Objective: To evaluate aesthetic and functional results of reconstruction of the nasal alar subunit using free cartilage grafts with an interpolated cheek or forehead flap and a vascularized mucosal flap when required.

Setting: University-based facial plastic surgery practice.

Patients: A case series of 50 patients with primary alar defects undergoing nasal alar reconstruction.

Main Outcome Measures: Observer’s and patient’s rating of the final results, patient’s rating of breathing and level of self-consciousness, and medical record review of complications.

Results: Most aesthetic outcomes were excellent to good. Breathing from the reconstructed side can be returned to preoperative status in most of these patients.

Conclusion: Staged reconstruction of the nasal ala using free cartilage grafts, interpolated cheek or forehead and mucosal flaps when necessary, result in a highly aesthetic and functional outcome in most patients.


The nose is highly contoured and occupies a central position on the face. These 2 features allow small asymmetries and imperfections of contour to be apparent. In addition to these aesthetic considerations, the nose must have an adequate nasal airway. Although nasal breathing is not a requirement for survival, patient comfort and satisfaction are intimately related to a normally functioning nose. These considerations make aesthetic and functional reconstruction of the nose one of the most challenging endeavors in facial reconstructive surgery.

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The nasal alar unit is highly contoured, has a free margin, and contributes to the external nasal valve. Many methods exist to reconstruct the ala, including local nasal flaps,1,2 skin grafts,1 composite auricular grafts,1,3 and pedicle flaps.1,4-8 In most instances, however, consistent results require a cartilage subsurface framework to resist the forces of contraction and provide a stable external valve and provide a scaffold for contour. As advocated by Burt and Menick,9 cartilage grafts are best placed at the time of the first reconstructive procedure. Free cartilage grafts necessitate vascularized tissue superficial and deep to the graft. Adequate function of the nose requires a thin internal layer most appropriately supplied by a vascularized mucosal flap.35 The skin is best resurfaced by a vascularized flap supplied by an interpolated cheek or forehead flap.

Over the past 10 years, 85 patients were identified who underwent reconstruction of the nose in which the primary nasal unit involved was the ala. This study reviews a subset of 50 patients whose noses were reconstructed with a free cartilage graft, interpolated cheek or forehead flap, and intranasal mucosal flap when internal lining was required. Many of the other patients represent reconstruction using single-stage transposition flaps performed before the 2-stage technique was adopted. While these cases will not be discussed in-depth, the lessons learned will be elucidated.
PATIENTS AND METHODS

We reviewed the medical records of 85 patients over the past 10 years who underwent nasal reconstruction by one of us (S.R.B.), where the nasal ala was the primary nasal aesthetic unit involved. Fifty patients serve as the basis of this study and most were operated on in the past 6 years. All patients had a minimal follow-up time of at least 3 months, with photographic documentation of the final result. Outcome was based on medical record review, photographic review, and patient telephone interviews. The following variables were recorded from the medical record review: age, sex, race, smoking and alcohol consumption history, medical history, complications, tumor type, defect size, flap type, flap size, and number of procedures. Aesthetic outcome was judged by 2 methods. First, the final postoperative photographs were judged by 1 physician and 2 nurses. The result was judged as excellent, good, fair, or poor. A result was judged as excellent when the result showed no asymmetry and no evidence of reconstruction. A good result showed minimal asymmetry or minimal visibility of scar in the photograph, but was not distracting to the patients’ appearance. A fair result showed moderate asymmetry or scar that was somewhat distracting to the patients’ appearance. A poor result showed obvious asymmetry or scar that dominated the patients’ appearance. Using the same criteria, analysis of the donor site scar was also performed by 1 physician. The second method of judging aesthetic results was patient interviews. Patients were asked to judge their results as excellent, good, fair, or poor. They were also asked to assess their level of self-consciousness about the reconstruction using one of the following choices: never self-conscious, occasionally self-conscious, almost always self-conscious, or always self-conscious. The functional result was judged by the patient interview. Patients were asked to evaluate their breathing through the reconstructed side compared with preoperative function. The choices were better, the same, slightly worse, or much worse than preoperatively.

Methods of reconstruction included a free auricular cartilage graft (occasionally septal cartilage is used), a bipedicled vestibular skin advancement flap, or septal mucoperichondrial flap when replacing internal lining, and skin coverage with an interpolated cheek or forehead flap. Prior to the surgical procedure patients were educated on the risks, benefits, and multiple stages involved in the process. They were shown photographs of patients at each stage of the reconstruction to give them a clear understanding of their appearance after each procedure and long-term.

NASAL DEFECT MANAGEMENT

Alar defects generally mandate replacement of the entire unit. If more than 50% of the tip or sidewall nasal aesthetic units are missing, resurfacing the remainder of these units is considered. When reconstructing the ala, 1 mm of alar skin just anterior to the alar-facial sulcus (similar to an alar-base excision) is left intact if still present. This preserves the alar-facial sulcus. The nasal skin is then undermined in the submuscular plane for a distance of 1 cm. When the defect includes cheek skin adjacent to the alar-facial sulcus, cheek tissue is undermined and advanced medially to the level of the sulcus. To facilitate this advancement, deep sutures are placed from the cheek to the periosteum of the pyriform aperture (or through drill holes placed in the bony pyriform aperture). After the wound is modified, an exact template of the nasal defect is made and the mucosal lining is restored.

BIPEDICLED FLAPS

For full-thickness defects consisting solely of the ala, a bipedicled vestibular skin advancement flap can be used for lining (Figure 1). This is created through an extended intercartilaginous incision from the nasal dome to the lateral floor of the vestibule. If more tissue is required for lining, the incision can be made more cephalad. Vestibular skin is then elevated from the remaining lateral crus of the alar cartilage and mobilized inferiorly, suturing the inferior edge to the remaining vestibular skin or the covering flap if the defect extends to the alar margin. The superior edge is sutured to soft tissue at the superior aspect of the defect. The tissue void representing the donor defect superior to the bipedicled flap is then covered with a full-thickness skin graft. This is supplied by excising the standing cutaneous deformity that occurs during primary closure of the interpolated cheek flap donor site. Bipedicled flaps yield a limited amount of lining tissue and should not be used for defects larger than the height of the ala.

SEPTAL FLAPS

For larger deficits of nasal lining, septal mucoperichondrial flaps based on the caudal septum are used (Figure 2). These are nourished on the septal branch of the superior labial artery that enters the nose near the nasal spine. If needed, most of the mucoperichondrium on one side of the septum can be used for the reconstruction. The typical boundaries of the incisions for the flap are superiorly, 1 cm from the dorsum of the nose, inferiorly along the maxillary crest, and posteriorly as far back as needed (usually to the middle one third of the bony septum). The anterior extent of dissection of the flap is limited to 1 cm posterior to the caudal edge of the septum. The flap is created by making the superior and inferior incisions with a sicle knife, and the vertical posterior incision with an angled blade. The flap is then mobilized from posterior to anterior with a Woodson elevator, and turned medially toward the defect so the mucoperichondrium faces externally and the mucosa is internal. The most distal edge of the flap becomes the caudal free margin of the reconstructed ala if the defect extends through the nostril margin. In these circumstances, the free margin is sutured to the interpolated covering flap. Care must be taken when harvesting the flap because if the distal edge does not survive, the overlying cartilage framework graft may necrose resulting in an alar notch. The exposed septal cartilage and bone is removed and the contralateral septal mucoperichondrium is left intact. It will eventually heal with a regenerated epithelial surface. Alternatively, the exposed septal cartilage and bone may be left intact and it likewise will become resurfaced within 8 to 10 weeks. During that interval, the patient is instructed to spray the interior of the nose with an isotonic Sodium Chloride solution 4 to 6 times daily to enhance humidity.

FREE CARTILAGE GRAFT

The framework grafts are crafted and sutured to the restored mucosal lining. Although septal cartilage can be used for the framework of the ala, auricular cartilage is preferred. Cartilage is generally harvested from the contralateral ear.
The interpolated cheek flap (INTERPOLATED CHEEK FLAP) cover the cartilage graft and resurface the entire ala. Cured in place, an interpolated skin flap is transposed to the caudal edge of the remaining alar cartilage from prolapsing into the airway and anchors the lateral aspect of the graft. A convex contour is maintained to the graft while suturing it to the lining flap. The apex of the graft is trimmed to fit into the nasal facet and is sutured to the nasal skin, everting the wound edges using figure 8 sutures that keep the graft from telescoping over the alar cartilage. After the cartilage is secured in place, an interpolated skin flap is transposed to cover the cartilage graft and resurface the entire ala.

INTERPOLATED CHEEK FLAP

The interpolated check flap (Figure 3) is based superiorly on the rich vascular supply at the alar-facial sulcus as described by Hebert and is usually designed with only a subcutaneous pedicle. An exact template of the alar unit is made from the contralateral normal side and reversed to design the flap. If the defect extends beyond the ala, an exact template of the defect is used for the design. The template is positioned over the melolabial fold so that the center of the flap is on a horizontal plane with the lateral commissure (Figure 3A). The flap is designed as a crescent-shaped skin island whose medial border lies in the melolabial crease. The superior extent of the incision is 5 mm lateral to the alar-facial sulcus, preserving this important aesthetic area. The flap is incised and elevated in the subcutaneous plane. The distal one third of the flap is thinned leaving 1 to 2 mm of subcutaneous fat on this portion of the flap. On reaching the superior aspect of the flap, the dissection is deepened to create the subcutaneous pedicle (Figure 3B). To facilitate closure of the donor site, an inferior standing cutaneous deformity is removed. The flap is turned toward the midline and sutured to the nasal skin. The template is then traced on the forehead, and vertical mattress cutaneous sutures are placed (if used) are detached at 3 weeks (Figure 4A-B).

CHEEK FLAP

The flap is cut at the base. The cheek wound margins are freshened and the adjacent skin is undermined for a distance of 2 cm around the periphery of the wound and closed primarily. The distal one third of the flap is defatted, and trimmed to fit the defect. Flap inset is accomplished with vertical mattress cutaneous sutures.

FOREHEAD FLAP

Flap debulking and creation of an alar groove is often required (Figure 5). This is performed 3 months after detachment. A template of the contralateral normal alar unit is made, reversed, and traced onto the reconstructed side. If the superior border of the flap is no greater than approximately 1 cm superior to the proposed groove, then the scar at the juncture of the flap and nasal skin is reopened. If a larger portion of the sidewall was resurfaced, a new incision is made along the proposed alar groove. The flap is undermined leaving a few millimeters of subcutaneous tissue attached to the dermis. The remainder of the subcutaneous tissue and scar is elevated off the auricular cartilage graft and disposed of. A trough 3 to 4 mm wide is created in the previously placed cartilage graft and centered under the proposed groove (Figure 5B). When appropriate contour is achieved, the wound is closed using simple interrupted sutures. A dental roll is cut longitudinally in half and bolstered in place straddling the reconstructed groove using through-and-through sutures tied over the roll (Figure 5C).

The standing cutaneous deformity at the hairline is removed vertically into the scalp prior to closure. If the wound cannot be closed in its entirety, a small portion is left to granulate and heal by secondary intention.

FLAP DETACHMENT

The forehead, cheek, and septal mucoperichondrial flaps (if used) are detached at 3 weeks (Figure 4A-B).

SEPTAL MUCOPERICHONDRIAL FLAP

This lining flap is based on the caudal septum and spans the nasal passage from the septum to the ala obstructing the airway. It is detached at the same time as the cutaneous covering flap. A scalpel is used to resect the mucosa bridging between the septum and the ala. The resulting raw edges of the remaining mucosa are cauterized to prevent bleeding.

Flap debulking and creation of an alar groove is often required (Figure 5). This is performed 3 months after detachment. A template of the contralateral normal alar unit is made, reversed, and traced onto the reconstructed side. If the superior border of the flap is no greater than approximately 1 cm superior to the proposed groove, then the scar at the juncture of the flap and nasal skin is reopened. If a larger portion of the sidewall was resurfaced, a new incision is made along the proposed alar groove. The flap is undermined leaving a few millimeters of subcutaneous tissue attached to the dermis. The remainder of the subcutaneous tissue and scar is elevated off the auricular cartilage graft and disposed of. A trough 3 to 4 mm wide is created in the previously placed cartilage graft and centered under the proposed groove (Figure 5B). When appropriate contour is achieved, the wound is closed using simple interrupted sutures. A dental roll is cut longitudinally in half and bolstered in place straddling the reconstructed groove using through-and-through sutures tied over the roll (Figure 5C).
dergone reconstruction of the nasal ala using either the superiorly based interpolated cheek flap or the forehead flap along with free cartilage grafts and vascularized mucosal flaps when the defect was full thickness. The patients ranged in age from 33 to 86 years, with an average age of 61 years. Most (43 patients [86%]) had defects resulting from the removal of basal cell carcinomas by Mohs' micrographic surgery. The remaining 7 patients had defects resulting from the removal of atypical melanocytic hyperplasia and/or melanoma (5 patients [10%]), or revision surgery (2 patients [4%]). There were 15 forehead flaps and 35 interpolated cheek flaps preformed.

FOREHEAD FLAPS

The defects repaired by forehead flaps averaged 7.45 cm², with a range of 4 to 21 cm². Ten defects were full thickness. Of these, 8 defects were repaired with a septal mucoperichondrial-hinged flap to provide lining, and the remaining 2 defects were repaired with a bipedicle nasal vestibular skin advancement flap. The final photographic results were judged by 3 examiners. Ten repairs (67%) were judged as excellent to good and 5 repairs (33%) were judged as fair. Eleven (73%) of 15 patients could be contacted by telephone about their results. All patients judged their re-

Figure 1. Drawings demonstrating sequence of reconstructing full-thickness alar defect using bipedicle vestibular skin advancement flap for lining. A, An extended intercartilaginous incision is made to develop flap. B, Bipedicle advancement flap of vestibular skin is mobilized inferiorly. The donor site is repaired with a full-thickness skin graft. C, Remaining skin of the alar unit is discarded and an auricular cartilage graft is used as an alar batten. D, Interpolated cheek flap serves as a covering for the ala.
sults as good to excellent. Further analysis of the patients judged as having fair results, revealed that 3 patients had a poor color match, 1 had a persistent notch from partial loss of the septal mucoperichondrial flap, and the final patient had some upper lip asymmetry with a good nasal reconstruction. This latter patient originally had a 10-cm² defect that included partial loss of the upper lip. Reconstruction resulted in asymmetry from replacement of hair-bearing lip skin with nonhair-bearing cheek skin. Nine of the 11 patients contacted reported their breathing to be similar to baseline and 1 patient, who underwent concomitant septoplasty, reported breathing better than baseline through the reconstructed side, bringing the better or same assessment to 91%. All patients were either never or occasionally self-conscious about their appearance secondary to the reconstruction. There were 3 complications in the 15 patients. All complications were related to partial necrosis of the lining flap (2 septal flap, 1 bipedicle advancement flap) that affected the results in only 1 patient, leaving a notch as described earlier (Table). No septal perforations or intranasal synechium were observed.

CHEEK FLAPS

The average defect resurfaced with a cheek flap was about half the surface area of those resurfaced with a forehead flap.
flap (3.8 cm² vs 7.45 cm²). Only 6 (17%) involved full-thickness losses, with internal lining usually supplied by a bipedicle advancement flap. Observers rated the final results as excellent to good in 30 patients (86%). Five patients (14%) had fair results. Of the 15 patients contacted, 14 (93%) rated their result as excellent to good. Further analysis of the 5 patients with fair results showed 2 patients had prominent donor site scars. One patient had a prominent donor site scar and an elevated ala secondary to loss of a portion of the mucosa lining the ala. In this patient, the defect extended down to, but not through, the mucosa. Despite the mucosa being intact, it underwent partial necrosis postoperatively. One patient had a notch of the ala from partial necrosis of the cheek flap, and another developed mild elevation of the nostril leading to slight asymmetry. Nine of the patients rated their breathing as the same and 6 patients rated it as only slightly worse than baseline. All patients said they were never self-conscious or only were occasionally self-conscious about their nose. There were 6 complications, 2 affected the final result as described earlier. One patient with infection responded to antibiotic therapy; one with hematoma responded to drainage. There were 3 cases of partial necrosis of the distal flap (1 patient was a smoker). Two of these cases responded to freshening the edges of the wound, advancing the flap, and resuturing the wound. There was one case of loss of mucosa in a patient whose defect extended down to, but did not include, mucosa. As described earlier, a retracted nostril margin developed in this patient. No intranasal synchium or septal perforations were observed.

**COMMENT**

Reconstruction of the nasal ala is a complex task. Burger has outlined 7 principles unique to aesthetic recon-
struction of the face. These are as follows: (1) The goal is normal facial contour. (2) The missing part is restored in its 3-dimensional form replacing each layer with like tissue. (3) Templates are used for the design of grafts and flaps. (4) Donor scars should be hidden or camouflaged. (5) Replace the entire nasal aesthetic unit when practical. (6) Use cartilage grafts to create contour, prevent collapse, and resist the forces of contraction. (7) Use subcutaneous sculpturing to refine the result.

Our early experience with “single-stage” superiorly based melolabial (nasolabial) transposition flaps has confirmed the wisdom of these 7 principles as applied to alar reconstruction. The following lessons were learned from the use of more conventional melolabial transposition flaps:

1. This method of alar reconstruction is seldom single stage if normal contour is the goal.
2. Cartilage is required for normal airway patency as well as contour.
3. When used as a turn-in flap to provide internal lining, airway patency is sacrificed, necessitating a debulking procedure.
4. The flap disrupts the important alar-facial sulcus and requires revision surgery to recreate it.
5. Using a melolabial transposition flap generally results in more procedures, with less predictable results when compared to the current method.

To date, to our knowledge, this study represents the largest series of alar defects reconstructed with the method described, which is very similar to the techniques used by Burget and Menick\textsuperscript{5,6,9} with minor differences in the design of the cheek and intranasal lining flaps, cartilage graft, and subcutaneous sculpturing techniques. Over the past few years there has been a tendency toward making alar reconstruction a 3-step process. During the third stage, the cartilage graft is contoured along with the subcutaneous tissue to restore the delicate alar groove. This stage puts the “finishing” touches on the contour of the ala and also improves the patients breathing by removing any ex-
cess cartilage or soft tissue in the nasal valve area. The width of the free auricular cartilage graft is 1.5 cm. This is sufficiently wide so that after contouring there is cartilage inferior and superior to the alar groove, which helps stent the internal valve.11,12

The selection of a forehead or a cheek interpolated flap is primarily based on the size of the defect (Figure 6). Defects that extend several millimeters from the ala into the nasal sidewall are probably best resurfaced with a forehead flap. If the defect encompasses a significant amount of the hemitip or sidewall, consideration should be given to resurfacing these areas in their entirety. However, it must be remembered that resurfacing an entire aesthetic unit with a poorly contoured flap provides a poorer result than a well contoured flap with a fine, flat scar that traverses the unit. Another relative indication for the forehead flap is the young patient with little cheek laxity and inconspicuous melolabial folds. To the trained eye, almost all cheek flaps result in some asymmetry of the melolabial folds. The typical stigmata is a flattening of the inferior aspect of the melolabial fold in all patients along with enhanced fullness of the fold superiorly in some. These problems can be improved with revision surgery or excision of the contralateral melolabial fold.13 However, most patients are not bothered or do not notice this asymmetry. In young patients with little cheek laxity, we have seen donor site scars remain conspicuous even a year after surgery. In contrast, properly closed forehead wounds, rarely heal with a poor long-term result. Forehead scars have the added advantage of being camouflaged with certain hairstyles.

All surgery is subject to complications. The most frequent complication encountered in this series was partial necrosis of intranasal lining flaps. Although smokers are probably at a greater risk for this, among our patients with complications, most did not smoke. When

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* This patient had a mucosal loss from a defect that extended down to, but not through, mucosa; no mucosal flap was done.

Figure 5. A, An incision is made in scar separating nasal skin from flap. B, A trough of cartilage is removed centered along the proposed alar groove. The trough will define the new alar groove. Note that cartilage remains superior and inferior to the trough that helps maintain integrity of the nasal valve. C, Bolster straddling alar groove is in place. This is left in place for 5 days.
encountered, this complication places the overlying cartilage at risk of necrosis with subsequent notch formation. Therapy for this consists of local wound care with daily cleaning and antibiotic ointment along with oral antibiotics. If a notch develops, it is repaired at a later date using Z-plasty technique or at the time of the third-stage debulking procedure. At this stage the trough of cartilage removed along the reconstructed alar groove is relocated to the alar margin in the area of the notch. This is very helpful in effacing small notches. The second most frequent complication encountered in our series of patients was partial necrosis of the distal portion of the cheek flap, which developed in 3 patients. In 2 of these patients, this was effectively managed by freshening the edges of the wounds and resuturing the flap. To assure a relative tension-free closure, the flap should be carefully mobilized at its pedicle at the time of this revision procedure. The ability to adequately manage these complications keeps these “setbacks” from becoming poor results.

**CONCLUSION**

This study supports the concept that reconstruction of most of the patients with nasal ala defects can achieve a highly aesthetic and functional result through the use of a multistaged procedure using free cartilage grafts and vascularized flaps.

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