Repair of Intermediate-Size Nasal Defects
A Working Algorithm

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IMPORTANCE "Large" nasal defects are typically classified as larger than 1.5 cm. Within that group, however, there is a subset of patients with smaller nasal defects (1.5-2.5 cm) who are treated differently. This study examines the different methods that we have used in the reconstruction of such "intermediate-size" nasal defects.

OBJECTIVE To review the treatment and outcomes of patients who have undergone reconstruction of intermediate-size nasal defects and to share our empirical algorithm.

DESIGN, SETTING, AND PARTICIPANTS This was a retrospective review at an academic university practice of all patients who had undergone reconstruction of intermediate-size (1.5-2.5 cm) nasal defects from January 1, 1999, to September 1, 2013. From these data, a working algorithm was derived.

INTERVENTIONS Nasal reconstruction of intermediate-size nasal defects.

MAIN OUTCOMES AND MEASURES Method of reconstruction was correlated with site and size of defects. Postoperative complications were reviewed.

RESULTS A total of 315 patients with nasal defects measuring 1.5 to 2.5 cm were identified. Of these, 199 patients (63.2%) had a defect in a single subunit, and 116 (37.8%) had involvement of a combination of subunits. Ninety-seven patients (30.8%) had local flaps, 94 patients (29.8%) had forehead flaps, 51 patients (16.2%) had full-thickness skin grafts (FTSG), 40 (12.7%) had composite grafts, and 33 (10.5%) had melolabial flaps. The defects were categorized according to subunit locations. There was a pattern of reconstruction for each defect according to their site, size, and depth. Alar defects were mainly repaired with melolabial flaps (25 of 85 patients [29.4%]), or by composite grafts (24 of 85 patients [28.2%]). Nasal tip defects were mainly repaired using local flaps (28 of 69 patients [40.5%]), FTSG (19 of 69 patients [27.5%]), and forehead flaps (19 of 69 patients [27.5%]). The reconstruction of choice in dorsal and sidewall defects were local flaps and forehead flaps. There were 28 wound-related complications, such as pincushioning, dehiscence, and infection (incidence rate, 8.9%), and 4 cases of postoperative nasal obstruction (1.3%).

CONCLUSIONS AND RELEVANCE There is a paucity of literature on the subject of reconstruction of intermediate-size nasal defects. This algorithm is derived from our practice and offers the surgeon specific reconstructive options for consideration when facing nasal defects of 1.5 to 2.5 cm. The algorithm is based on subunits.
Reconstruction of nasal defects dates back to ancient times when nasal amputations were performed as punishment. Nasal reconstruction remains a major part of facial plastic surgery today, although most relate to cutaneous malignant neoplasms. We have improved our techniques with a higher understanding of form, function, and aesthetics.

The concept of the aesthetic subunit was first described by Gonzalez-Ulloa. Flap design is crafted in a way that allows strategic placement of scars along the borders of adjacent aesthetic subunits. Burget and Menick helped to popularize this concept in nasal reconstruction.

Reconstruction of small and large defects has been described in the literature and generally offers concise—albeit equally challenging—algorithms. Most large defects are repaired with forehead flaps. There is a dearth of publications that focus on the repair of intermediate-size nasal defects (ie, those measuring 1.5 to 2.5 cm in diameter). Ironically, there is a wider array of good options for this group. Commonly described techniques of reconstruction include local flaps, full-thickness skin grafts (FTSGs), composite grafts, melolabial flaps, and forehead flaps. Each technique has its advantages, disadvantages, and nuances. Herein, we present our experience with reconstruction of intermediate-size defects over a 13-year period. Defects are categorized based on subunits and organized into a working algorithm that may help the surgeon in choosing a reliable method of reconstruction.

Methods
A retrospective medical record review was performed of patients with nasal Mohs defects from January 1, 2000, to June 31, 2013. Included were patients with nasal defects of 1.5 to 2.5 cm who had undergone reconstruction and had complete medical records. The data collected included patients’ comorbidities, smoking status, size of defect (maximum diameter), subunit involved, reconstructive technique, complications, presence of alar notching, and presence of nasal obstruction. Positive smoking history was defined as continued tobacco use during the perioperative period. Institutional review board approval was obtained from the University of Virginia.

Results
A total of 828 cases of nasal reconstruction were reviewed, and 315 patients met the inclusion criteria. There were 176 women (55.9%) and 139 men (44.1%). The mean patient age was 65 years (age range, 16–96 years). Twenty patients (6.3%) remained active smokers.

The defects were categorized according to subunit locations. The subunits included the ala (85 defects [27.0%]), nasal tip (69 [21.9%]), dorsum (28 [8.9%]), sidewall (17 [5.4%]), and a combination of 2 or more subunits (116 [36.8%]). Reconstructive options were FTSG, local flaps, local flaps with FTSG, composite grafts, melolabial flaps, and forehead flaps (Table 1). Figures 1, 2, and 3 highlight the different defects and surgical techniques used. The mean size of the defects was 19.2 mm.

Cartilage grafting was used in 147 patients (47.0%) (Table 2). Involvement of the ala, either as a single subunit or in combination, was noted in 122 of these patients (82.4%).

There were 26 patients (8.3%) with full-thickness defects. The internal lining was repaired by composite graft (12 defects [46.2%]), primary closure (6 [23.1%]), septal flap (4 [15.4%]), epithelial turn in flap (3 [11.5%]), and bipedicled mucosal advancement (1 [3.8%]).

Complications were encountered in 27 patients (8.6%), of whom 2 were smokers (7.1%). Eleven patients had pincushioning, 5 had wound dehiscence, 4 patients had wound infections that resolved with oral antibiotic therapy, 3 patients had lateral ala and/or facial webbing, 2 had hematomas (drained with a needle aspirate), and 1 patient had a standing cutaneous deformity that was revised. Graft failure was encountered in 1 patient who had a composite graft.

Discussion
From the data set, we constructed an algorithm demonstrating the reconstructive patterns used for intermediate-size nasal defects, based on subunits (Figure 4). It shows the prevalence of different repair methods at different locations. There are obviously numerous considerations when selecting a specific reconstructive technique, including patient needs and expectations. These subjective patient factors are difficult to describe in an article.

Alar Defects
Alar defects are unique in 2 ways. They are the most common subunit to involve the internal lining and thus require a more complex, 3-dimensional repair. In addition, they are most vulnerable to collapse and retraction. As such, structural support is an integral part of the reconstruction and usually involves cartilage grafting from the ear. In our series, common reconstruction techniques included a 2-layer auricular composite graft or the interpolated melolabial flap, with separate cartilage grafting.

The donor sites for the auricular composite graft are either the helical root or the conchal bowl, depending on the destination. One the one hand, if skin is needed from the convex side (ie, the cutaneous portion of the ala), the graft is harvested from the root of the helix. On the other hand, internal lining defect requires the epithelium of the graft to be on the concave surface of the cartilage and the conchal bowl is the preferred donor site. Use of the composite graft combines both structural support and skin resurfacing. Rees first described the use of composite graft, and it was used in the reconstruction of defects ranging from 15 to 35 mm. We have generally used it for reconstruction of smaller cutaneous defects (mean size, 17.9 mm).

Many alar defects are often repaired with a conchal cartilage graft and an interpolated melolabial flap. The curved conchal cartilage is ideal for this area, and it is important to seat it...
Nasal Tip Defect
Nasal tip defects are challenging because of their midline position and because any rotational tension vector from a local flap will create some tip twisting and alar base asymmetry. Tissue recruitment should be symmetric to avoid this deformity. The skin characteristics of the nasal tip are also a fundamental determinant of the reconstructive algorithm. An FTSG will not camouflage on a thick-skinned or sebaceous nose.

Local flaps are the first consideration owing to their simplicity and acceptable outcomes. It represents the largest group of repairs for the nasal tip. The most common flap is bilateral advancements with excision of superior and inferior standing cutaneous deformities. This is especially suitable in the setting of a wide and bulbous nasal tip. Traditional nasal tip narrowing maneuvers used in cosmetic rhinoplasty can be used here (eg, as cephalic trims, interdomal sutures).

An FTSG can be used for the nasal tip in selected cases. Individuals with thin skin or with a superficial defect are excellent candidates for this simple repair. The graft is aggressively thinned and cut to be slightly smaller than the defect. This creates slight tension on the repair and minimizes the pinch cushion effect. Careful skin edge approximation is critical to create a smooth transition between the graft and native skin. Studies concur that in the right patient, an FTSG can provide aesthetically pleasing results.7-9

The forehead flap is ideal for large nasal tip defects and allows the scars to be placed along the border of tip subunit. Tip sutures can be conveniently placed and lend support and shape to the repair.

Nasal Sidewall Defects
Isolated sidewall defects are less common. When they are situated caudally, close to the supra-alar crease, one must consider alar retraction and collapse to the nasal valve. For these reasons, the sidewall is the second most common site for cartilage grafting after the nasal ala. The technique is similar to that of a functional rhinoplasty with lateral wall batten grafts from the conchal bowl or septum.

Resurfacing is most often accomplished with a local flap, followed by the forehead flap. Advancement and rotational flaps are well suited for this location. A variation of the bilateral advancement technique is the east-west flap.10,11 The flap is described as a vertical linear closure with the inferior redundancy displaced medially to the midline of the nose. The superior cone is as wide as the defect, whereas the inferior cone is shorter and narrower. This flap has traditionally been advocated for the patient with the sebaceous nose and thick skin. Tissue match is excellent, and there is minimal donor site morbidity.

The bilobe flap is a double transposition flap that allows movement of the looser skin from cephalic or medial nasal area into a small nasal defect of the lateral caudal nose and adjacent nasal tip. The arc of rotation of the bilobed flap was modified by Zitelli12 to roughly 100° with an approximate 45° pivotal arc between each lobe, resulting in smaller standing cutaneous deformity and less pincushioning. Outcomes from an FTSG vs a local skin flap have been compared. Rustemeyer et al8 showed that the advantages of local flap repair were lower rates of infection and skin loss, but that it had a higher rate of aesthetic deficits.

Nasal Dorsum Defects
Dorsal nasal defects rarely jeopardize the nasal airway. The most common repair uses local flaps, especially bilateral advancements. Intrinsic deformities, such as a large dorsal nasal hump of bone and cartilage, can be addressed and facilitate the reconstruction. Dorsal nasal advancement flaps are occasionally used in this case by bringing glabellar skin onto the nose through an advancement. This may create mild nasal tip elevation, which occasionally is a good thing for the elderly population.

Local flaps in combination with FTSGs have proven to be useful in the reconstruction of slightly wider nasal dorsum defects. This technique combines the use of a local flap to close as much as possible without creating excessive pinching or nasal obstruction. This is followed by an FTSG, harvested from the standing cutaneous deformity of the advancement flaps. Tissue match in terms of color and texture is excellent.

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Table 1. Flap and/or Graft Design by Subunit Location

<table>
<thead>
<tr>
<th>Location</th>
<th>Local Flaps</th>
<th>Local Flaps and FTSGs</th>
<th>Composite Grafts</th>
<th>FTSGs</th>
<th>Melolabial Flaps</th>
<th>Forehead Flaps</th>
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<td>3</td>
<td>1</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
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<td>8</td>
<td>11</td>
<td>17</td>
<td>7</td>
<td>48</td>
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</table>

Abbreviation: FTSG, full-thickness skin graft.
Figure 1. Reconstruction of Dorsal Nasal Defect With Forehead Flap

Larger dorsal defects in patients with higher expectations will often require a forehead flap. It allows the scars to be placed strategically and favorably.

**Subunit Combinations**

Intermediate-size defects with 2 or more subunit combinations comprised 37.8% of our patient series (116 of 315 patients), the largest group. By crossing the aesthetic border, the repair is often more complex and involves larger flaps and grafts. There were predictable patterns of reconstruction within this group of patients with more than 1 subunit involved.

In patients with both nasal tip and dorsum involved, the predominant method of reconstruction was forehead flaps and FTSG. For superficial defects, FTSGs work well since the skin over the dorsum is thin. A combination of bilateral advancement and FTSG is also well suited in this case. Alar and sidewall defects were preferentially reconstructed with...
forehead flaps and local flaps. The bilobe flap was the most commonly used local flap and is suited for defects of the distal third of the nose. Alar collapse and retraction must be guarded against.

For patients with combination dorsum and sidewall defects, the most common reconstructive methods were forehead flaps and combined FTSG with east-west flaps.

### Cartilage Grafts

Our data show a liberal use of cartilage grafts, even for these intermediate-size defects. Of 315 patients, 148 had cartilage grafts. The elastic cartilage of the ear is preferred over the hyaline cartilage of septum or rib. The external nose is frequently subject to external deformation, and the elastic properties of the auricular cartilage lend themselves well for these grafts. The decision to use cartilage grafts is frequently prophylactic. Expected 3-dimensional wound contracture will lead to alar retraction and sidewall collapse, even if none exists preoperatively.

### Lining Defects

Full-thickness defects are less common among intermediate-size nasal defects but can occur with aggressive tumors of the alar subunit. The repair mandates a 3-layered reconstruction: skin, structural grafts, and lining. In our series, we had 26 patients with full-thickness defects. These defects were repaired mainly by composite grafts to the nasal vestibule, fol-
Two-layered composite grafts from the conchal bowl are ideally suited for this type of repair. It is important not to shear the graft skin off the underlying cartilage, including during infiltration of local anesthetic. Small perforations through cartilage can also be created to allow nutrients and granulation tissue to penetrate through to the overlying skin. Postoperative corticosteroids can be considered, although they are not routinely used. Hartman and Goode studied rabbit auricular composite graft survival with corticosteroids. The group receiving 4 days of postoperative corticosteroids had a 75% graft survival rate compared with a 41% rate in the control group. Postoperative application of ice packs decreases metabolic demands of the grafts and may improve survival.15,16

Complications

The overall rate of nasal obstruction in our series of patients is 1.3%. When evaluating at-risk patients (those with repairs involving the ala and/or sidewall), the rate was 3.3% (4 of 122 patients). We attributed this low rate of functional compromise to our liberal use of cartilage grafting.

The most common complication we encountered in our series is pincushioning. This can be the result of normal wound contracture across a curvilinear line or scar. The patients are often treated with corticosteroid injections with reasonable outcomes. Epidermolysis occurred in 5 of our patients and can be treated conservatively. They usually heal well after 2 weeks when epithelialization has occurred.

Conclusions

There are multiple options available for nasal reconstruction, and a full array is used for intermediate-size defects. Reviewing our series shows some clear predilections based on subunits. Local flaps and forehead flaps represent the workhorse for these repairs. Combination techniques with skin grafts are an excellent option in many cases.