Evaluation of a new procedure for nasal alar rim and valve collapse: Nasal alar rim reconstruction

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OBJECTIVE: A new operative technique to improve nasal valve collapse by placement of cartilage struts along the alar rim was compared with the standard nasal valve cartilage graft (NVG) technique.

METHODS AND PATIENTS: A retrospective study of consecutive patients with nasal valve collapse was performed at Stanford University Medical Center. Seventy-nine patients with nasal valve collapse underwent reconstruction with either the classic NVG technique or a newly developed nasal alar rim reconstructive (NARR) procedure. The mean age of the NARR group was 50.13 years (SD ± 9.40), with 36 men (92.3%) and 3 women (7.7%). The mean age of the NVG group was 52.14 years (SD ± 10.83), with 36 men (90%) and 4 women (10%).

MAIN OUTCOME MEASURES: These included functional and subjective evaluation of nasal valve collapse.

RESULTS: Forty patients (50.6%) underwent the NVG technique, and 39 (49.4%) received the NARR procedure. The NVG technique revealed 0% worsened, 15.0% (6/40) unchanged, 25.0% (10/40) improved, and 60% (24/40) free of obstruction. The NARR procedure revealed 2.6% worsened, 2.6% unchanged, 7.7% improved, and 87.1% free of obstruction.

CONCLUSIONS: Nasal alar cartilage struts placed along the caudal alar rim offer sufficient support to the alar rim and valve area. This procedure appears to be as effective as currently available reconstructive alternatives, while being technically uncomplicated. (Otolaryngol Head Neck Surg 2000;122:204-11.)

Nasal obstruction may be caused by numerous abnormal anatomic structures, including an enlarged adenoid pad, tumors, polyps, synechiae, septal deviation or spurs, nasal tip ptosis, turbinate hypertrophy, and nasal alar rim or valve collapse. A comprehensive nasal examination to include an assessment of the external appearance, anterior rhinoscopy, and posterior rhinoscopy or nasopharyngoscopy is essential to establish all the possible causes of obstruction to nasal airflow. Other procedures such as the application of topical decongestants, use of the Cottle maneuver, trial of a Nasovent spring or nasal valve adhesive strips, and acoustic rhinometry may aid in the diagnosis. Most commonly, nasal obstruction is multifactorial, and to resolve this obstruction, each of these areas must be properly diagnosed and treated.

The nasal cavity offers a rigid bony framework throughout its course, except for the most anterior aspect at the nasal alar rim and valve area. The anterior part of the nose is the narrowest part of the upper airway and produces more than half the total resistance during nasal respiration, which may decrease the airflow.1 In most individuals, the nasal valve area is the narrowest point of the nasal cavity, as long as there are no other obstructive pathologies, such as a septal deviation or turbinate hypertrophy.2,3 The nasal valve composition includes the caudal aspect of both the upper lateral cartilages, with connections to the septum and pyriform aperture, and the lower lateral cartilages, with attachment to the upper lateral cartilage by the scroll. The nasal alar support is composed of the lateral crura of the lower lateral cartilages with medial crura extension, ligamentous connections to the nasal septum, and the attachment to the upper lateral cartilages. Deficiencies of support of the anterior nose usually result from aging, from trauma, or postoperatively, from a rhinoplasty procedure.3

Weakness of these structures and/or excessive negative airway pressure during inhalation can result in collapse of the nasal valve with resultant obstruction. Patients with sleep-disordered breathing (SDB) (ie, upper airway resistance syndrome or obstructive sleep apnea syndrome [OSAS]) can generate large negative intrathoracic pressures that are transmitted to the upper airway. This phenomenon can cause the nasal alar rim or valve to collapse during sleep, while revealing no signs of deficient support while awake.

The vast majority of the medical literature reveals that maintaining patency of the nasal passages and the nasopharynx is essential for successful treatment of


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SDB in most cases. The pathophysiologic changes in SDB, especially in OSAS, stem from velopharyngeal, retrolingual, and hypopharyngeal collapse. When the negative pressure that develops during inspiration is greater than the force generated by contraction of the pharyngeal musculature responsible for maintaining airway patency, upper airway collapse ensues. It is this increased negative intrathoracic pressure that not only produces a suction force to further collapse the pharynx but also can collapse a weakened nasal rim and valve.4

Numerous techniques have been devised to treat collapse of this difficult anatomic area, but few ensure reliable functional support, and some may negatively alter facial aesthetics and function. The most effective methods have used cartilage or composite grafts to function as spreader grafts to enlarge the diameter of the internal nasal valve, to strengthen the lateral crura of the lower lateral cartilage, or to support the connections of this cartilage to the pyriform aperture.5-8 A novel approach by Paniello9 fixes sutures to the orbital rim placed through a transconjunctival incision to suspend the nasal valve. The nasal valve walls are fixed in position without a measurable increase in minimal cross-sectional area.

The deficiencies of the previous methods along with their basic architectural design led to the development of a reliable, technically simple, structurally sound, and cosmetically pleasing procedure to strengthen the nasal valve area. The nasal alar rim reconstructive method (NARR) implants cartilage, usually homologous irradiated costal cartilage, along the inner aspect of the alar rim from the pyriform aperture to several millimeters short of the nasal tip. This design provides sufficient structural support to the nasal rim and valve area.

METHODS AND MATERIAL

Patients with nasal alar rim and/or nasal valve collapse as the primary cause of nasal airway obstruction were offered surgical reconstruction as a treatment option. If other causes of nasal obstruction were also present, these were corrected at the same setting. Early in the analysis, it was noted that many patients after septoplasty and inferior turbinatectomy had continued symptoms of nasal obstruction. Identification of actual nasal rim and/or valve obstruction or the risk of nocturnal collapse after these procedures heightened our awareness of this entity. Initially, patients underwent the standard nasal valve grafting (NVG) technique. The results were evaluated to be good, but not optimal. A new technique, NARR, was devised to offer more reliable structural support to both the nasal rim and nasal valve areas. Thus patients with nasal alar and/or valve collapse after the introduction of this procedure all had the new technique.

All patients' SDB had been diagnosed by polysomnogra-

phy, and they were referred for surgical evaluation either after unsuccessful treatment with nasal continuous positive airway pressure or as the initial therapy. Preoperative assessment included a complete medical history including the subjective sensation of nasal airway impairment, a comprehensive head and neck examination, fiberoptic nasopharyngoscopy, and lateral cephalometric analysis. Acoustic rhinometry was contemplated, but because the collapse was at the alar rim in most
Fig 2. A, Insertion of the irradiated cartilage graft into the subcutaneous pocket toward the pyriform aperture. Grafts have beveled ends to allow easier insertion. B, Drawing of the technique of graft insertion toward the pyriform aperture. C, Insertion of the irradiated cartilage graft into the subcutaneous pocket toward the nasal tip. D, Drawing of the technique of completing the graft insertion into the nasal rim. The graft is pushed up toward the nasal tip. E, Completed NARR as seen on base view.

cases, acoustic rhinometry would not accurately assess reduced nasal airflow because of the nosepiece of the measuring device stenting open the area of concern. The physical examination included an assessment of the external appearance of the nose, the Cottle maneuver, manual dilation of the alar rim and valve with cotton-tipped applicators, and anterior rhinoscopy with and without topical decongestion with 0.05% oxymetazoline or 0.25% NeoSynephrine (phenylephrine hydrochloride). Fiberoptic nasopharyngoscopy was performed after the topical application of 0.5% lidocaine with 1:100,000 epinephrine and 0.05% oxymetazoline or 0.25% NeoSynephrine.

Patients with improvement of airway patency by the Cottle maneuver or manual dilation with cotton-tipped applicators were considered candidates for NARR. In most patients, a trial with a Nasovent spring or a nasal valve adhesive strip was also performed. Nasal valve surgery was often performed as an isolated procedure, but adjunctive nasal procedures were
performed simultaneously if indicated. Patients were followed up after surgery with a similar complete physical assessment and subjective assessment of nasal airway patency. Patients were asked to subjectively evaluate their nasal breathing as unobstructed, improved, unchanged, or worsened from before surgery. The surgeon used the same scale and evaluated the nasal valve for collapse. If the two evaluations did not correspond, the less successful assessment was used to compare the results. Patients received preoperative and postoperative photographic documentation while breathing quietly and at maximum nasal inspiration.

Each procedure was performed with the patient under general anesthesia, intravenous sedation, and/or local anesthesia. Patients undergoing other upper airway reconstructive procedures received general anesthesia. NARR begins with the administration of local anesthesia. Initially the columella, nasal tip, and ala are injected with 0.5% lidocaine with 1:200,000 epinephrine. A 4-mm vertical incision in the nasal vestibule skin is made at the junction of the nares and nasal lobule, which is two thirds the length of the nasal rim from the pyriform aperture (Fig 1A). The skin under the lower lateral cartilage is undermined with scissors from the pyriform aperture to several millimeters short of the nasal tip (Fig 1B and C). The cartilage strut implants (~2.5–3.0 cm length and 3–4 mm height and width) are carved from irradiated cartilage, and the ends are beveled. The cartilage grafts are carefully inserted into the alar subcutaneous pockets (Fig 2). After the implants are positioned appropriately, the nasal airway is assessed for support and symmetry. The grafts are noted between the vestibule skin and the lower lateral nasal cartilages (Fig 3A and B). The incision is closed with simple, interrupted 5-0 chromic sutures (Fig 3C). Dressings or nasal packing is unnecessary. The postoperative result should provide structural support, while preserving aesthetics (Fig 4).

The classic nasal valve cartilage graft technique uses either autologous auricular cartilage, nasal septal, or homologous irradiated cartilage. If an autologous auricular graft is used, a postauricular approach acquires the conchal cartilage (Fig 5A). The cartilage graft is fashioned to the appropriate size, and care is taken to ensure that the perichondrium remains intact on one side of the cartilage implant to improve its viability and decrease absorption (Fig 5B). An incision in the nasal valve area adjacent to the location of collapse is per-
RESULTS

Seventy-nine consecutive patients undergoing nasal valve surgery were evaluated with either the classic NVG technique or a new procedure, NARR. The NVG technique was performed until postoperative results were inspected and persistent collapse was identified. NARR was introduced and used in all further nasal alar and/or valve collapse patients. Forty patients (50.6%) underwent the NVG technique, whereas 39 (49.4%) had the NARR procedure. The mean age of all patients undergoing nasal valve surgery with either technique was 51.28 years (SD ± 10.20), with 72 men (91.1%) and 7 women (8.9%). The mean age of the NARR group was 50.13 years (SD ± 9.40), with 36 men (92.3%) and 3 women (7.7%). The mean age of the NVG group was 52.41 years (SD ± 10.83), with 36 men (90%) and 4 women (10%). The mean follow-up was 16.89 months (SD ± 17.63), with a minimum of 1 month and a maximum of 88 months.

The NVG technique revealed 0% worsened, 15.0% (6/40) unchanged, 25.0% (10/40) improved, and 60% (24/40) of the patients completely free of obstruction after surgery. NARR revealed 2.6% (1/39) worsened, 2.6% (1/39) unchanged, 7.7% (3/39) improved, and 87.1% (34/39) completely free of obstruction. When response was defined as improvement or freedom from any obstruction after surgery, the NVG technique revealed a 75.0% (30/40) response rate compared with the NARR procedure, which had a 94.9% (37/39) response rate.

Evaluation of the 10 patients in the NVG group who had improvement but persistent nasal obstruction revealed 4 with residual nasal valve collapse, 2 with only right-sided nasal valve collapse, and 1 with obstruction posterior to the nasal valve (who was the patient who had both the NVG and NARR techniques performed simultaneously). The NARR group had 3 patients who were improved: 2 with residual bilateral collapse and 1 with obstruction posterior to the nasal valve area. Both the NVG and NARR patients whose assessment of nasal obstruction was unchanged from the preoperative evaluation had persistent bilateral nasal valve collapse. The patient whose obstruction worsened after surgery in the NARR group had an irradiated cartilage graft infected with methicillin-resistant Staphylococcus aureus, which necessitated graft removal. No cartilage grafts were lost to extrusion.

With regard to the use of adjunctive nasal procedures to treat all identifiable causes of nasal obstruction, both nasal valve surgical technique groups had a similar number of adjunctive procedures (Tables 1 and 2). The most common adjunctive procedures were nasal septoplasty, a columella strut, followed by bilateral inferior turbinoplasty.

Fig 5. A, Acquisition of the auricular cartilage through a postauricular incision and excision of the conchal cartilage with little postoperative cosmetic deformity. B, Auricular cartilage is carved to the appropriate size and shape for the specific area of collapse identified in the nasal valve region. C, Completed NVG technique as seen on base view.
Table 1. Nasal valve surgery adjunctive nasal procedures

<table>
<thead>
<tr>
<th>Procedure</th>
<th>NARR (n = 39)</th>
<th>NVG (n = 40)</th>
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<tbody>
<tr>
<td></td>
<td>Responders</td>
<td>Nonresponders</td>
</tr>
<tr>
<td>None</td>
<td>17</td>
<td>1</td>
</tr>
<tr>
<td>Septoplasty</td>
<td>9</td>
<td>0</td>
</tr>
<tr>
<td>Turbinostranglal</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Columella strut</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Septoplasty and turbinostranglal</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Septoplasty and Columella strut</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Septoplasty, turbinostranglal, and Columella strut</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Lysis nasal scar</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
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Table 2. Nasal valve surgery response rates

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<tr>
<th></th>
<th>NARR (n = 39)</th>
<th>NVG (n = 40)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Responders</td>
<td>Nonresponders</td>
</tr>
<tr>
<td>With adjunctive procedures</td>
<td>51.2%</td>
<td>2.6%</td>
</tr>
<tr>
<td>Valve surgery alone</td>
<td>43.6%</td>
<td>2.6%</td>
</tr>
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The cartilage grafts were fabricated from either auricular, nasal septal, or homologous irradiated costal cartilage (Table 3). Most of the NARR grafts were constructed from irradiated cartilage because the auricular cartilage had insufficient strength to support the nasal rim and there was usually an insufficient quantity of nasal septal cartilage available for the size of struts necessary with this technique. One patient initially had an auricular cartilage graft with the NARR procedure and showed improvement but had persistent obstruction. Later, an irradiated cartilage graft was placed with the same NARR technique with improved nasal patency and objectively significant additional structural support compared with the auricular cartilage.

DISCUSSION

NARR offers a technically uncomplicated, reliable procedure for nasal alar and valve collapse with a high success rate, low complication rate, and minimal patient discomfort. As in this study, ensuring nasal airway patency is especially important in patients with SDB.

The deficiencies of the previous methods along with their basic architectural design led to this development. This method implants homologous, irradiated costal cartilage along the inner aspect of the alar rim from the pyriform aperture to several millimeters short of the nasal tip. Irradiated costal cartilage is the preferred material because of its sufficient size, ease of strut fabrication, and structural support. Other potential sources of implant material include autologous septal or auricular cartilage and curved outer table calvarial bone. Nasal septal cartilage is probably the best cartilage graft material available, but unfortunately, there is usually an insufficient size and shape to fabricate a strut for this technique. Calvarial bone offers excellent support with approximately a 10% absorption rate, but it provides a less cosmetically pleasing nasal alar appearance and an unnatural stiff feeling to the touch.

A concern when irradiated cartilage is used as a structural component is long-term strength and absorption. We recognized from the medical literature investigating irradiated homograft costal cartilage that the cartilage may undergo absorption over time. The discouraging results from animal experiments, however, conflict with the generally favorable experience in human beings. Dingman and Grabh10 reported minimal absorption in more than 600 grafts. Donald and Col11 noted that homograft costal cartilage underwent less resorption than autologous costal cartilage. Schuller et al12 noted 1.4% absorption in 145 irradiated costal cartilage grafts, with the longest follow-up at 36 months. Welling et al13
reported on the long-term outcome in 62 of these grafts and reported that the average resorption increased to 75% up to 9 years after implantation. Kridel and Konior evaluated 306 irradiated homograft costal cartilage grafts used in 122 nasal augmentation procedures and did not find any significant absorption in patients followed up for as long as 84 months after surgery. Donald investigated implantation of irradiated cartilage to the facial skeleton of sheep and dog. After 16 to 72 months of implantation, complete resorption was seen in 87.7% of the irradiated grafts, with only 1 of the grafts remaining viable with chondrocytes. He found no antigenicity in the implants, pointing to a nonimmunologic cause of graft resorption. Other animal studies have also discovered the eventual complete absorption of irradiated costal cartilage over time.\(^15\)\(^16\)\(^17\)

Donald noted that his clinical experience concerning irradiated cartilage grafts has been uniformly good. He noted that the resorption rates varied with graft location in the face. Grafts placed subperiosteally had the greatest percentage of absorption, and grafts over the dorsum of the nose or malar eminence showed very little absorption.

In our NARR study, the mean age of follow-up was more than 16 months, with the longest follow-up at more than 7 years. No patient reported recurrent obstruction. There may be decreased structural support over time; if this becomes clinically significant, revision surgery may be contemplated. The question will be what percentage of patients will need revision surgery and how long after surgery do most retain structural support of the nasal valve. The results of this study and the results of the other human clinical studies using irradiated homograft costal cartilage appear to suggest that structural integrity of the nasal valve should be retained for a significant amount of time in most patients.

There is always a concern of cost-effective medicine. The operative time to carve 2 irradiated cartilage grafts to the appropriate size and shape was approximately 6 to 8 minutes. The operative time to acquire an auricular cartilage graft was 15 to 20 minutes. The average cost of the irradiated cartilage graft was $225 to $250. If one considers the operative time charges, the irradiated cartilage technique is more cost-effective.

There are several hypotheses postulating the higher response rate with the NARR technique (94.9%, 37/39) compared with the NVG technique (75%, 32/40). The integrity of a graft material placed between 2 stable supports offers a better structural design than a free-standing graft in soft tissue. The cartilage grafts themselves are larger and, when fabricated from irradiated cartilage, provided more structural support than autologous auricular cartilage. The techniques are different, and we agree that to compare the procedures directly has inherent limitations, specifically with regards to the size of the cartilage grafts, which are significantly larger with the NARR technique. Finally, some patients had collapse from the both nasal valve and the nasal rim. The NARR technique provides more support for both of these anatomic areas than the NVG technique, which does little to support the nasal rim. The responder groups of the 2 surgical techniques had similar numbers of adjunctive procedures.

Patients with SDB, as in our population, are at an increased risk of both nasal valve and nasal alar collapse. The pathophysiologic changes in SDB stem from velopharyngeal, retrolingual, and hypopharyngeal collapse. When the negative pressure that develops during inspiration is greater than the force generated by contraction of the pharyngeal musculature responsible for maintaining airway patency, upper airway collapse ensues. A significant negative pressure is created, and it is this increased negative intrathoracic pressure that not only produces a suction force to further collapse the pharynx but also can collapse a weakened nasal rim and valve.\(^4\)

The vast majority of the medical literature reveals that maintaining patency of the upper airway is essential for successful treatment of SDB, and the nasal rim and valve area are regions of the upper airway that cannot be ignored. Partial or complete nasal obstruction without other areas of airway collapse can cause apneas and hypopneas with their associated arousals and sleep fragmentation. Experimental complete occlusion of both nasal passages during sleep in subjects documented by polysomnography not to have OSAS resulted in recurrent apneas and hypopneas in some individuals.\(^18\)\(^19\) These studies used an esophageal balloon, the most sensitive technique available, to detect the increased intrathoracic pressures and increased work of breathing as well as the obstructive breathing episodes. McNicholas et al\(^20\) used measurements of nasal resistance and polysomnography to evaluate 7 patients with allergic rhinitis during and after ragweed season. The symptomatic phase revealed nasal resistance of 4.9 ± 0.8 cm H\(_2\)O/L/second, and patients had 1.7 ± 0.3 obstructive apneas per hour of sleep, compared with the control period with nasal resistance of 2.5 ± 0.3 cm H\(_2\)O/L/second, during which patients had 0.7 ± 0.4 obstructive apneas per hour of sleep. Suratt et al\(^21\) revealed a correlation with the severity of obstructive respiratory events during sleep and the degree of nasal patency. They also showed an increase in the number of oxyhemoglobin desaturations and the number of obstructive apneas and hypopneas, with an elevation in the awake nasopharyngeal resistance. These data show that nasal obstruction can be a contributing factor to sleep fragmentation with
its associated excessive daytime sleepiness and can cause or worsen SDB.

In summary, NARR offers a technically uncomplicated, reliable procedure for nasal alar and valve collapse with a high success rate, low complication rate, and minimal patient discomfort. Ensuring nasal airway patency is especially important in patients with SDB.

REFERENCES