Alar Expansion and Reinforcement

A New Technique to Manage Nasal Valve Collapse

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Objective: To describe the new technique of alar expansion and reinforcement as a comprehensive approach to the surgical management of nasal valve collapse.

Methods: Alar expansion and reinforcement expands the narrow nasal valve and reinforces the floppy nasal sidewall. Forty-one patients underwent rhinoplastic surgery for nasal valve collapse between May 1, 2002, and April 30, 2005, using an external rhinoplasty approach; of these, 32 responded to our postoperative questionnaire. Twenty-four patients (75%) underwent primary surgery and 8 (25%) had undergone previous rhinoplasty. All patients had permanent adjustable expansion sutures. Twelve patients (38%) had an excessively floppy nasal sidewall that required a high-density porous polyethylene alar batten implant to anchor the expansion sutures. Patients underwent clinical review from 6 months to 3 years after surgery, and a telephone survey was used to evaluate their functional and cosmetic satisfaction rates.

Results: Thirty patients (94%) experienced good improvement in their nasal airway. The improvement in nasal airway patency was statistically significant (P<.001). Two patients (6%) reported no improvement. There were no complications. Cosmetic outcome was satisfactory in all 8 patients who also requested cosmetic improvement. Of the 24 patients who had surgery for nasal obstruction only, 10 (42%) rated their cosmetic appearance as better, with the remaining 14 (58%) indicating that they did not identify any significant change in their nasal appearance.

Conclusion: Alar expansion and reinforcement is a safe, reliable, and effective technique to manage nasal valve collapse.

Arch Facial Plast Surg. 2006;8:293-299

IN 1903, MINK1 FIRST DESCRIBED THE ANATOMIC SIGNIFICANCE OF THE NASAL VALVE. AIRFLOW THROUGH THIS CRITICAL SEGMENT IS LIMITED BY STRUCTURAL AND DYNAMIC FACTORS. STRUCTURAL FACTORS REFER TO THE NARROW CROSS-SECTIONAL AREA OF THE VALVE, WHICH RANGES FROM 55 TO 64 mm².2,3 This anatomy was defined by Bridger2 and consists of the caudal border of the upper lateral cartilage, the head of the inferior turbinate, the floor of the nose, and the nasal septum. The valve angle describes the angle that the caudal border of the upper lateral cartilage makes with the nasal septum. The valve angle normally measures no less than 10° to 15°.

Increased airway resistance may be structural, due to a reduced cross-sectional area at the nasal valve. There may be inadequate growth of the airway (a small nose) leading to a reduced cross-sectional airway. In some cases, the valve angle is normal, but concavity of the lateral part of the lateral crus of the lower lateral cartilage folds into the airway, causing blockage. Other causes of structural narrowing include internal mucosal scarring from trauma or surgery, turbinate hypertrophy, or septal deflection at the valve. A combination of factors might be responsible.

Increased airway resistance may be dynamic, owing to the effect of inhalation causing collapse of the nasal sidewall at this area. Unlike most of the nasal airway, which is surrounded by a rigid bony case, this zone has a floppy sidewall and can be likened to a semirigid tube. The diameter of the nasal valve can diminish under the effect of the negative pressure, which develops during inhalation. This collapsibility makes this segment a Starling resistor, which is directly affected by Bernoulli forces.2

Airflow resistance increases when the negative pressure created in the nose during inhalation pulls the floppy nasal sidewall toward the septum. Clinically, the likelihood of dynamic collapse increases in patients with a narrow nasal valve or a floppy sidewall.

Methods proposed to correct nasal valve collapse fall into the following 2 categories: procedures that address the structural narrowing by creating a larger cross-sectional surface area and procedures that

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address the dynamic collapse by strengthening the nasal sidewalls. Many techniques have been devised to increase the cross-sectional area of the nasal valve. The spreader graft technique describes the placement of cartilage grafts between the upper lateral cartilage and the nasal septum to push out the upper lateral cartilage. This technique focuses on the superior part of the valve, opening the valve angle and thereby increasing the airflow at the valve. External sutures, anchored to the maxillary periosteum, have been used to pull out the nasal sidewalls. This technique focuses on opening the nasal valve nearer the nasal floor. Park and Sciuto and Bernardeschi used sutures to pull the upper lateral cartilage away from the septum and open the nasal valve angle.

A floppy sidewall can be strengthened by placement of structural alar battens over the weak sidewall cartilages. Various materials have been used, including septal, auricular, and rib cartilage and high-density porous polyethylene (HDPP). The lateral crural spanning graft also supports the floppy sidewall by using the septum as a fulcrum. Each end of this graft lies under the lateral crus to prevent it from collapsing into the airway. The J flap tightens the lateral nasal wall by excising a portion of mucosa and cartilage at the caudal margin of the protruding lateral crus.

None of these single-modality techniques have gained universal acceptance, probably because valve collapse is multifactorial and individual factors vary in each patient. Variables include the shape of the valve, the valve angle, and the floppiness of the sidewall. Consequently, because each procedure focuses on only 1 factor, none is universal for every situation.

This report describes a new technique to improve nasal valve collapse. Unlike other procedures, this technique addresses the structural issue of reduced cross-sectional area and the dynamic collapse by providing support to the weak sidewall if required.

The measurement of nasal valve structure and function can be performed using various techniques, such as computed tomography, acoustic rhinometry, and rhinomanometry. However, any technique that interferes with the valve may produce an artificial result. Most clinicians use physical examination and patient satisfaction scores to measure valve collapse in practice. We used this clinical approach for our study.

The study monitored 41 patients (21 men and 20 women) who underwent nasal surgery for nasal valve collapse between May 1, 2002, and April 30, 2005. Their ages ranged from 19 to 71 years, with an average age of 46 years.

Before surgery, each patient underwent a full history and physical examination of the nose and face, with a focus on the nasal airway. One of us (M.S.M.) diagnosed nasal valve collapse during the physical examination by observing movement of the nasal valve during quiet and deep respiration. Each nostril was assessed individually, and the sidewall was held out using a fine probe to identify the presence, position, and extent of collapse and the effect of nostril support on improving airflow. Significant septal deviation, nasal polyps, and significant rhinitis were managed first if necessary. Patients with these problems were not included in this study. Minor septal pathology was corrected at the time of nasal valve surgery. Some patients were given a trial of an internal or an external nasal dilator if there was doubt regarding the diagnosis or if the patient expressed a desire to try other options.

A patient survey to assess breathing and cosmetic satisfaction was conducted by means of a standardized telephone questionnaire. Follow-up ranged from 6 months to 3 years. Breathing improvement was measured using a 1-to-10 analog scale, with 1 representing complete obstruction and 10 representing complete patency. Patients were also asked to rate the postoperative cosmetic appearance as better, the same, or worse. Finally, they were asked whether they would undergo this procedure again.

Nasal surgery was performed with the patient under general anesthesia. The nose was prepped inside and outside with povidone-iodine solution if the patient had a floppy sidewall and the need for alloplastic grafts seemed likely. With the use of an external rhinoplasty approach, the lateral crura of the lower lateral cartilages were widely exposed and assessed for strength by palpation (Figure 1A). Lateral crura that were strong enough to tolerate the pull of the expansion sutures were not reinforced. Weak lateral crural cartilages were reinforced with an alar batten implant of HDPP measuring 0.85 mm thick, 3 mm wide, and 1.5 to 2.5 cm long. This implant was placed over the lateral crus, away from the dome. It served as an anchor for the sutures, to prevent the sutures from pulling through or bunching the weak sidewall.

These HDPP implants were sutured directly onto the lateral crura using 4/0 chromic sutures in the exact site required for subsequent alar expansion suture placement. The caudal implant edges were kept away from the marginal incisions to avoid implant exposure. The domes of the lower lateral cartilages were then stabilized by placing 2 dome-defining sutures, an interdomal suture, and 1 or 2 flare control sutures with 5/0 polypropylene (Prolene; Ethicon Ltd, Edinburgh, Scotland) (Figure 1B). These tip-stabilizing sutures were necessary to resist the torsional forces applied to the tip when the lateral expansion sutures were placed.

The lateral expansion sutures were next placed using a 5/0 polypropylene suture. This suture passes through the lateral crus and into the nasal vestibule immediately adjacent to the lateral crural margin. The suture loops back through the mucosa and lateral crus (Figure 1C). In cases with symmetrical cartilages, the suture then passes over the septum to undergo the same maneuver on the opposite side. In some cases of asymmetry where the lateral crus lies in a different position on one side, a unilateral expansion suture is placed through the lower lateral crus and through the septum to elevate it and produce better symmetry. As this suture is carefully tied, the lateral crus and nasal valve are seen to open immediately (a video is available online at http://www.archfacial.com). Two to 4 more sutures are placed to reinforce the valve (Figure 1D).

The exact position of each suture is controlled to suit the pathology. If the suture causes the crus to buckle, the expansion sutures are removed and reinforcement bat-
ten implants of HDPP are placed on each side. When the reinforcement implants have been positioned, the expansion sutures are passed through the HDPP implants to avoid any buckling.

The nose is checked for distortion and asymmetry at each step. The expansion sutures can be removed, adjusted, and replaced as required to provide optimal enlargement and symmetry. The external rhinoplasty wound

Figure 1. Illustration of a new technique of alar expansion and reinforcement to manage nasal valve collapse. A, External rhinoplasty approach to expose the alar cartilages. B, Placement of the lateral expansion suture. The domes of the lower lateral cartilages have been stabilized with dome-defining, interdomal, and flare-control sutures. C, Testing the best location to place a second lateral expansion suture. D, A second lateral expansion suture is placed to act as reinforcement.
is closed using 4/0 chromic sutures to the marginal incisions on each side and multiple 5/0 polypropylene sutures to the skin of the columella. There is no need for packing or internal splinting. The nose is taped and the patient receives postoperative antibiotics for 1 week. At the postoperative visit, it is not possible to see the polypropylene expansion suture loops in the nasal vestibule.

Of the 41 patients who underwent alar expansion and reinforcement, 32 responded to the questionnaire (78% response rate). Twenty-four patients (75%) underwent primary surgery and 8 (25%) had undergone previous rhinoplasty. Twenty-four patients (75%) had surgery for breathing enhancement only, and 8 (25%) also wanted cosmetic enhancement. Twelve patients (38%) required HDPP implants to manage excessively floppy alar sidewalls.

Thirty patients (94%) experienced improvement in their nasal airway (Figure 2). The mean improvement in nasal airway patency was 296 (P=0.001), indicating a significant difference in patency between preoperative and postoperative examinations.

Two patients (6%) felt no improvement in their nasal patency. The first patient had inadequate tightening owing to concerns regarding cosmetic outcome. Tighter sutures would possibly have provided a better outcome, but the senior surgeon (M.S.M.) was concerned to avoid creating excessive cosmetic broadness. Very narrow nostrils (external valve collapse) were noted in the second patient.

The results of patient ratings of cosmetic appearance were analyzed on the basis of whether the aim of surgery was for breathing enhancement alone or for breathing and cosmetic enhancement. Of the 8 patients who wanted cosmetic enhancement, all noted improvement. Of the 24 who had surgery for nasal obstruction only, 10 (42%) rated their cosmetic appearance as better, with the remaining 14 (58%) indicating no change in appearance (Figure 3).

Twenty-eight patients (88%) reported an overall satisfaction with surgery, indicating that they would undergo the procedure again. Four patients (13%) would not undergo this surgery again, although 2 of these had reported good improvement in nasal patency. In these 2 patients, there was technically good improvement; however other factors such as rhinitis and depression appear to have been the main reasons for dissatisfaction.

There were no complications such as suture infection or exposure or graft infection or extrusion.

Two representative cases are shown in Figure 4 and Figure 5.

Nasal valve collapse is a multidimensional problem. In some patients, the reduced cross-sectional area or an acute valve angle of less than 10° is the main problem. In others, the weak nasal sidewall plays a major role. In some patients, a combination of factors exists. Alar expansion and reinforcement constitutes a comprehensive approach to manage nasal valve collapse and addresses the floppy sidewall and the reduced cross-sectional area of the nasal valve. The procedure requires the surgeon to evaluate the specific pathology and tailor the technique to suit each case. The positioning, tightness, and number of alar expansion sutures used permit flexibility in fine-tuning the amount of airway expansion. The HDPP lateral crural batten implant provides extra flexibility to deal with the excessively floppy sidewall, which is an intrinsic part of this pathology in some patients. The procedure is reliable, adjustable, simple to perform, and fully reversible.

This technique uses multiple sutures to actively dilate the airway at the nasal valve. The force generated by these sutures is strong enough to cause buckling of the weak alar sidewall. This is important in this patient population because a floppy nasal sidewall is commonly associated with nasal valve collapse in some patients. To correct this problem, a slim, thin, strong, lateral crural batten implant of HDPP provides a firm anchor for the expansion sutures. Such an implant was necessary in 38% of the presented cases. In addition to anchoring the sutures, this implant provides leverage to amplify the pull of the sutures, which distributes the force of the expansion to the full lateral extent of the implant. This gives the surgeon the power to pull the entire nasal sidewall out and up if required. The amount of opening would be limited by the cosmetic concerns of the patient.

(Reprinted) Arch Facial Plast Surg/Vol 8, Sep/Oct 2006 WWW.ARCHFACIAL.COM

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The 0.85-mm-thick HDPP implants provide a little extra bulk to the nasal sidewall. The batten implant need only be wide enough to accept the sutures, but can be widened to provide greater rigidity and strength if preferred. Keeping the implant narrow reduces the risk of infection or extrusion. The caudal implant edge is kept slightly away from the marginal incision to reduce the risk of implant exposure inside the nostrils. Without an expansion suture, the lateral crural graft/implant adds some mass to the sidewall, and the effect of inhalation and gravity could pull it into the airway, which would worsen nasal valve collapse.

The use of multiple short permanent sutures provides greater strength and distributes the forces over a wider area. The vectors of pull open the valve angle and pull the lateral wall up and out. The power of these sutures requires the placement of tip-stabilizing sutures before the expansion process. The surgeon examines the valve site during inhalation in the office and during surgery. The sutures are positioned at these exact sites of collapse. Unilateral sutures can be used between the lateral crus and the septum to provide adjustment of symmetry and to use even shorter suture lengths to reduce the risk of stretch over time, as seen in Figure 5. The surgeon can test each suture as it is placed to determine the optimal position to open the valve.

All techniques that dilate the nasal valve have the potential to produce some cosmetic widening of the nose. Because this procedure is adjustable, the surgeon can control this balance with the suture tension. Mild tightening of the expansion sutures provides tensioning of the sidewall, reducing the dynamic collapsibility. This provides no real cosmetic or structural change and can be done in any external rhinoplasty to support the sidewalls and reduce alar collapse. Increased tension on the expansion sutures incrementally opens the valve angle and increases the cross-sectional area of the valve. Mild dilation of the valve provides a subtle cosmetic change only, by enlarging the nose at the alar groove. Many patients with nasal valve collapse have a “pinched” tip, and some widening here provides cosmetic enhancement, as seen in Figure 4. If a patient wishes to avoid cosmetic

Figure 4. A representative case of bilateral alar valve collapse. A and B, Preoperative appearance. C and D, Bilateral alar valve expansion after placement of lateral expansion sutures.
widening, yet wants improved breathing, the surgeon adjusts the suture tension to produce moderate expansion, which provided some breathing enhancement without causing significant nasal widening. Maximal suture tensioning provides a more dramatic airway and aesthetic widening, especially when combined with a buttten implant to pull the entire nasal sidewall outward. This needs to be discussed with the patient before surgery to ensure that the appropriate level of airway widening is balanced with the cosmetic concerns of the patient.

By following these principles, no patient in this series complained that the nose was too wide after surgery, although the technique has the potential to widen the nose significantly if used to extreme. Eight patients (25%) requested cosmetic nasal enhancement at the same time as nasal valve surgery for breathing. The exercise of careful control provided high satisfaction levels regarding cosmetic results. Small amounts of nasal widening were well tolerated by this patient subgroup.

The alar expansion technique dilates the airway and is limited by the stretching of the internal mucosa. An alternate procedure, the J flap, involves excision of some of the internal nasal lining to tighten the valve. Removal of the internal lining when undertaking the J flap could constrict the airway and limits the amount of dilation possible.

The procedure has not yet been revised. If there is any relapse over time or should a patient request increased enlargement, it should be possible to reopen the nose and place some tighter sutures to further enlarge the airway if required.

So far, all procedures have been performed through an external rhinoplasty approach. The procedure could be performed using an endonasal approach; however, the external approach provides greater ease in establishing symmetry and in preventing distortion. The senior surgeon continues to prefer the external approach for this procedure, despite using the endonasal approach for most of his rhinoplasty caseload in general.

The alar expansion sutures loop into the vestibule from the dissection field. At 1 week, it is not possible to find the suture loop in the nose, and there have been no cases.

**Figure 5.** A representative case of unilateral alar valve collapse. A and B, Preoperative appearance. C and D, Unilateral alar valve expansion after placement of right-sided lateral expansion sutures.
of foreign body reaction or infection. The suture loop seems to bury itself through the mucosa against the lateral crural cartilage. We have kept the loop length about 2 to 4 mm. A shorter loop could pull through the cartilage, whereas a longer loop provides no further benefit and may not fully bury itself under the mucosa.

The senior surgeon (M.S.M.) has used many surgical techniques over time to manage nasal valve collapse and has not found any with universal application. Spreader grafts widen the valve angle but may not widen the nose laterally at the largest airflow zone, and they do not strengthen weak sidewalls. Orbito-alar suture surgery relies on 1 or 2 longer sutures that run through the face.6,7 This approach may require facial or orbital dissection and incisions and may result in scarring on the face. The suture can weaken if it pulls through the periosteum or stretches over time. The alar expansion technique described herein uses multiple short suture lengths to pull on the lateral crura.

Alar batten grafts used alone strengthen the nasal sidewall but do not open the cross-sectional area. We have seen many bulky alar batten grafts, especially those composed of auricular cartilage, protrude or collapse into the airway over time, presumably owing to the forces of gravity and repeated inhalation.

Patients were asked in the questionnaire whether they would undergo this procedure again. In 4 cases the patients declined. One patient technically had an excellent result, but she was clinically depressed and unable to focus on the questions asked. She was too depressed to contemplate any additional surgery.

Three patients had clinically significant rhinitis, which compromised their airway. Results of the clinical examination revealed technical success, with opening of their valve airways. In the absence of other pathology such as septal deflection or nasal polyps, we suspect that incomplete symptom resolution despite technically successful nasal valve surgery probably reflects rhinitis. There may be swelling and dryness of the nasal mucosa, including the turbinates. We suspect that many cases of nasal valve collapse develop secondarily to years of breathing through a stuffy nose and chronic sniffing, which causes the floppy sidewalls to collapse progressively. Although nasal valve surgery may open the nasal valve, patients with rhinitis still have swollen dry mucosa. The cycle could then start again, and the patients are not cured of their breathing obstruction. Consequently, we actively investigate and manage the rhinitis before and after surgery. We warn all patients undergoing nasal valve surgery that they may require long-term nasal saline and/or topical corticosteroid spray therapy to manage rhinitis, despite successful nasal valve surgery.

Nasal valve collapse occurs because of structural narrowing of the nose and dynamic collapse of the weak nasal sidewalls during inhalation. The alar expansion and reinforcement technique addresses structural and dynamic causes of nasal valve collapse. This technique is a reliable and safe way to support and expand the nasal valve. It can be finely adjusted to provide subtle or more dramatic increase in the nasal valve caliber. The power and control of this suture have made it our technique of choice for managing this common problem.

Accepted for Publication: May 30, 2006.
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Previous Presentation: This study was presented in part at the 11th Congress of the International Rhinology Society; October 28, 2005; Sydney, Australia.
Additional Information: A video demonstrating the technique described in this article is available online at http://www.archfacial.com.

# References