

# Anatomic Reconstruction of the Nasal Tip Cartilages in Secondary and Reconstructive Rhinoplasty

Frederick J. Menick, M.D.

Tucson, Ariz.

Most techniques for secondary rhinoplasty assume that useful residual remnants of the tip cartilages remain, but frequently the alar cartilages are missing—unilaterally, bilaterally, completely, or incompletely—with loss of the lateral crura, middle crura, and parts of the medial crura. In such severe cases, excision of scar tissue and the residual alar remnants and their replacement with nonanatomic tip grafts have been recommended. Multiple solid, bruised, or crushed cartilage fragments are positioned in a closed pocket or solid shield-shaped grafts are fixed with sutures during an open rhinoplasty. These onlay filler grafts only increase tip projection and definition. Associated tip abnormalities (alar rim notching, columellar retraction, nostril distortion) are not addressed. Problems with graft visibility, an unnatural appearance, or malposition have been noted.

Fortunately, techniques useful in reconstructive rhinoplasty can be applied to severe cosmetic secondary deformities. Anatomic cartilage replacements similar in shape, bulk, and position to normal alar cartilages can be fashioned from septal, ear, and rib cartilage, fixed to the residual medial crura and/or a columellar strut, and bent backward to restore the normal skeletal framework of the tip. During an open rhinoplasty, a fabricated and rigid framework is designed to replace the missing medial, middle, or lateral crus of one or both alar cartilages. The entire alar tripod is recreated. These anatomic alar cartilage reconstructive grafts create tip definition and projection, fill the lobule and restore the expected lateral convexity, position the columella and establish columellar length, secure and position the alar rim, and brace the external valve against collapse, support the vestibular lining, and restore a nostril shape. The anatomic form and function of the nasal tip is restored. This technique is recommended when alar cartilages are significantly destroyed or absent in secondary or reconstructive rhinoplasty and the alar remnants are insufficient for repair.

Anatomically designed alar cartilage replacements allow an aesthetically structured skeleton to contour the overlying skin envelope. Problems with displacement are minimized by graft fixation. Graft visibility is used to the surgeon's advantage. A rigidly supported framework with a nasal shape can mold a covering forehead flap or the scarred tip skin of a secondary rhinoplasty and create a

result that may approach normal.

Anatomic alar cartilage reconstructions were used in eight reconstructive and eight secondary rhinoplasties in the last 5 years. Their use in the repair of postrhinoplasty deformities is emphasized. (*Plast. Reconstr. Surg.* 104: 2187, 1999.)

The entire character of the nose—its refinement, inclination, length, and width—is determined by the contour of the nasal tip. The alar cartilages provide support and configuration to the tip lobule. Their shape, size, and position define tip aesthetics.

Ideally, during primary rhinoplasty, the tip cartilages are modified by partial excision, transection, repositioning, suture modification, or augmentation to create the desired result. However, when a rhinoplasty fails, restoration of alar cartilage form and function becomes vital. The injury must be undone and the desired characteristics of the tip lobule and of the columella, nostril, alar rims, and airway restored.

In revisional rhinoplasty, tip cartilage remnants, which are fixed by scar or sutures in an abnormal position, may remain. Current techniques recommend the following:

1. The release, repositioning, and repair of residual alar cartilages, perhaps with an alar spreader graft to push the tip remnants inferiorly and laterally<sup>1</sup>
2. Suture unification of the right and left alar cartilages to equalize projection
3. A columellar strut to project the residual medial crura and support the tip complex
4. Individual onlay cartilage grafts to re-

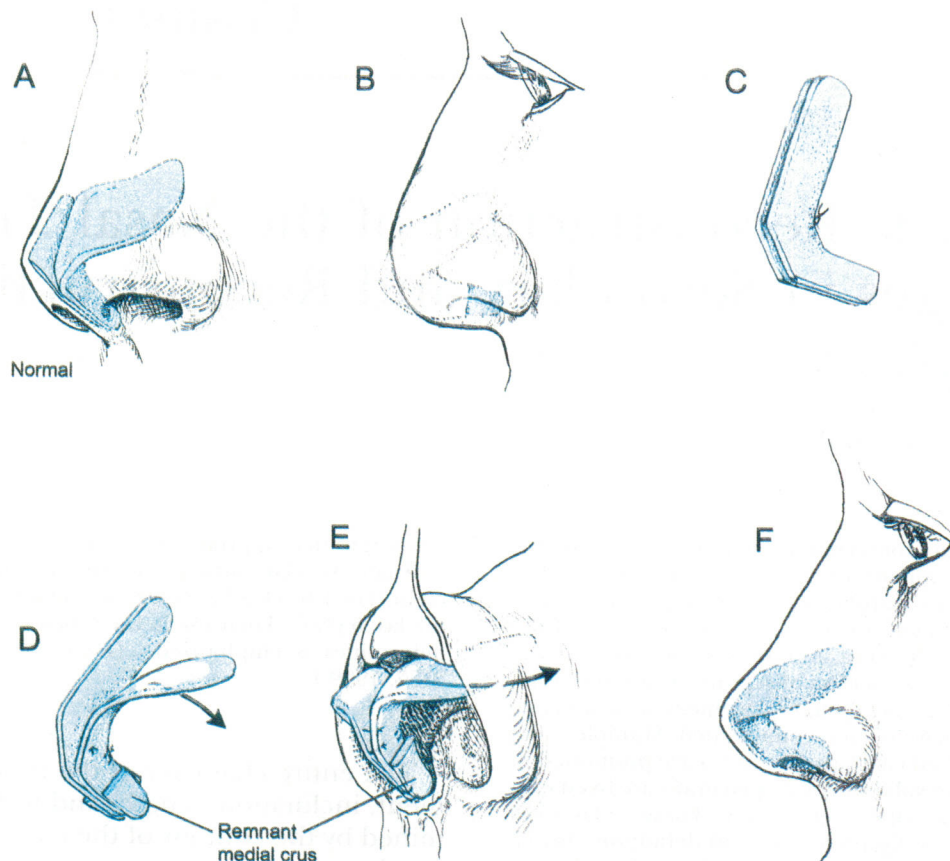


FIG. 1. Diagrammatic outline of an anatomic alar cartilage graft reconstruction in secondary rhinoplasty. (Above, left) In the normal nose, the shape, size, and position of the paired alar cartilages are reflected through the skin as surface anatomy and determine the aesthetic form and function of the tip, columella, nostril, and external valve. (Above, center) Nasal deformity after excision of lateral, medial, and parts of the medial crura during primary rhinoplasty. The tip is shapeless and inadequately projected. (Above, right and below, left) Septal, ear, or rib cartilage graft alar replicas are sutured together, stabilized to the residual medial crura, and bent backward to simulate the middle and lateral crura and medial and lateral genu. (Below, center and right) Anatomically designed alar cartilage replacements, fixed during an open rhinoplasty, allow an aesthetically structured skeleton to control the overlying skin envelope, restoring support, definition, and the correct nasal shape to the entire inferior one-third of the nose. A columellar strut (not shown) can be used as a jig to secure the cartilage grafts to the medial crural remnants.

create bidomal definition,<sup>2,3</sup> a lateral crural onlay graft to reestablish the expected convexity of the missing lateral crura,<sup>4</sup> and separate rim grafts to support the alar rim and external valve<sup>5-7</sup>

Most discussions of secondary tip reconstruction assume that useful residual remnants of the tip cartilages remain and can be modified. However, the loss of alar cartilage can be unilateral, bilateral, partial, or complete, and frequently the lateral crus, middle crus, and part of the medial crus are totally destroyed or ablated. Few authors address these most significant deformities. Sheen and Sheen<sup>5</sup> recommend closed dome excision with an en bloc ablation of scar remnants and reconstruction

of the tip with multiple solid, bruised, and crushed grafts in a limited closed pocket. Johnson and Toriumi<sup>4</sup> recommend excising scarred, buckled lateral crura, scar sculpturing, a columellar strut, shield-shaped tip graft, and separate lateral crura onlay grafts, if needed, during an open technique. Juri<sup>8</sup> recommends excising the fibrotic cartilage remnants of the dome, leaving only a vertical segment of the medial crura, and camouflaging the tip defect with a shield-shaped ear cartilage graft or an onlay anchor-shaped graft if alar collapse is present.

These single and stacked onlay grafts may camouflage the defect, but they do not replace the alar cartilages. Although filler grafts may

mold overlying skin and a buttress graft brace unsupported tissue, these techniques are non-anatomic. Plastic surgery is a practical profession. The end justifies the means if the technique works. However, can a nonanatomic approach to the replacement of ablated tip cartilages satisfy all the requirements of form and function in a predictable and controlled fashion?

Fortunately, techniques useful in reconstructive rhinoplasty can be applied to severe secondary cosmetic deformities. During a reconstructive rhinoplasty for skin cancer, excision of covering skin is accompanied by progressive loss of support and lining. In fact, primary, secondary, and tertiary cosmetic rhinoplasties are in a continuum with reconstructive rhinoplasty. What starts as a midlayer abnormality in a cosmetic rhinoplasty frequently leads to tip cartilage destruction and significant injury to covering skin and underlying lining. Replacement of anatomically shaped cartilage grafts is applicable to both secondary and reconstructive rhinoplasties. A fabricated rigid framework designed to replace the missing medial, middle, and lateral crura restores the normal alar tripod, shaping and supporting the entire lower one-third of the nose.

#### SURGICAL TECHNIQUE

##### *Anatomic Reconstruction of the Alar Cartilages*

Cartilage replicas similar in shape, bulk, and position to normal alar cartilages are fashioned

from septal, ear, or rib cartilage and fixed to the residual medial crura and/or to a columellar strut to restore a skeletal framework.<sup>9,10</sup> When seen through the covering skin, they recreate the form and function of a normal nose. The technique is useful in secondary rhinoplasty or in reconstructive rhinoplasty when the tip cartilages are absent or unrepairable (Fig. 1).

First, a preoperative evaluation of the columella, tip lobule, ala, and nostril margin is completed. During open rhinoplasty (or before flap resurfacing), a precise anatomic diagnosis of tip deformity is made. The medial crura remnants are identified, if present. If residual cartilage remnants are not available for repositioning and repair, then an anatomic reconstruction of the alar cartilages is performed (Fig. 1).

Donor cartilage is harvested from the septum, ear concha, or rib. Septal cartilage is stiffer than normal alar cartilage but can be bent and scored, if necessary. Ear cartilage is usually thicker and more friable, but its inherent curves can be used to advantage. Rib cartilage is stiff and easily fractured, especially as it calcifies with age, but thin strips that include perichondrium and a thin sliver of cartilage can be carved into useful grafts. Two grafts, 5 to 6 mm wide  $\times$  3.0 to 3.5 cm long  $\times$  2 mm thick, are formed. A 35-degree bend can be incorporated into the original design or carved into the final graft to establish an angle of



FIG. 2. Case 2. The form and function of this 24-year-old woman's nasal tip were severely impaired after a previous rhinoplasty.

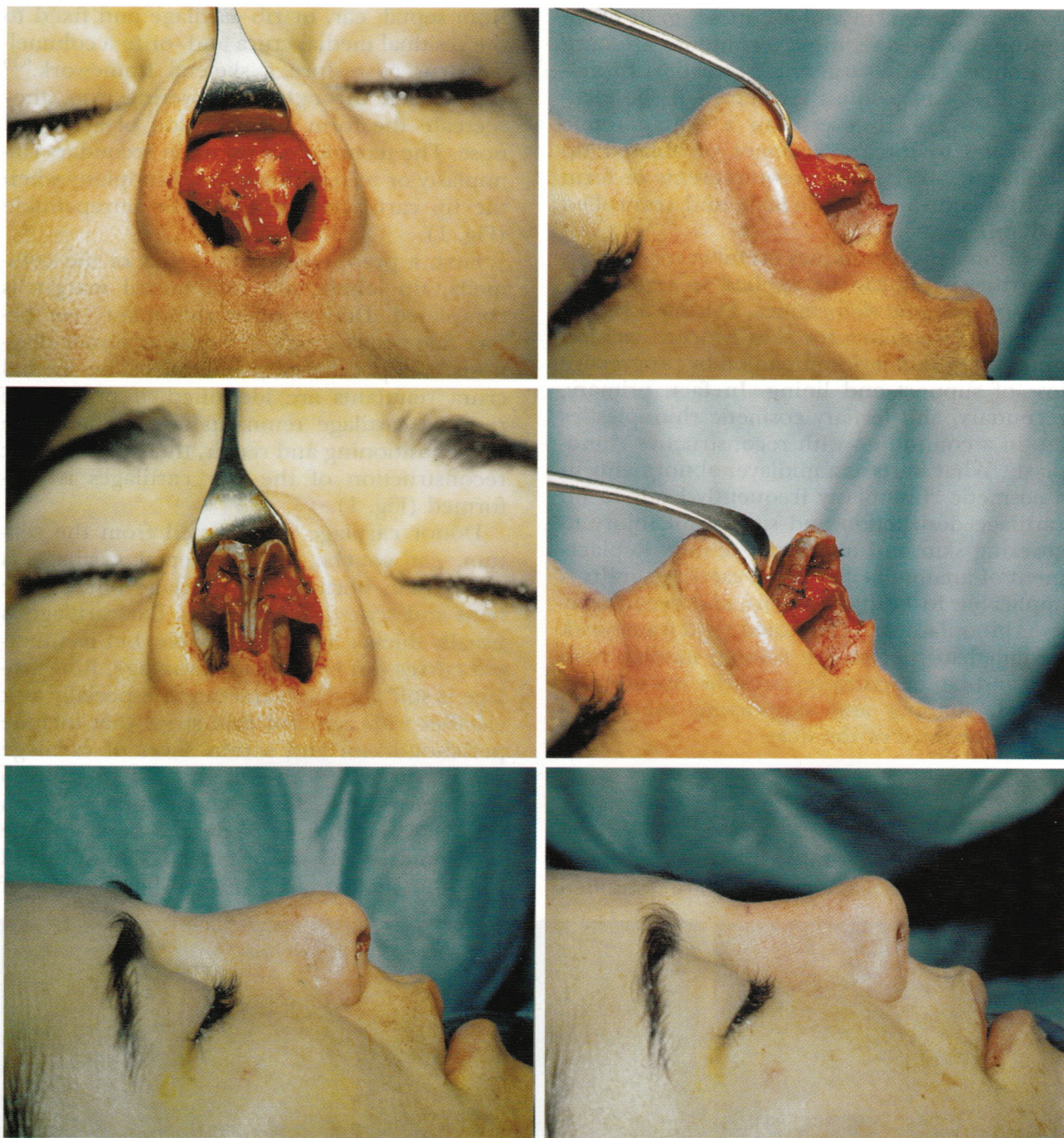


FIG. 3. (Above) During an open rhinoplasty, a precise anatomic diagnosis of tip deformity was made. The right lateral and medial crus and the left lateral crus were missing. (Center) The cartilage of the dorsal septal angle was lowered, and lateral spreader grafts were placed. Two 6 mm  $\times$  3 cm  $\times$  2 mm septal cartilage grafts with a 35-degree angle of rotation were sutured with 5-0 nonabsorbable sutures along the cephalic margins. These unified strips were then stabilized to the residual medial crura and bent backward to simulate the medial crura, lateral crura, and medial and lateral genu. They were fixed with sutures to the nasal lining to abut and parallel the caudal margin of the upper lateral cartilages. These sutures resuspended the vestibular skin. Dome-spanning sutures were used to further define nasal projection and tip definition after careful cartilage scoring to control septal cartilage bending. Projection control sutures were placed through a hemitransfixion incision to securely position the complex tip reconstruction. No onlay tip grafts were placed (see Fig. 1). (Below) Intraoperative change in tip conformation before and after tip graft placement.



FIG. 4. Postoperative result at 2.5 years. No further surgery was performed. The surface anatomy reflects the underlying alar replicas, simulating the contour of the medial, middle, and lateral crura.

rotation. It is often helpful to use a columellar strut as a jig to help brace the cartilage grafts to the residual medial crura. Brown Adson forceps and 5-0 and 4-0 polypropylene sutures on a taper needle protect graft material from unnecessary trauma.

The two graft struts are sutured inferiorly along their future cephalic margin, unifying the two pieces. Their slight caudal flare will simulate the normal flare of the medial crura. The unified strips are then stabilized to the residual medial crura and bent backward to simulate the middle crura, lateral crura, and medial and lateral genu. They are fixed with suture to the nasal lining and abut and parallel the caudal margin of the upper lateral cartilage. These sutures resuspend the vestibular skin, reforming the "cupola" of the vestibule. Any gap between the cartilage grafts and scarred lining can be filled with cartilage scraps to eliminate dead-space, if desired. If the alar margin is retracted by scar, fibrous soft tissue can be excised, and the lining can be advanced inferiorly, fixing it by suture to the stabilized alar cartilage graft. A retracted alar margin can thus be repositioned inferiorly. Columellar position can also be controlled by the width of the alar graft and the columellar strut, which allows the repositioning of a retracted columella. Dome-spanning sutures and lateral crura-spanning sutures<sup>11,12</sup> are used to further define nasal projection and tip definition. Careful car-

tilage scoring can be used to control cartilage bending. A shield-shaped tip graft can be sutured over the reconstruction to improve bidomal definition or projection, if desired. Projection control sutures are used to increase or decrease tip projection by advancing the cartilaginous tip complex up or down on the caudal septum through a transfixion incision. Nasal abnormalities in other areas are corrected with dorsal grafts, lateral spreader grafts, etc.

At the completion of the tip reconstruction, an anatomically correct replica of one or both alar cartilages restores all or part of the medial, middle, and lateral crura. Similar to normal alar cartilages, they can reestablish the form and function of the columella, tip lobule, nostril, and alar margin.

In the past 5 years, eight secondary rhinoplasty cases (one requiring a forehead flap and lining flaps) and eight reconstructive cases required total reconstruction of the alar cartilages (Figs. 2 through 10). No revisions or additional augmentations were performed or have been necessary on any of the seven routine secondary rhinoplasty patients. Each reconstructive rhinoplasty was undertaken as part of a three-stage forehead flap reconstruction that included flap transfer, an intermediate subcutaneous sculpturing operation, and pedicle division. Five of the eight reconstructive cases had a "touch-up" procedure at 6 months to debulk the airway and thin the alar



FIG. 5. Case 3. This 66-year-old woman underwent a rhinoplasty at 40 years of age. The nose was overreduced, and a dorsal silicone implant was placed. Several years later, it extruded. She presented with a pinched tip, retracted and collapsed alar rims, and an overreduced dorsum.

margin, improve definition of the alar crease, or dermabrade normal sebaceous nasal skin abutting the forehead flap to improve blending.

#### DISCUSSION

The nasal tip is a three-dimensional structure of curves and angles. The underlying alar cartilages support and configure the tip lobule. The shape, size, and position of the paired alar cartilages are reflected through the skin as surface anatomy.

Each alar cartilage consists of a medial crus, middle crus, and lateral crus—each compo-

nent influencing the form and function of that part of the nose. The medial crus lies within the columella and ends at the medial genu (the columellar/lobular junction or columellar breakpoint), where it joins the middle crus. The medial crus thus controls the columellar/lobular ratio and the cephalad or caudal position and width of the columella. The middle crus bridges the medial and lateral crus. Its length, configuration, and angularity determine the shape, height, and protrusion of the infratip lobule. Its cephalad angulation is the angle of rotation that forms the columellar/lobular junction. Its lateral angulation from

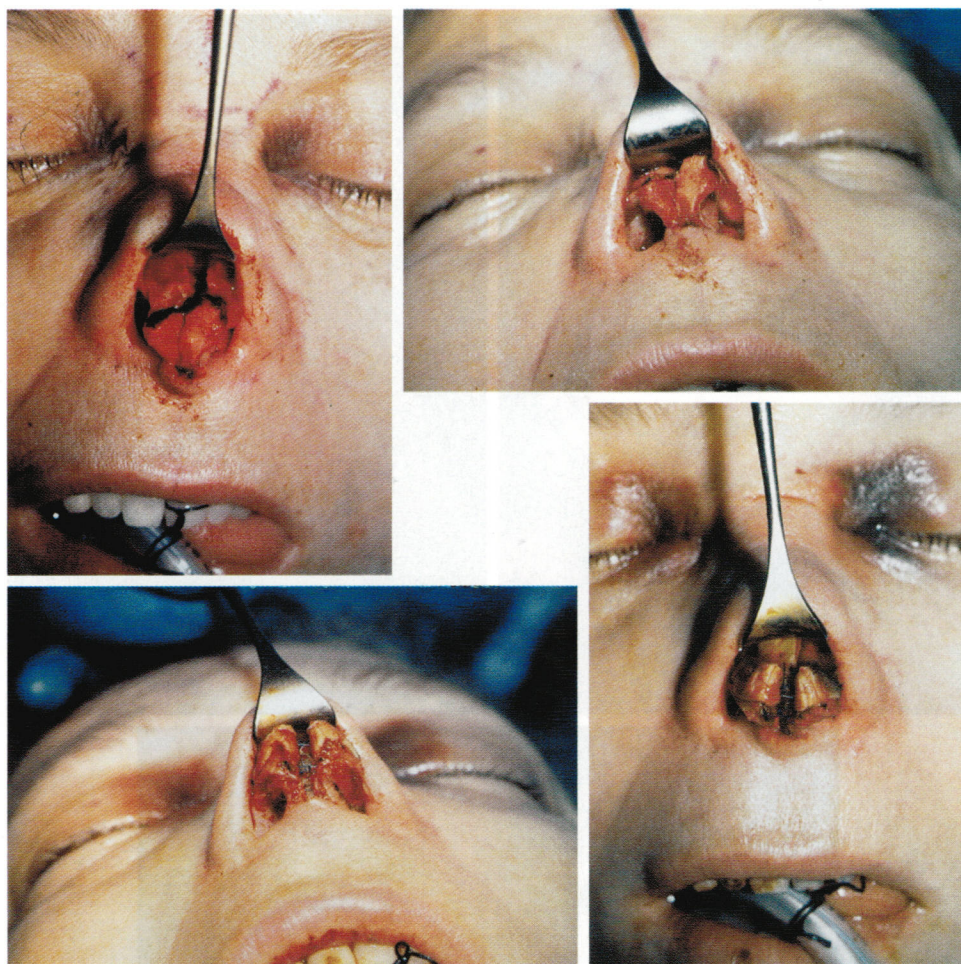


FIG. 6. (Above) At exploration during an open rhinoplasty, both alar cartilage domes were transected (marked by ink) and severely scarred. (Below) Residual cartilage remnants were repaired and advanced maximally to the midcolumellar level on a rib cartilage columellar strut to lengthen the nostril. Ear cartilage replicas similar in shape, bulk, and position to normal alar cartilages were also fixed to the columellar strut to restore a tip framework. Scar tissue was excised from the lining, which was advanced inferiorly to reposition the retracted alar margin. The lining was then fixed by sutures to the stable alar cartilage replacement grafts, securing the alar margin inferiorly. No onlay tip graft was placed. A dorsal osteocartilaginous rib graft was also placed.

the midline (the angle of divergence) determines the intracrusal distance. The middle crus extends to its junction with the lateral crus (the lateral genu, or domes). The domes determine the projection, width, and definition of the nasal tip. The lateral crura then extend into and fill the tip lobule, abutting and partially entering the superior ala. Thus, a tripod is formed by the paired medial crura (fixed within the columella by fibrous tissue) that support the central leg and the lateral crura, which extend laterally to form the two other spanning legs.

The aesthetics of the nasal tip are determined by the underlying skeleton. As characterized by Sheen and Sheen,<sup>5</sup> the medial, middle, and lateral crus determine the essential

landmarks of a refined tip—lateral projection of the right and the left domes, points of tip differentiation from the dorsum (supratip break), and the columellar/lobular junction (columellar break). Less emphasized is the contribution of the tip cartilages to the form and function of the entire lower one-third of the nose. More than just tip aesthetics, the alar cartilages define tip/lobular contour; columellar length, width, and position; nostril shape; alar rim position; alar support and airway patency; and apparent nasal length. A predictable reconstruction requires that all functions be restored.

The current popularity of tip grafting can be attributed to Sheen.<sup>2</sup> Initially, when overresection of the alar cartilages was found at second-



FIG. 7. Postoperative result at 3.5 years. No further surgery was performed. Normal form and function of the tip, alar rim, columella, and nostril and airway patency were restored.

ary rhinoplasty, single, rigid, septal cartilage shield-shaped grafts were placed in a limited subcutaneous pocket within the tip lobule to increase projection and define the columellar/lobular angle. Subsequently, this technique was applied to primary rhinoplasties with inadequate tip projection. Problems with graft visibility, unnatural postoperative flatness, and graft malposition led to the current modification that uses multiple solid, bruised, and crushed cartilage grafts to decrease visibility, backed by an ethmoid bone brace to increase fixation and limit displacement. Uncorrected problems such as inadequate rim support or alar retraction are addressed by placing sepa-

rate grafts in subcutaneous pockets along the rim margin or by composite skin grafting to resupply both lining and support.

Constantian<sup>13,14</sup> uses a similar closed tip-grafting technique, employing multiple individual pockets within the soft tissue of the tip to selectively augment (or recreate) the anatomy of each region—the superior lobule to increase tip projection, the anterior lobule to alter the contour of the middle crural area, and the inferior lobule to correct concavities or retraction in the region of the medial crura or anterior columella. Multiple crushed grafts are placed in individual pockets within each third of the tip lobule and columella to simu-



FIG. 8. Case 4. This 42-year-old woman had undergone two previous rhinoplasties. Examination revealed an overreduced dorsum, a high supratip, and inadequate tip projection.

late the contours of the medial, middle, and lateral crura, without increasing the overall lobular volume. However, this technique is not suitable for patients requiring a substantial augmentation or in a secondary rhinoplasty with a contracted, scarred nasal tip.

Peck<sup>15</sup> corrects inadequate tip projection with an "umbrella" graft. This consists of a vertical cartilaginous strut placed between the medial crura to increase support and a horizontal onlay graft,  $9 \times 4$  mm, overlying the alar domes to define the tip. The most common complications of the umbrella graft are also graft show and strut dislocation.

Concurrently, Johnson, and Toriumi,<sup>4</sup> Gunter and Rohrich,<sup>1,7</sup> Gunter,<sup>16</sup> and Juri<sup>8</sup> and Juri et al.<sup>17,18</sup> popularized open rhinoplasty. Joining bilateral rimming incisions with a transcolumellar incision allowed the elevation of nasal skin and wide exposure, diagnosis of injury, and manipulation and suture fixation of grafts. Solid shield-shaped tip grafts, separate lateral crura onlay grafts, or the anchor-shaped graft of Juri were sutured in place, which permitted in-situ cartilage sculpture and increased architectural rigidity and graft immobility.

In severe cases of alar cartilage destruction or excision, proponents of both closed and open tip grafting recommend the excision of scar tissue and residual alar remnants and the construction of a nonanatomic tip with multiple solid, bruised, and crushed cartilage shield-shaped grafts in closed pockets,<sup>2,5,6,13,14</sup> or with

suture fixation of solid grafts during open rhinoplasty.<sup>4,5</sup>

Although the results can be superb, problems with graft visibility and malposition continue to challenge the surgeon. Sheen,<sup>2</sup> in an attempt to decrease graft visibility and displacement, altered his closed technique from single or stacked rigid, shield-shaped grafts to multiple smaller, softer, bruised and crushed grafts confined within one or more limited subcutaneous pockets within the nasal tip. This "stuffing" technique, although often successful, is perplexing. If one believes that the nasal surface reflects its underlying architecture, it seems contradictory to attempt to increase nasal shape and definition with less supportive and contoured materials, especially in secondary rhinoplasty when subcutaneous scars limit both the reexpansion and reshaping of the covering skin sleeve and underlying lining. One wonders if the stiffer skin controls the softer graft (rather than the desired goal of the graft shaping the overlying skin). Closed tip grafting also assumes that malleable shapeless material can be placed by the average surgeon under edematous skin to create a poorly defined subcutaneous mound that will mold overlying skin into an aesthetic shape after myofibroblastic contraction of the operative site is completed and the wound is mature.

As patient expectations grow and surgical techniques become more bold, secondary rhinoplasty patients present with depleted donor

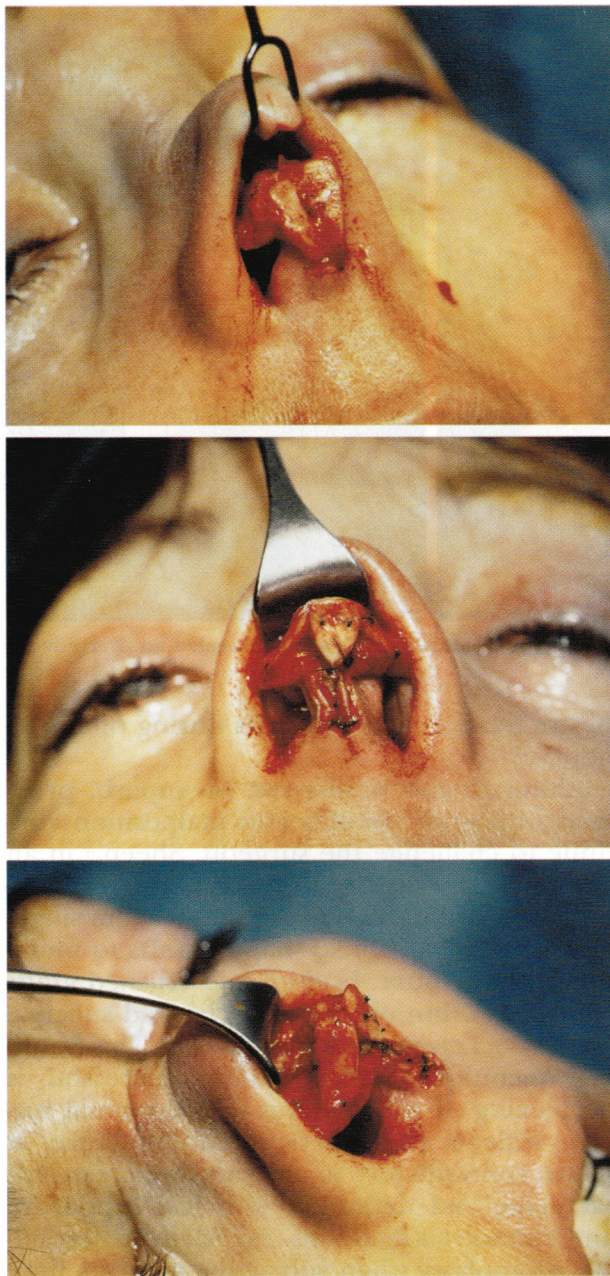


FIG. 9. During surgery, the lateral crura were absent. Anatomic tip replacements of conchal cartilage capped with a Sheen tip graft were fashioned to support and contour her nasal tip. Septal cartilage grafts were also used as lateral spreader grafts, a dorsal graft, and a columellar strut.

sites. Previous septoplasty and ear cartilage harvests may limit both the quality and quantity of cartilage donor material. Proponents of the closed approach suggest that bits and pieces of crushed or otherwise modified cartilage, which cannot be sutured in place during an open rhinoplasty, can be positioned successfully in a closed subcutaneous pocket.<sup>13,14</sup> Unfortunately, although cartilage grafts usually survive, it is also acknowledged that the greater the

degree of crushing, the greater the loss of graft viability and potential for reabsorption.<sup>5,13</sup> Substantial solid grafts may be more difficult to find and use but may be preferable.

The developers of the open rhinoplasty technique<sup>1,4,7,8,16-18</sup> approached the problem of displacement by taking advantage of increased exposure to manipulate and suture solid tip grafts, creating rigid support and graft immobility. It does seem that a more rigid and supportive graft would better control the shape of the covering skin envelope.

However, both these closed and open tip graft approaches are nonanatomic. Neither replaces missing alar cartilages; both use onlay filler grafts to camouflage the anatomic deficiencies. Both were designed to restore only bidomal definition or increase projection, not to restore the form and function of the lateral, middle, and medial crura—volume, definition, width, projection, rotation, and columellar and nostril shape and position.

Should the visibility of standard tip grafting techniques be considered a complication? Perhaps not. In reality, visibility is the desired end point. A shield-shaped tip graft looks abnormal because it has a nonanatomic design. The solution to unnatural-looking grafts is to design them in a natural shape. When seen through covering skin, they will not “show” because they will appear to be the normal underlying architecture.

An astute critic of the technique espoused in this article might ask, “What is anatomic about a columellar strut, an additional shield-shaped tip graft, or a stiff rigid nasal framework?” In truth, there is little that is anatomic about a secondary rhinoplasty with a crucified tip! Even disregarding the near-total absence of native alar cartilage, the skin is deformed and scarred, and the subcutaneous tissue and the fibrous ligament attachments between the alar cartilages and caudal septum, septal angle, upper lateral cartilages, and each other are lost. A rigid framework is useful to mold the overlying skin and brace the repair against scar retraction. If used, a columellar strut provides rigidity, restoring the central alar tripod and permitting secure, jig-like fixation between the residual medial crura and the rebuilt middle and lateral crus. Once stable, the alar replacements can be bent backward to form the appropriate domes, genua, and columellar and supratip “breaks.” A shield-shaped tip graft is added only to improve bidomal definition or to



FIG. 10. Postoperative result at 16 months. No further surgery was performed.

modestly increase projection (rather than accepting an imperfect fabrication or intraoperatively reforming an imperfect alar graft again and again). This simplifies the sculpturing and time requirements, while accepting the limitations of the donor graft material. Even nature creates tip cartilages without innate perfection!

The anatomic reconstruction of the alar cartilages in secondary and reconstructive rhinoplasties is designed to provide precise anatomic replicas of the missing normal anatomy using septal, ear, or rib grafts. During open rhinoplasty, a fabricated, rigid framework is designed to replace the missing medial crus, middle crus, or lateral crus of one or both alar cartilages. This restored alar tripod is securely positioned and fixed with sutures. Anatomic alar cartilage reconstructive grafts should do the following:

1. Create tip definition and projection
2. Fill the lobule and restore the expected lateral convexity
3. Position the columella and reestablish columellar length
4. Support and position the alar rim and brace the external valve against collapse
5. Support the vestibular lining
6. Restore a nostril shape

Conceptually, the technique also acknowledges that the alar cartilages control more than tip projection or definition. They are integral to the tip lobule, columella, alar rim, and ex-

ternal valve function. The essential elements of the technique are as follows:

1. Exposure by open rhinoplasty
2. Anatomic diagnosis
3. Anatomic reconstruction
4. Secure suture fixation
5. Controlled contouring by in situ graft sculpture, tip-suturing techniques, and shield-shaped onlay grafting, if needed
6. Forceful remodeling of the skin envelope by the underlying skeletal structure
7. The release, repositioning, and reshaping of both cover and lining by wide undermining and the release of subcutaneous scars

The described technique is recommended when the alar cartilages are significantly destroyed or absent in secondary or reconstructive rhinoplasty and the alar remnants are insufficient for repositioning and repair. It is useful when support is absent or severely abnormal, lining is excised or retracted, and subcutaneous scarring limits reexpansion of both the skin sleeve or lining. Sheen and Sheen<sup>5</sup> said that "the shape, size, and position (of the alar cartilages) manifest as surface anatomy and therefore should determine the surgical actions that will alter their surface appearance." Rather than camouflaging the loss of the alar cartilages by limited subcutaneous augmentation, they should be rebuilt. Anatomic reconstruction of the alar cartilages replaces

them anatomically and functionally and restores the normal aesthetic subunit outline on the nasal skin surface. Anatomically designed alar cartilage replacements, fixed solidly during an open rhinoplasty, allow an aesthetically structured skeleton to positively influence the conformation of the overlying skin envelope. Problems with displacement are minimized by graft fixation. Graft visibility is used to the surgeon's advantage.

Good results in rhinoplasty depend on a structurally sound nasal skeleton covered by a conforming skin and soft-tissue envelope. Precise anatomic reconstruction of the missing alar cartilages in secondary and reconstructive rhinoplasties should be added to our surgical armamentarium. A rigidly supported framework with a nasal shape can mold a covering forehead flap or the scarred tip skin of a secondary rhinoplasty to create a result that may approach normal.

Frederick J. Menick, M.D.  
5285 E. Knight Dr.  
Tucson, Ariz. 85712  
jsmenick@aol.com

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