Surgery of the nasal valve is a particularly challenging aspect of rhinoplasty surgery. The nasal valve area represents the segment with the smallest cross-sectional diameter of the entire airway. For diagnostic purposes, expertise in clinical examination is unsurpassed. Inspection of the nasal inlet with relaxed and forced inspiration allows observation of nasal valve collapse. Alleviation of obstruction with gentle mechanical spreading of the nasal valve during inspiration is indicative of valve collapse and rules out important pathologic abnormalities of the posterior nasal passages (Cottle test); rotation of the nasal tip may show the same effect (Cottle sign). Of particular surgical relevance is the point of first contact observed during nasal valve collapse. Preliminary data from an ongoing study by one of us (H.G.G.) suggest that the midpoint of the ala, about 2 mm distal to the caudal edge of the upper lateral cartilage, is the most frequent point of first collapse. A simple model explains this observation: The lateral crus may be regarded as a pair of relatively long levers that start at the domal segment and at the alar base, respectively, and meet at the midpoint of the ala. The structural support of the midpoint of the ala is weakest as the mechanical support from the nearest anchoring points (the domal segment and the alar base) is transmitted over a relatively long distance.

Multiple surgical techniques have been described for nasal valve correction. One may categorize them into medial and lateral maneuvers. Medial maneuvers include variations of the spreader graft or flaring suture. Lateral techniques include variations of batten and alar strut grafts and the lateral suspension suture. Of course, the foundation of adequate correction is a caudal end of the septum of adequate quality, and sufficient rotation and projection of the nasal tip.

In principle, medial methods are limited by an unfavorable leverage relative to the point of greatest collapse. Lateral grafts can be fashioned to reach across the midpoint of the lateral crus and thus support this critical area better. The alar strut graft was first described by Gunter and Friedman and has been shown to achieve good functional and aesthetic outcome. Subsequently, multiple modifications have been described. With this technique, a rectangular cartilage graft stents and lateralizes the lower lateral cartilage. Sufficient length of the alar strut graft allows positioning its lateral extent onto the piriform crest, thus providing a solid mechanical foundation. As a result, the reinforced lateral crus becomes less prone to collapse. Herein, we analyze a novel method to modify the lateral anchoring point of lateral grafts for nasal valve correction.

**Methods**

Eight consecutive patients with a diagnosis of nasal valve collapse were identified from a retrospective medical chart review. The study was performed in accordance with the Dec-
The Stairstep Graft

The stairstep graft is used for patients who require correction of nasal valve collapse, point of first contact at the midpoint of the ala, written informed consent to participate in the study, return of completed questionnaire, minimum follow-up of 3 months, and availability of follow-up photographs. Patients were not compensated for their participation.

The stairstep graft is used for patients who require correction of nasal valve collapse with the point of first contact at the midpoint of the ala. These are patients who would have previously received long and strong alar strut grafts in our practice and, if required, correction of the caudal end of the septum with rotation and projection of the nasal tip.

A transvestibular approach of Fuleihan is modified as follows: the marginal incision does not follow the cephalic turn of the lateral crus and is extended more caudally along its lateral extent. This design results in a wider flap of vestibular skin and generates a greater distance of the inserted graft from the incision line, thus reducing the risk of graft exposure or extrusion. After hydrodissection with 0.5 mL of hyaluronidase (Hylase; all patients gave consent for the off-label use of this drug), the vestibular skin is dissected from the undersurface of the lateral crus. The lateral crus is then followed laterally to identify and transect the piriform ligament. This dissection is continued to complete a soft-tissue pocket lateral to the piriform crest. This pocket must be wide enough to allow free lateral excursion of the lateral extent of the lateral crus. These measure about 5 × 3 mm with a thickness of 1 to 3 mm and are affixed with a 5-0 Vicryl mattress suture to the lateral end of the alar strut graft. These stairstep grafts rest on the piriform crest and allow for controlled and reliable lateralization of the lateral crus (Figure 1).

The number and thickness of the stairstep grafts may be tailored to the required effect. Figure 2A schematically depicts the effect of 1 or 2 stairstep grafts on the width of the nasal valve area and the nasal valve angle. Figure 2B shows the effect of double-layered stairstep grafts inserted on the left but none yet inserted on the right.

The alar (lateral crural) strut graft is affixed at its medial extent with a triangular suture of 4-0 Vicryl, RB1. This suture grasps the graft in the midline 3 mm from its medial extent, runs through the cartilage of the lateral crus, exits and reenters the external skin at the same point, and comes back out at the caudal edge of the lateral crus. Thus, it forms a sling around the caudal edge of the alar strut graft and adapts it snugly to the undersurface of the lateral crus. The vestibular skin incision is closed with 2 to 5 simple interrupted sutures of 4-0 Vicryl.

A sandwich of 1-mm silicon foils is affixed to very gently compress the ala with a 4-0 nylon mattress suture, which is left in place for 7 days. Care is taken not to overtighten the suture to avoid the risk of pressure damage to the alar soft tissues.

Report of Cases

A total of 8 patients (including the case reported herein) with at least 3 months of follow-up were evaluated retrospectively. The Table shows the characteristics of the included patients: 7 of 8 patients had at least 1 previous septorhinoplasty. Their mean age was 38.6 years; there were 5 men and 2 women.
Questionnaire evaluation revealed the following: 8 of 8 patients reported an improvement of nasal airway 3 months after surgery, 7 of 8 patients reported ideal nasal airways bilaterally 3 months after surgery, 3 of 8 recognized a postoperative improvement of nasal appearance, and 5 of 8 assessed no changes concerning their appearance postoperatively.

Postoperative photographic evaluation revealed that on base view, persistent normalization of the preoperatively narrow alar base was noted in 8 of 8 patients. There were no complications documented in any of the patients during the entire follow-up period.

A representative case of a 40-year-old woman diagnosed as having nasal valve collapse is shown to illustrate the clinical effect. The patient had previously undergone extensive grafting in the context of thin skin and flimsy cartilaginous support (Figure 3A). This was achieved through an open-structure rhinoplasty approach with bilateral placement of double-layered spreader grafts and alar strut grafts (Figure 3B).

After an initial asymptomatic interval, the patient presented 12 months later with recurrent bilateral nasal valve obstruction. On physical examination, bilateral symptomatic alar collapse was noted on inspiration. The middle vault and the nasal tip appeared adequate. However, a relatively narrow nasal base with consecutive acute nasal valve angles was noted.

Revision surgery with costal cartilage grafting through an endonasal approach was discussed with the patient. Bilateral marginal incisions were placed, and the vestibular skin was dissected to complete a modified transvestibular approach of Fuleihan, as described. Previously placed alar strut grafts were removed, and bilateral lateral pockets were dissected to widely expose the piriform crest. Long alar strut grafts were fashioned and placed in typical fashion along the undersurface of the lateral crura. Stairstep grafts were fashioned from costal cartilage and affixed with sutures to the lateral extent of the alar strut grafts. These rested on the bony piriform crest.

The grafts were affixed with percutaneous triangular sutures and the vestibular incisions were closed with 4-0 Vicryl. Per routine, no nasal packing was placed, and silicone compression foils were affixed with sutures to compress both alar surfaces for 1 week. The grafts widened the alar base, resulting in a notably wider nasal valve area and blunter nasal valve angle (Figure 4). The patient noted a subjectively excellent bilateral nasal airway.

Discussion
Corrective surgery of the nasal valve requires detailed analysis of all contributing factors. Often, multiple surgical maneuvers are required to correct the problem. Even with combination of multiple indicated techniques, success of valve correction is not always ideal, as demonstrated with the present case. The lateral anchoring point of the alar lobule has an important effect on the architecture of the nasal valves. If this point remains unchanged, the base of the nasal valve area may be widened only by means of narrowing the columellar base. The introduction of the stairstep graft represents an evolution of techniques. We initially released the piriform ligaments and placed alar strut grafts with long lateral extensions to rest on the piriform crest. Subsequently we added Paniello-type suspension sutures, followed by wide triangular sutures that grasped the soft tissues of the cheek and further lateralized the alar strut grafts and the soft tissues of the alar base.

Three major suture techniques are described in the literature. The main drawbacks of the valve suspension techniques reported so far are the risk of infection and the loss of suspension. The introduction of the stairstep graft has
improved our surgical results over those observed with suture techniques, as seen in the 8 study patients and a total number of 21 patients so far.

The concept of the stairstep graft introduces an innovation in nasal valve surgery: transection of the piriform ligament, wide undermining of the soft-tissue insertions along the piriform crest, and lateralization of the anchoring point of the alar strut graft with a structural graft have not been described to our knowledge. This graft is versatile because multiple stairstep grafts may be placed and tailored to the degree of pathologic abnormality. It can be placed through a minimally invasive endonasal, transvestibular approach. Cartilage of inferior structural quality is sufficient to withstand the minor compressive forces encountered; it is combined with the established concept of alar strut grafts and enhances this technique. Preliminary results are encouraging. The stairstep graft has the potential to widen the routine armamentarium of surgical techniques in functional correction of the nasal valves. In our practice, it has profoundly changed our surgical treatment of nasal valve pathologic abnormalities and can be applied in most cases.

Conclusions

The description of the stairstep graft introduces a new concept in nasal valve surgery: lateralization of the lateral anchoring point for the alar strut graft (or other lateral functional grafts). Two additional aspects are introduced with the current report: the utility of the point of first contact as a diagnostic measure and the use of hyaluronidase for hydrodissection in septoplasty and rhinoplasty surgery.

REFERENCES