Surgery for the Dysfunctional Nasal Valve

Cadaveric Analysis and Clinical Outcomes

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Objectives: To quantify changes in the cross-sectional area of the nasal valve after placement of spreader grafts and flaring sutures and to review clinical outcomes after nasal valve surgery.

Design: The minimal cross-sectional area of cadaveric nasal valves was measured after placement of spreader grafts and flaring sutures. Clinical outcomes for patients undergoing functional rhinoplasty were retrospectively reviewed.

Setting: Academic medical center.

Subjects: Six fresh cadaver heads and a review of patients from September 1994 through May 1998.

Intervention: Acoustic rhinometry was performed after placement of spreader grafts, flaring sutures, and the two together. Clinically, a site-specific repair was performed with spreader grafts and flaring sutures for statically narrowed internal nasal valves and cartilaginous battens for dynamic collapse.

Main Outcome Measure: Cross-sectional areas of cadaveric valves. Functional and aesthetic results were determined by nasal patency scores from 1 (complete obstruction) to 10 (complete patency) and a rating of postsurgical cosmetic changes.

Results: Spreader grafts improved the cadaveric minimal cross-sectional areas by 5.4% (P > .05), flaring sutures by 9.1% (P > .05), and spreader grafts combined with flaring sutures by 18.7% (P < .05). Mean nasal patency scores improved from 3.4 to 6.5 (P < .01) with the combination of spreader grafts and flaring sutures. Cartilaginous battens improved scores from 2.7 to 6.3 (P < .01).

Conclusions: The combination of flaring sutures and spreader grafts has the greatest impact on the cadaveric nasal airway. Either technique alone failed to have a statistically significant impact on the minimal cross-sectional area of the nasal valve. Clinical review confirms significant improvement in nasal function using this combination technique.

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NASAL VALVE dysfunction has a role in up to 13% of adults complaining of chronic nasal obstruction, and yet this anatomical and dynamic factor continues to be overlooked by many otorhinolaryngologists. Physiological obstructions, such as mucosal congestion and allergic rhinitis, can have a significant impact on the nasal airway. Once these reversible components have been satisfactorily addressed, structural and anatomical changes to the nasal skeleton can be considered.

The internal nasal valve is defined as the area between the caudal end of the upper lateral cartilages and the cartilaginous septum. This angle is normally 10° to 15° in the white (leptorrhine) nose and is more obtuse in African American and Asian (platyrrhine) noses. The external nasal valve consists primarily of the fibrofatty tissues of the alar lobule and, to a lesser extent, the lower lateral cartilages, the caudal septum, and the piriform aperture. The entire nasal valve complex is bounded superiorly by the reflection between the caudal end of the upper lateral cartilages and the septum, posteriorly by the head of the inferior turbinate, inferiorly by the floor of the nose, and laterally by the bony piriform aperture and its adjacent fibrofatty tissue. The normal cross-sectional area of the nasal valve is between 55 and 83 mm² and is the site of highest nasal resistance. It functions as the primary regulator of airflow, providing physiological resistance and the sensation of normal nasal airway patency. External devices to alter the valve area are frequently used by professional athletes, and it has been...
MATERIALS AND METHODS

CADAVER STUDIES

Cross-sectional areas of nasal cavities in 6 fresh cadaver heads were measured using acoustic rhinometry (Eccoviision; Hood Laboratories, Pembroke, Mass). The minimal cross-sectional area (MCA) at the level of the nasal valve was determined before any incisions were made. Septal cartilage was harvested from the first cadaver head through a standard hemitransfixion incision and fashioned into spreader grafts 1 to 2 mm thick. These grafts were used with all heads throughout the investigation to ensure uniformity. An open rhinoplasty approach was used for all grafting and suture techniques, and the soft tissue envelope was redraped before the rhinometric data were collected. Repetitive acoustic clicks were used until a reproducible graph was obtained and thought to represent the cross-sectional area of the nasal passage. Four measurements were obtained from each side of the nose: (1) after degloving, (2) flaring suture alone, (3) spreader graft alone, and (4) flaring suture and spreader graft together. Lateral battens were not studied because they are not designed to change the resting MCA.

CLINICAL DATA COLLECTION

We reviewed the medical charts and operative reports of all patients who underwent rhinoplasty, septorhinoplasty, or nasal reconstruction between September 1, 1994, and May 30, 1998. The patient population for this study was limited to individuals undergoing procedures to alleviate nasal obstruction due to valve dysfunction. Those with isolated septal deviation, nasal bone dislocation, or polyposis were excluded. Each patient was directly contacted to obtain functional outcomes and postoperative scores. Patients rated preoperative and postoperative nasal patency on a scale of 1 to 10, with 1 representing complete obstruction and 10 representing no obstruction. Patients rated their postoperative cosmetic appearance as better, worse, or unchanged from their preoperative appearance, and they also gave an overall opinion on whether or not they would undergo surgery again.

PREOPERATIVE ANALYSIS

The preoperative assessment was performed with the focus on 3 questions: (1) Is there nasal valve dysfunction contributing to airway obstruction? (2) Where, precisely, is the obstruction located and which anatomical structure is deficient or malformed? (3) Is the obstruction due to a static narrowing or a dynamic collapse?

A history of seasonal variation, alternating sides, or excessive use of topical decongestants indicates that there may be a nonanatomical element involved. Also, valve obstruction may be mild at rest (in the clinic chair) but significantly exacerbated during strenuous aerobic exercise, during which vigorous nasal respiration is used. Other individuals complain of unilateral nasal obstruction while lying in a decubitus position with the flaccid side up, where gravity accentuates sidewall collapse. Physical examination begins with inspection of the nose, both at rest and during inspiration. Anterior and base views can reveal specific areas of narrowing, such as the “hourglass” deformity seen with a narrow internal nasal valve due to upper lateral cartilage collapse. Normal inspiration may demonstrate unusual flaccidity of the sidewall or alar lobule. Direct inspection of the internal nasal valve must be done while minimizing the distortion from a nasal speculum. A cotton-tip applicator is useful for supporting specific points intranasally and identifying those areas that most improve airflow. A distinction is made between collapse from the sidewall and a deflected dorsal septum, as both can contribute to the narrow internal valve. Once the dysfunctional element(s) of the internal or external valve has been determined, a site-specific treatment plan is formulated. We begin by correcting major deformities of the septum and nasal bones, and then we re-evaluate the patency of the valves. Displaced nasal bones distort the cephalic margin of the underlying upper lateral cartilages and can dramatically alter the nasal valve angle. Accurate reduction with osteotomies may be the most direct means of addressing internal valve stenosis.

Static collapse of the sidewall causing valve obstruction is repaired with spreader grafts and/or flaring sutures. Valve dysfunction due to a dynamic collapse of the lateral crura or alar fibrofatty tissue is corrected using alar batten grafts placed directly over the site of collapse. Select cases of tip ptosis may cause enough narrowing of the vestibule to warrant a tip-lifting maneuver. The cosmetic changes that may arise as a result of valve surgery must be anticipated and discussed preoperatively.

OPERATIVE TECHNIQUE

Septal cartilage is harvested in a standard fashion through a hemitransfixion or Killian incision and fashioned into spreader grafts. When septum is unavailable, conchal cartilage is a fair alternative, although the intrinsic curvatures must be corrected. Spreader grafts are placed as originally described by Sheen in a submucosal pocket between the septum and the upper lateral cartilages. These grafts are typically 1 to 2 mm thick and extend the entire length of the upper lateral cartilages, from the cephalic border beneath the nasal bones to their caudal margin. They are suggested that such alterations can have some objective effect on performance.9

To correct valve dysfunction, the physician must begin with an accurate preoperative diagnosis with focus on the precise site of deficiency and a distinction between static and dynamic dysfunction. This assessment dictates the type of surgical repair that may lead to the most dependable results. The purposes of this study were to determine the objective, quantitative effects of various surgical maneuvers on fresh cadavers, to present our approach toward patients with nasal valve obstruction through a systematic preoperative evaluation, and to analyze our treatment outcomes.

RESULTS

CADAVER STUDIES

The average MCA of cadaveric nasal valves before any surgery was performed was 0.86 cm². Spreader grafts alone
improved the MCA by 5.4% (\textit{P}<.05 by paired Student \textit{t} test); flaring sutures alone improved the MCA by 9.1% (\textit{P}<.05); and spreader grafts combined with flaring sutures improved the MCA by 18.7% (\textit{P}<.01, \textbf{Figure 5}).

\section*{CLINICAL STUDIES}

Thirty-four patients (19 men and 15 women; median age, 48 years; age range, 25-80 years) underwent 35 operations to correct valve dysfunction. Four patients were unavailable for follow-up and were unable to provide functional or aesthetic feedback. We operated on 1 African American and 33 whites who had symptoms for an average of 14 years (range, 1 month to 48 years) and were followed up for an average of 17 months (range, 2-33 months). Eighteen (53\%) of our 34 patients had undergone previous operations on their noses, including 1 patient who had 5 basal cell carcinomas removed.
from the nose and 1 patient who had undergone partial maxillectomy for squamous cell carcinoma of the maxillary sinus. The remaining 16 patients had previously undergone rhinoplasties and/or septoplasties. Twelve patients (35%) reported previous nasal trauma. Thirty-one procedures were performed using an open approach; 2 open procedures were major nasal reconstructions performed through midface deglovings, and 2 were approached endonasally. Spreader grafts were placed in 21 (60%) of 35 valve procedures and accompanied by flaring sutures in 20 of the 21 cases. A total of 28 flaring sutures were placed, in conjunction with spreader grafts in 20 cases and either alone or with alar battens in 8. Alar battens were placed in 17 cases and were bilateral in 8 cases.

Spreader grafts improved mean nasal patency scores from 3.3 to 6.7 ($P = .05$ by Wilcoxon test for paired nonparametric data); flaring sutures improved scores from 3.3 to 6.7 ($P < .01$); and alar battens improved scores from 2.7 to 6.3 ($P < .01$, **Figure 6**). Nasal patency improved in 80% of patients receiving spreader grafts and/or flaring sutures and in 82% of

**Figure 2.** Flaring sutures. A, Flaring sutures are placed through the caudal lateral border of the upper lateral cartilages and traverse the dorsum to the contralateral side. Inferior retraction of the lateral crura is often needed for adequate exposure. B, The flaring suture pulls the upper lateral cartilage superiorly and laterally and widens the valve angle (from Park11).

**Figure 3.** Schematic showing combined use of spreader grafts and flaring sutures to improve the cross-sectional area of the internal valve (from Park11).

**Figure 4.** Alar batten grafts sewn in place to reinforce against dynamic collapse in the area of the lateral crura.
patients treated with alar battens. Five patients (16%) demonstrated unfavorable increased width to the middle nasal vault as a result of these valve maneuvers, and 79% of patients stated that they would undergo the valve surgery again.

There currently exists little work concerning the objective effects of various surgical maneuvers on the cross-sectional area of the nasal valve. Several authors report improvements in patients’ subjective sensation of nasal patency, but data concerning objective improvements are conflicting.12-14 Ideally, the rhinological surgeon will be able to determine preoperatively which patients will benefit from specific maneuvers. In maneuvers designed specifically to improve the valve area, cadaver studies have demonstrated that the combination of spreader grafts and flaring sutures significantly increased the MCA, but either maneuver alone produced insignificant improvements. Interestingly, spreader grafts alone are probably the most common treatment for internal nasal valve obstruction, yet they demonstrated the smallest quantitative improvement in cross-sectional area. Sidewall battens were not studied, because the grafts are not intended to change the resting intranasal anatomy. They are designed to reinforce the nasal skeleton to resist collapse on inspiration. Inherent differences between living and fresh cadaveric tissue, as well as between anatomical and physiological data, make it difficult to compare experimental and clinical results. Most of our procedures were performed on cadavers that did not have narrowed nasal valves. The mean valve area in our cadavers was 0.86 cm², which is greater than that reported in most living patients.2,8,12,14,15 This discrepancy may dampen the measured changes seen in the cadavers with respect to pathologic valves in living patients. The long-term changes in the MCA as scarring occurs, and the clinical outcomes of these surgical maneuvers, are currently being studied. Previous studies have shown conflicting results when attempts have been made to correlate patients’ subjective sensation of nasal patency with objective measurements.8,12-14 The clinical review demonstrates acceptable results with the surgical techniques discussed, but this success is predicated on 2 independent components: (1) effective surgical maneuvers and (2) accurate preoperative diagnosis. The cadaveric data demonstrate significant improvement with the combination techniques of spreader grafts and flaring sutures. It is our opinion that flaring sutures have a greater impact than spreader grafts and can often be used alone with comparable clinical results.

Our success rate with spreader grafts and flaring sutures for internal valve obstruction (80%) is similar to that of Zijlker and Quaedvlieg,16 who used only spreader grafts and noted improved patency in 81% of their patients. We used an open approach in nearly all our patients (33 of 35). We believe that this method allows better visualization, more precise grafting, and accurate suture fixation than does an endonasal approach. Our success rate for improved patency using alar batten grafts was 82%. Each procedure targets a specific deficiency based on the findings of the preoperative physical examination, and none is performed at random. Spreader grafts and flaring sutures are used for static obstruction of the internal nasal valve, while alar batten grafts provide sidewall rigidity without distortion to correct dynamic collapse.

Prior trauma, both surgical and accidental, accounted for the majority (71%) of our cases of valve dysfunction, which is similar to what others have found.1,4 The role of previous reduction rhinoplasty as a preventable cause of nasal valve obstruction cannot be overstated. Procedures that destabilize the fibrous attachments of the upper lateral cartilages, such as dorsal hump reductions, may lead to progressive collapse of the sidewall. When performing such procedures, it is advisable to reattach the upper lateral cartilage to the dorsal cartilaginous septum if the stability of the upper later cartilage is in doubt.

Prior septal surgery is not uncommon in patients presenting with sidewall dysfunction. Primary valve dysfunction may have been missed, or deviations of the dorsal septum that impinge on the valve area may be persistent. Dorsal septal problems remain challenging and often contribute to valve obstruction, yet, fortunately, the deflection is readily repaired through the open approach during nasal valve surgery.
Displaced nasal bones may contribute to valvular obstruction because of their relationship to the upper lateral cartilages. When osteotomies are required, they are usually performed at the onset of the procedure and can have a profound impact on the entire sidewall and valve complex. Conversely, no valve grafting will be sufficient in the face of a deviated bony nasal skeleton that is compressing the lateral nasal wall.

The inferior turbinate is probably a minor contributor to valve obstruction; in 35 patients, we performed only 1 limited submucosal resection of a hypertrophied inferior turbinate. The results of our study and others\textsuperscript{14} confirm that aggressive resection of the inferior turbinate is rarely warranted.

In summary, our approach to the dysfunctional nasal valve requires a thorough assessment, with particular attention paid to the specific site (external vs internal valve) of collapse and a distinction between static or dynamic obstruction. Spreader grafts and flaring sutures are used in combination for most cases of internal valve narrowing, with placement of alar batten grafts being the procedure of choice for dynamic sidewall collapse.

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\textbf{REFERENCES}


\textbf{Correction}

In the article titled “Modification of the Subunit Principle” by Gary G. Burget, MD, published in the January-March issue of the \textit{ARCHIVES} (1999;1:16-18), Figure 2 on page 16 had appeared in an earlier article by Dr Burget in another journal, acknowledgment of which was inadvertently omitted. That earlier article was titled “Aesthetic Reconstruction of the Tip of the Nose” in \textit{Dermatological Surgery} (1995;21:419-429). The original publisher of the figure, Elsevier Science Inc, New York, NY, has kindly granted permission to reproduce it.