



Piriform Margin Augmentation as a Treatment for Persistent Nasal Valve Dysfunction: A Cadaveric Investigation and Report of Initial Clinical Results

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Abstract

Background: Revision nasal valve reconstruction is one of the few treatment options available for patients with persistent nasal valve dysfunction after primary functional rhinoplasty. Revision nasal surgery is challenging, hampered by the presence of scar tissue, incorporated grafts, and the morbidity of obtaining additional autologous cartilage.

Objective: In order to enhance nasal valve function while avoiding revision nasal surgery, a sublaminar technique was developed to increase the projection of the piriform margin via allograft augmentation.

Methods: Piriform margin augmentation was developed using cadaveric dissection and subsequently used *in vivo* to treat persistent unilateral nasal valve dysfunction in patients previously treated with functional rhinoplasty. Results were assessed by serial examination and completion of the NOSE questionnaire preoperatively and one year postoperatively.

Results: Eight total patients were studied. Mean +/- standard deviation values of the preoperative and postoperative NOSE scores were 60.6 +/- 9.4 and 35.0 +/- 21.5, respectively, with a difference of 25.6 (P-value = 0.0028).

Conclusion: Piriform margin augmentation yielded subjective nasal airway improvement in six of eight subjects one year after surgery. Objective improvement was verified using the NOSE questionnaire. This underscores the importance of piriform margin integrity in the nasal valve mechanism and provides a possible new useful salvage technique for those who fail traditional functional rhinoplasty.

airway resistance. The external nasal valve- defined by the alar lobule, the nasal sill, and the columella- is a secondary site of increased nasal airway resistance [3,4]. In 2004, Khosh et al. described the leading causes of nasal valve dysfunction [5]. Their series of 53 patients revealed that iatrogenic causes (e.g. previous rhinoplasty) were responsible for 79% of nasal valve dysfunction, while blunt trauma (15%) and congenital causes (6%) were far less common. Nasal valve dysfunction is increasingly recognized as a problem that can be encountered in any individual who has nasal deformity and/or poor nasal support, regardless of the etiology.

When anatomic nasal obstruction is encountered, operative techniques targeting structural abnormalities are employed, including septoplasty, inferior turbinate reduction, and nasal valve reconstruction. Nasal valve surgery is effectively categorized into medial and lateral maneuvers. Medial techniques utilize spreader grafts and flaring sutures to enhance the nasal valve mechanism, while lateral techniques involve the use of batten grafts, alar rim grafts, stair step grafts, and bone anchored nasal wall suspension techniques (BAST) [5-14]. Success of nasal valve surgery relies upon accurate diagnosis and good operative technique, but also upon adequate nasal tip support, a straight septum, and appropriately-sized inferior turbinates. Depending on the specific nasal abnormalities encountered, multiple techniques used in combination are often necessary for airway improvement.

Despite nasal airway reconstruction, some patients have persistent nasal valve dysfunction and seek additional therapy. Our goal was to develop an operative technique that treats persistent nasal valve dysfunction after functional rhinoplasty by addressing the nasal valve apparatus from an extranasal approach. The margin of the piriform aperture (apertura piriformis) adjacent to the inferior turbinate is a logical therapeutic target since it is the location of Cottle Maneuver's pull, and the vicinity where batten grafts, stair step grafts, and rim grafts derive their support. This investigation was initiated to determine the feasibility of this technique through cadaveric dissection, and then progressed to clinical implementation.

Introduction

Nasal obstruction is a common disorder that leads to decreases in disease-specific quality of life [1]. An estimated 13% of patients with nasal obstruction have some degree of nasal valve dysfunction [2]. The internal nasal valve- the region between the caudal border of the upper lateral cartilage and septum at the location of the anterior face of the inferior turbinate- is known to be the site of greatest nasal

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Methods

One fresh, cadaveric head was obtained through the Maryland State Anatomy Board (Baltimore, Maryland). A sublabial mucosal incision was made from tooth #6 to #11 (#13-23, FDI notation). The maxillary periosteum was elevated, exposing the lower half of the piriform aperture. Elevation of the periosteum inside the piriform aperture was also done to reveal the exact location of the bony inferior turbinate origin. A titanium plate (Synthes) was bent to resemble the Greek letter omega and affixed to the margin of the piriform aperture adjacent to the inferior turbinate face to increase projection of the piriform margin and enhance soft tissue support. Because the margin flares obliquely to the facial plane, the vector of projection is superior and lateral. Anterior rhinoscopy was used to assess any intranasal change and photographs of the technique were taken to document the procedure (Figure 1 and Figure 2).

Subsequent to the cadaveric dissection, individuals with unilateral internal nasal valve dysfunction despite prior functional septorhinoplasty (> 6 months) were screened and counseled regarding the procedure. Subjects with vestibular stenosis (external valve stenosis), external valve collapse, obstructive septal remnants, or persistent turbinate hypertrophy, were excluded. Subjects with evidence of bilateral internal valve dysfunction were also excluded. Eight subjects with isolated unilateral internal nasal valve dysfunction (stenosis and/or collapse) underwent unilateral piriform margin augmentation (PMA) using an alloplastic implant composed of titanium and porous polyethylene. *In vivo*, a unilateral gingivolabial sulcus incision was utilized corresponding to the side of patient



Figure 1: Exposure of the piriform aperture in the cadaver.



Figure 2: View of the left piriform margin in the cadaver. Dotted line marks the location of the inferior turbinate attachment.

symptoms and positive physical exam findings. Implant localization was achieved using intranasal identification of the inferior turbinate, as well as subperiosteal visualization of the inferior turbinate bone. A Medpor Titan Fan implant (Stryker) was customized and secured to the piriform margin using 3 monocortical self-drilling titanium screws. The field was irrigated prior to closure of the sublabial incision. Average operative time under orotracheal anesthesia was 52 minutes. Patients were followed for 1 year, and their results were documented via physical examination, implant questionnaire, and NOSE questionnaire [15].

Case Report

A 52-year-old man presented with chronic left sided nasal obstruction despite prior functional septorhinoplasty and turbinate reduction 3 years earlier. His operative report indicated septal cartilage had been used for intranasal grafting including batten grafts, spreader grafts, and rim grafts. Examination revealed left internal valve stenosis and collapse in the presence of a straight septal remnant, normal inferior turbinates, and normal external nasal valves. He consented to PMA on the affected side using an alloplastic implant as described above (Figure 3). The procedure was well tolerated. He was assessed at 3, 6, 12, and 24-month intervals and felt his problematic airway obstruction had resolved.

Results

Eight total patients were studied. Results are displayed in table 1. Subjectively, 6/8 patients reported improved airflow on the operated side twelve months postoperatively. 2/8 patients reported no improvement. 0/8 patients reported worsening of their nasal airflow. Statistical comparison between preoperative and postoperative NOSE scores was performed using the paired sample t-test. A two-sided threshold of $P < 0.05$ was used to evaluate statistical significance. Analysis was performed using Stata statistical software, version 13 (StrataCorp LP, College Station, Texas). Mean +/- standard deviation values of the preoperative and postoperative NOSE scores were 60.6 +/- 9.4 and 35.0 +/- 21.5, respectively. The difference between the means was 25.6 (95% confidence interval: 12.1-39.1). Comparison of the means using the paired sample t-test demonstrated a statistically significant difference ($P = 0.0028$).

All study patients could feel the implant with direct palpation, but only 1/8 reported direct palpation to be bothersome. 7/8 reported no



Figure 3: Intraoperative view of the modified Titan implant, fixated to the left piriform margin.

Table 1: 1-year results after unilateral piriform margin augmentation.

Parameter	N
Subjective Airway Improvement	6/8
Subjective Airway Worsening	0/8
Implant Palpable	8/8
Subjective Implant Migration	0/8
Implant Visible to Others	0/8
Pain	0/8
Numbness	1/8
Infection	0/8
Explantation	0/8

adverse symptoms due to its location near the nasal facial crease. 0/8 reported chronic pain with the implant, but 1/8 reported formication and numbness along the V2 distribution at one year. No fistulas or infections have occurred and no devices have been explanted to date.

Discussion

Nasal valve reconstruction with autologous cartilage grafting (also known as functional rhinoplasty) is considered to be the optimal therapy for obstruction caused by nasal valve dysfunction. When combined with septoplasty and inferior turbinate reduction, most forms of nasal obstruction can be improved significantly. As with any treatment, there are failures. Some patients benefit only partially from methods commonly employed. Persistent nasal obstruction after functional septorhinoplasty and inferior turbinate reduction remains a clinical challenge.

Residual obstruction is attributed to some combination of persistent nasal valve incompetence, septal remnant deflection, and/or inferior turbinate hypertrophy. Despite innovative work in this area, more nasal surgery is not necessarily warranted once appropriate procedures have been performed adequately. External appliances such as elastic strips or vestibular springs are treatments of last resort. Revision surgery might be indicated in cases where obvious deficiencies in prior treatment exist, but secondary (revision) septorhinoplasty is hampered by difficult dissection, co-morbidities of additional cartilage harvest, and risk of unintended aesthetic deformity and septal perforation. Therefore, the challenges of revision nasal airway surgery must be weighed carefully against potential benefits.

The integrity of the piriform margin is of critical importance to the nasal airway. A piriform ligament has been described as an investing fascia that unilaterally encircles the nasal aperture, originating broadly from the piriform margin and nasal bone, inserting into and around the upper and lower lateral cartilages [16]. The authors of the present study have noted that medial displacement or comminution of piriform margin fractures are associated with a high degree of residual unilateral nasal obstruction if untreated, possibly due to disruption of the piriform ligament. During rhinoplasty, resident surgeons are instructed that proper lateral osteotomy technique is important to underscore that the piriform adjacent to the inferior turbinate should never be medialized. Furthermore, the alar lobule, nasal sidewall, and associated sesamoid cartilages are all supported by the piriform margin. Augmenting the piriform at this location elevates overlying soft tissues in a superior and lateral direction, potentially affecting the piriform ligament, and appears to enhance nasal valve competence in a fashion that can be thought of as an “internal” Cottle Maneuver with a decrease in stenosis, collapse, or both (Figure 4).

In the present report, the technique of PMA was developed in a cadaver, followed by treatment of a small cohort of 8 individuals using the technique with a modified Medpor Titan Fan implant, yielding longstanding improvement as reported subjectively in 6/8 (75%) subjects, and supported with data from the NOSE questionnaire. The implant failed to improve subjective airflow, however, in 25% of the test subjects. One patient reported symptoms consistent with a traction injury to the maxillary division of the trigeminal nerve, but subsequently reported numbness since undergoing two root canals in the upper jaw prior to PMA. This individual was also one of two subjects who reported equivocal airflow change after treatment. Implants were palpable, as predicted, due to lack of fat at the site of implantation, yet visibility was not a reported problem due to the favorable contour of the nasofacial crease (Figure 5). No implants have required removal in this small series, but it must be remembered that infections and extrusion are a distinct risk with allograft implants in the midface [17]. Lack of quantitative airflow data before and after surgery is a limitation of the present work, but is an ongoing project.

Conclusion

Piriform margin augmentation was developed in a cadaver, and subsequently performed on eight patients, a subset of who reported

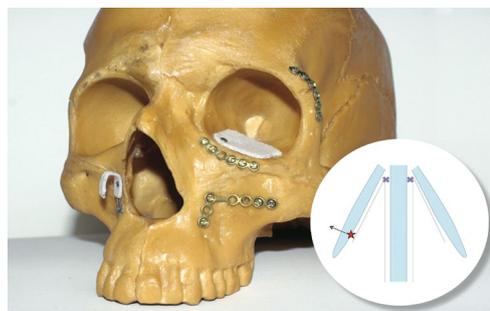


Figure 4: Panel A. Oblique view of a skull model showing a prototype implant fixated to the right piriform margin adjacent to the inferior turbinate attachment. Other alloplastic implants commonly used in facial reconstruction are also displayed. Panel B. Cross sectional schematic illustrating the typical location of spreader grafts (x) and the site of piriform margin augmentation (star).



Figure 5: Pre operative (a) and post operative (b) photos after left piriform margin augmentation (PMA).

airway improvement as late as one year after surgery. The use of titanium and high-density porous polyethylene (Medpor) in the midface is common in traumatic and oncologic reconstruction, but the authors are not aware that alloplastic augmentation of the piriform margin has been advocated previously for nasal airway benefit. The present work illustrates a method for treating persistent nasal valve dysfunction via a sublial approach, thereby avoiding revision rhinoplasty. It does not rely on a suture suspension technique that could break, stretch, or pull through tissue, losing effectiveness over time, but rather elevates the position of the bony piriform margin at the location of the internal nasal valve via a customized, bone anchored, alloplastic material. This method may also prove applicable to treat patients with nasal obstruction caused by facial nerve paralysis or partial maxillectomy. This research underscores the importance of the piriform margin as an integral component of the nasal valve mechanism and describes a potential salvage technique for patients who suffer from persistent symptoms of obstruction associated with unilateral internal nasal valve dysfunction after undergoing functional septorhinoplasty.

Author Disclosure

The authors have no financial disclosures or conflicts of interest to report.

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