solid, single tip grafts, which are more likely to require revision beneath thin than thick skin.\(^4,8,10,11\)

Placed in the context of all types of revision (Table IV), 45 percent of revisions were performed primarily for tip problems \( (p < 0.0005) \), followed by revisions for deliberately staged procedures [i.e., those reconstructions that could not be completed safely in one operation \( (NS, p < 0.133) \)], dorsal irregularities \( (NS, p < 0.39) \), a new request by the patient that was not part of the original surgical plan \( (NS, p < 0.133) \), and revisions for other graft problems \( (NS, p < 0.68) \). Only one of 58 patients required secondary surgery for inadequate correction of the airway \( (p < 0.005) \).

The indications for tip grafting are shown in Table V. It is noteworthy that the majority of primary and secondary rhinoplasty patients underwent tip grafting for contour (76 percent and 80 percent, respectively), not tip projection (24 percent and 20 percent, \( p < 0.0005 \)). Of the total number of 151 patients grafted in the final 3 years of the study, by which time the limitations of the technique had been better established, 79 percent of all patients underwent grafting for contour and only 21 percent primarily for tip projection. These numbers reflect an evolution of the author’s tip grafting indications (see Discussion).

**CASE REPORTS**

**Case 1** (Figs. 3 and 4)

*Primary rhinoplasty: superior lobule grafted for contour.* This young woman had a posttraumatic nasal deformity, bilateral airway obstruction, and inspiratory collapse of both lateral nasal walls. Tip projection was adequate but the superior lobule was flat; the point of maximal tip projection was low (see Discussion). Reconstruction involved maxillary augmentation, dorsal and lateral crural reduction, caudal septal resection, spreader grafts\(^1\) of unequal thickness to align the high septal deviation, multiple tip grafts to the cephalic third for contour,\(^2\) a single graft at the nasal root, and bilateral osteotomies. Mean nasal airflow increased \(1.8 \times\) postoperatively. Two and a half years after surgery, the valves remain stable with forced inspiration. The nose is more symmetrical. Changes in bridge height, radix, and tip lobular contour seem to have moved the nose cephalad on the patient’s midface.

**Case 2** (Fig. 5)

*Primary rhinoplasty: superior lobule grafted for contour.* This woman wanted more angular tip
contours. Reconstruction consisted of dorsal and caudal septal resections, lateral crural re-duction, spreader grafts, and tip grafts. By min-imizing soft-tissue contraction, the supportive grafts have increased tip refinement (Fig. 5, right). Spreader grafts increased postoperative mean nasal airflow 1.4 × over preoperative values.

Case 3 (Fig. 6)

Primary rhinoplasty: superior lobule, inferior lobule/columella grafted for contour and support. This

Fig. 6. Case 3. Primary rhinoplasty: large tip lobule; superior lobule and columella grafted. (Above, left) Schematic of the surgical plan. (Above, right) Tip grafts used. (Below, left and right) Preoperative and 15-month postoperative oblique views.
young woman wanted an angular tip. Although the superior lobule and columella were flat and unsupported, her tip lobule was large, and tip lobular mass was cephalad to the point of greatest projection. The nasal septum yielded little usable cartilage, characteristic of many African American noses. Reconstruction consisted of maxillary augmentation; dorsal and membranous septal resection and lateral crural reduction; and septal cartilage grafts at the nasal root, internal valves, and tip. To avoid additional tip lobular expansion, only the superior and caudal thirds were grafted. At 15 months postoperatively, mean nasal airflow had increased $13.3 \times$ over preoperative values. Postoperative views demonstrate the retoussé and angularity that

Fig. 7. Case 4. Primary rhinoplasty; “tension nose”; anterior and inferior lobules grafted to increase projection and nasal length. (Above, left) Schematic of the surgical plan. (Above, right) Tip grafts used. (Below, left and right) Preoperative and 1-year postoperative oblique views.
the patient wished without an absolute increase in tip lobular size.

Case 4 (Fig. 7)

Primary rhinoplasty: anterior/inferior lobule grafted; tip grafts for contour and projection/support; apparent nasal lengthening desirable. This 6-foot-2-inch tall man had bilateral internal valvular obstruction accompanying a "tension nose."23,24 His nasal tip hung from the septal angle. He desired any change that would make his nose appear longer. Reconstruction involved reduction of the cartilaginous dorsum and posterior caudal septum; upper dorsal, spreader, and tip grafts placed on the caudal tip lobule and anterior columella.25 Airflow at 33 months following surgery show an increase of 2.7 × over preoperative values during quiet inspiration and 6.7 × during forced inspiration. Cephalic repositioning of the nasal root and grafts placed on the caudal surface of the tip lobule have increased apparent nasal length.3,25 Dorsal reduction and greater tip projection have improved nasal balance.

Case 5 (Fig. 8)

Primary rhinoplasty; superior lobule grafted for contour; apparent nasal shortening desirable. This patient had thick soft tissues with convex, cephalically malrotated alar cartilage lateral crura26 with adequate tip support. Her nasal dorsum was low relative to a large nasal base; her soft tissues were sebaceous and only minimally contractile. Reconstruction involved maxillary augmentation, 3 mm anterior caudal and membranous septal resection; reduction and relocation of the cephalically rotated lateral crus; a layered dorsal graft; and cephalically positioned tip grafts to shape the superior lobule without enlarging overall nasal base size. Postoperatively, dorsal elevation and reduction of tip lobular mass have improved nasal balance (contrast to case 4, Fig. 7). Postoperative mean nasal airflow increased 4.1 × over preoperative values.

Case 6 (Fig. 9)

Secondary rhinoplasty: large nasal base, excessive tip projection; anterior lobule grafted for contour. This patient had undergone a substantial dorsal resection with placement of a single, solid tip graft, producing an unbalanced nose with a dominating lower third. Internal valvular incompetence from the previous dorsal resection created airway obstruction.21 The old tip graft was removed; spreader grafts, a single-layer crushed cartilage dorsal graft, and multiple crushed grafts were placed in the anterior lobule to provide contour with less projection. Twenty-month postoperative views show improved nasal balance from increased dorsal height and reduced tip projection;6,22; mean nasal airflow has increased 55 × over preoperative values.
Case 7 (Fig. 10)

Secondary rhinoplasty; tip grafts for contour and support: superior, anterior, and inferior lobules grafted for contour and support. This patient had undergone two previous rhinoplasties that created a contracted tip lobule, supratip deformity, and airway obstruction at the internal and external nasal valves despite prior septoplasty.\textsuperscript{17–19} Reconstruction consisted of dorsal resection; conchal cartilage spreader grafts; a layered upper dorsal graft; composite skin/conchal cartilage grafts to support the external valves\textsuperscript{18}; split, crushed conchal cartilage tip grafts (Fig. 10, above, right) placed into the anterior, superior, and inferior lobular thirds for projection (above the supratip) and contour; and revision of the open rhinoplasty columellar scar. Postoperative views show improved nasal balance from dorsal reduction and nasal base augmentation (compare with Fig. 9). Postoperative mean nasal airflow increased $4 \times$ over preoperative values.

DISCUSSION

Like dorsal grafts, tip grafts create changes in nasal balance and proportion far beyond the immediate area to which they are applied.\textsuperscript{4,6,8,22,27} Within the lobule itself, augmentation increases tip lobular volume and projection, hence its usefulness in supratip deformity and cases of inadequate tip support.\textsuperscript{2,4,8} In both primary and secondary rhinoplasty, augmentation alters the contour of the lobule itself: properly placed tip grafts increase the point of maximal tip projection (the so-called tip-defining point), flatten the supratip, and increase the “infratip lobular” mass, all characteristics associated with attractive nasal tip lobules\textsuperscript{22} (Fig. 2, right). Poorly shaped tip lobules have the opposite characteristics: convex supratips, caudal points of maximal tip projection, and tip lobular masses that rise cephalad to the point of greatest projection, not caudal to it (Fig. 2, left). It follows, then, that augmenting the lobule redistributes this mass and can modify its contour characteristics for the better.

As one’s satisfactory experiences with tip grafting grows, its applications become broader. Although originally conceived only as a method of correcting inadequate tip projection,\textsuperscript{1–5} tip grafts can favorably alter the contours of tips with adequate projection (Figs. 4, 5, 8, and 9), a point that I made some years ago\textsuperscript{27} without fully understandings its ramifications. A recognition of the power of tip augmentation, and of controlling tip support beyond that supplied by the orthotopic alar cartilages, has spawned a number of graft variations.\textsuperscript{28–39} Other surgeons have addressed lobular contour in adequately and inadequately projecting tips by employing suturing methods instead.\textsuperscript{40–53}

The tip graft method described in this article...
is not conceived as new, but rather as minor modification of the method popularized by Sheen over the last two decades, that was stimulated by the need (1) to avoid increasing tip lobular size in some patients (Fig. 1) and (2) to maximize the effect of increasingly small amounts of donor cartilage. As more surgeons become familiar with varying autogenous donor sites, a group of secondary rhinoplasty patients has emerged with donor site depletion, having already undergone septoplasty or harvesting of one or more auricular, calvarial, iliac, or rib grafts. Some patients limit the surgeon further by prohibiting donor sites that are painful (iliac crest) or frightening (calvarium). Even the primary rhinoplasty patient may be relatively “donor-site-depleted” if the septum is bony and yields minimal usable cartilage (a circumstance that is more likely to occur in the non-Caucasian nose or posttrau-
matic nose, but that frequently occurs outside these circumstances as well). Graft “shortages” can also occur in patients whose septa are normal if augmentation requirements are high enough (i.e., radix, spreader, lateral wall, tip grafts). The surgeon faced with such patients is inevitably driven to evolve techniques that will allow acceptable functional and aesthetic results with suboptimal graft material.

The segmental tip graft method can be conceived anatomically as selective augmentation of the lateral crus (at the lateral genu, superior lobule), the middle crus (between the genua, anterior lobule), or the medial crus (inferior lobule and columella). A cardinal feature of this technique is the endonasal approach, which offers several distinct advantages. By limiting the caudal extent of the superior pocket, the surgeon
can obtain maximal effect from a relatively small amount of donor cartilage. Both Peck\textsuperscript{3} and Pape\textsuperscript{13} have described grafts placed into transverse lobular pockets to increase tip support. Because many patients do not supply any single graft of the dimensions classically described [two or three $4 \times 9$ mm grafts (Peck)\textsuperscript{2} or $7.5 \times 12$ mm (Sheen)\textsuperscript{2,8} ], multiple grafts may be required to supply adequate structural volume and minimize asymmetries\textsuperscript{4,10,11}; in a closed, endonasal pocket, suture fixation\textsuperscript{34} can be avoided.

The data in this group of 405 patients indicate that revision rates understandably decreased over the 6-year study period as familiarity with the technique grew: whereas tip reoperations accounted for 12 percent of all revisions in 1992, the incidence fell to 4 percent by 1997. When annual rates were compared with those of the first year of the study, statistical significance was reached by year 4 (1995, $p < 0.01$, Table II); thus 5 years’ experience was needed before reoperation rates decreased substantially below the rate observed during the first year of the study. In all, only 26 of 405 patients underwent tip revision, including those in the earlier “developmental period,” which reflects the reliability of the method. Nevertheless, tip imperfections were still the most common reason (45 percent of all revisions) for a second operation during the 6-year period. An 80-percent tip graft revision rate has been reported by other authors\textsuperscript{10}, the lower rate in the present series may have been caused in part by the use of multiple, crushed grafts. It was this frustration with the technical difficulty of tip reconstruction that compelled Sheen to revise his original method\textsuperscript{4} and that has spurred other surgeons to abandon shield grafts,\textsuperscript{10} employ graft suture-fixation methods,\textsuperscript{11,28–38,54} or seek tip reconstruction techniques that modify the existing cartilages through an open rhinoplasty approach.\textsuperscript{19–53,55}

More patients required reoperation for undercorrection than for overcorrection (Table III), although the difference was not statistically significant ($p < 0.267$), perhaps because of sample size. Three times as many secondary rhinoplasty patients as primary patients underwent tip revision ($p < 0.005$). Although this finding may simply indicate the difficulty of obtaining proper tip contours in previously operated noses, other factors such as the vascularity of the bed, scarring, “tightness” in the tip lobule itself,\textsuperscript{4} and the adequacy, composition,\textsuperscript{56} and availability of donor material\textsuperscript{12} undoubtedly were also factors.

Patients undergoing tip revision were as likely to have had thick skin as thin skin, a finding that has not been reported previously in patients undergoing tip grafting. On the contrary, “thin-skinned” patients are often considered poor candidates for tip grafting, primarily by surgeons who employ single, solid cartilage grafts, which commonly show asymmetries through a thin soft-tissue cover. Conversely, thick-skinned patients are usually believed to be “safer” tip graft candidates.\textsuperscript{10,11} In this series, presumably because of the use of multiple grafts,\textsuperscript{1} patients with “thin skin” were no more likely to undergo revision than their “thick-skinned” counterparts. Patients were significantly less likely to need reoperation for residual airway obstruction ($p < 0.005$), attesting to the efficacy of septal and vaultular reconstruction, even without turbinectomy.\textsuperscript{17–19}

In interpreting revision rates, the reader is cautioned to recognize the limitations of the study. Whereas the numbers listed are believed to be accurate, the annual reoperation incidence contains an inevitable margin of error because patients revised in any given year did not necessarily undergo their original procedures in the immediately preceding year (nor perhaps even during the course of the study); therefore reoperation trends can be only loosely drawn. Secondly, “revision rates” are only meaningful in terms of a particular patient and surgeon: just as some surgeons revise very few rhinoplasties even when improvement might be obtained, some patients will not permit a revision even when it is needed. Finally, any tip reshaping technique must be assessed not only by its complications but also by the spectrum and difficulty of the surgical problems that it solves.

Familiarity and experience with any technique naturally brings an expansion of its indications (Table V). Whereas tip grafting was originally conceived primarily as a procedure for increasing tip projection in patients with congenitally hypoplastic tips (i.e., cleft lip nasal deformity) or following an aggressive previous rhinoplasty (i.e., supratip deformity),\textsuperscript{1–3} the author’s applications for tip augmentation have increased progressively.\textsuperscript{4} “Projecting” nasal tips may benefit from the contour changes conferred by augmentation: cephalic repositioning of the point of greatest projection and redistribution of tip lobular mass (Figs. 4, 5,
and 8). Even patients with excessive tip projection, in whom some “deprojection” is advisable, gain control over tip contour from re-grafting (Fig. 9). During the course of the study period, an alteration in lobular contour, not an increase in tip projection, became the primary indication for tip augmentation in both primary and secondary patients. This reliance on soft-tissue, not skeletal, parameters carries additional advantages for the surgeon because the same strategy can be used in primary and secondary patients, whether or not the nasal skeleton influences surface contours.22 Even within the secondary rhinoplasty group, in whom poor tip projection is commonplace, a progressive trend toward the contour indication occurred between 1995 and 1997 (p < 0.046). Finally, selective tip grafting still provides additional support for patients whose projection is inadequate (Figs. 6, 7, and 10). The segmental method described in this article permits individual augmentation of the superior, anterior, or inferior lobule and columella in those patients for whom a limited increase in lobular size is desirable and in whom a limited amount of autogenous donor cartilage may be available.

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REFERENCES