
How I Do It

A Targeted Problem and Its Solution

A Novel Intranasal Stent for Functional Rhinoplasty and Nostril Stenosis

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Objectives/Hypothesis: The surgical correction of nostril stenosis and external nasal valve collapse typically involves the addition of tissue to widen and strengthen these areas. However, over the ensuing months, postoperative scar contracture may act to reverse the surgical modifications. This study aimed to determine the safety and efficacy of the use of nasal stents fashioned from a nasopharyngeal airway tube to prevent postoperative contracture at these sites. **Study Design:** Retrospective review of six patients who underwent functional rhinoplasty with alar batten graft placement for nasal valve collapse and one patient who underwent composite graft repair of unilateral nostril stenosis. **Methods:** Patients completed a survey inquiring about the ease of use, discomfort, presence of infection, and ability to breathe with these nasal stents. Patients also completed the NOSE (nasal obstruction symptom evaluation) instrument to compare their overall level of preoperative and postoperative nasal breathing. The functional rhinoplasty patients were examined for degree of dynamic airway nasal wall collapse and position of the lateral nasal wall on intranasal examination. **Results:** Six of seven patients overall reported no to minimal discomfort, easy application, and no to minimal obstruction of nasal breathing with the use of the stents. One patient reported difficulty with application. Preoperative NOSE scores averaged 67.1 (SD 10.4), 18.6 (SD 14.6) at the time of splint removal, and 21.4 (SD 15.2) at 3 months after stent removal. Paired *t* test analysis

showed significant differences between the NOSE scores preoperatively as compared with the time of splint removal ($P = .0002$) or 3 months after splint removal ($P = .0003$). All patients demonstrated a significant reduction of lateral nasal wall collapse with inspiration on physical examination. **Conclusions:** The use of nasal stents made from nasopharyngeal airway tubes is a safe, convenient, and economic treatment for the prevention of contracture after surgical correction of nostril stenosis or nasal valve insufficiency. **Key Words:** Nostril stenosis, nasal stent, nasopharyngeal airway.

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INTRODUCTION

The correction of fixed nasal obstruction requires surgical maneuvers that aim to widen and strengthen areas of anatomic narrowing. A common region of dynamic and static narrowing is the internal nasal valve area. This area is described as consisting of the nasal septum, the caudal margin of the upper lateral cartilages, the inferior turbinates, and the pyriform aperture/nasal floor.¹ Not included in most descriptions of the internal valve area is the lateral nasal wall just superior to the inferior turbinate, cephalad to the alar lobule, and posterior to the termination of the lateral crura. Because this area is largely devoid of cartilage or bone, dynamic inspiratory collapse is apt to occur here in predisposed individuals. We refer to this area as the supra-alar lateral wall and consider it an important component of the internal valve area.

Internal nasal valve dysfunction may be a primary disease or may result from collapse or scarring caused by previous nasal surgery. Static narrowing in this region is caused by crowding of these structures (e.g., septal deviation, inferior turbinate hypertrophy, and small angle between the upper lateral cartilage and septum). Dynamic inspiratory collapse in this area is typically attributable to a weak supra-alar lateral wall. Alar batten grafting is a workhorse technique in functional rhinoplasty for widening and strengthening the supra-alar lateral nasal wall. This cartilaginous batten graft is placed into a precise

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pocket within the deep tissue of the lateral wall. The graft serves to stent the supra-alar lateral nasal wall and resist against its collapse, thus addressing both static and dynamic components of obstruction.

Stenosis of the nostril is a much less frequently seen deformity that may be congenital or acquired, usually caused by a loss of the vestibular lining. There are multiple causes for this deformity, including infection, trauma, and after excision or electrocoagulation of tumors, chemical cauterization, prolonged nasal packing under tension, and other surgery that involves the vestibular lining.² Postoperative webbing tends to occur after large surfaces around the nostril circumference are denuded. Many surgeons consider this problem to be challenging because of the difficulty in maintaining the corrected position and the need for further revisions. Surgical correction of nostril stenosis involves division or resection of the scar followed by support of the wound with tissue that will resist subsequent contracture. It is the preference of the senior author to use composite cutaneous-cartilaginous grafts from the concha for this purpose.

A problem that occurs after both alar batten grafting and composite graft repair of nostril stenosis is postoper-

ative narrowing caused by scar contracture and constant inspiratory forces. These forces can serve to negate the effects of surgery or create a smaller nasal aperture than was present in the preoperative period. Some authors have suggested that during a preoperative evaluation, palpating the nasal ala to determine the presence or absence of residual tissue resistance is useful for assessing the likelihood of postoperative wound contracture.³ However, this is not an effective measure and despite preoperative evaluation, it is difficult to predict which patients will present with postoperative scar contracture and nasal stenosis.

To guard against postoperative contracture and narrowing in nasal surgery, some surgeons have used nasal stents to serve as mechanical barriers to inward scarring. The use of stents is commonly seen in pediatric and neonatal surgery because of the status of infants as obligate nasal breathers. Restenosis in these patients has been effectively treated with catheter tubes inserted into the nasal airway immediately after surgery.⁴

The adaptation of the nasal stent device to the patient population undergoing rhinologic surgery may aid in preventing postoperative restenosis and the need for further

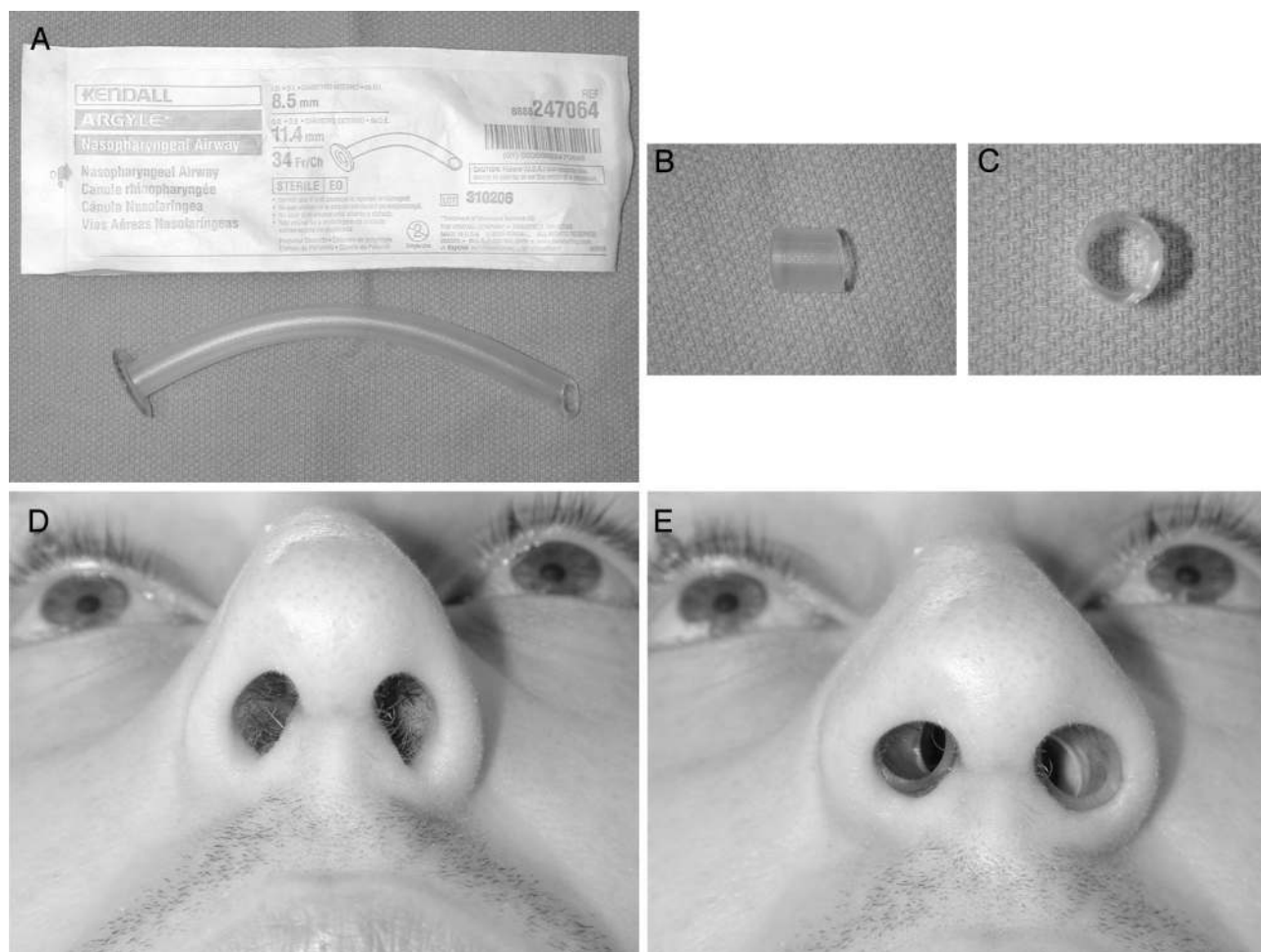


Fig. 1. (A) Standard 34 French nasal airway tube. (B, C) Segment cut for use as nasal stent. (D) Base view 2 weeks postfunctional rhinoplasty with placement of alar batten grafts. Note intranasal lateral wall is partially medialized, signifying risk for postoperative inward contracture. (E) Base view with intranasal stents in place. Note supportive reinforcement to lateral wall.



Nasal Obstruction Symptom Evaluation (NOSE) Instrument



→ **To the Patient:** Please help us to better understand the impact of nasal obstruction on your quality of life by **completing the following survey**. Thank You!

Over the past **1 month**, how much of a **problem** were the following conditions for you?

Please **circle** the most correct response

	<i>Not a problem</i>	<i>very mild problem</i>	<i>moderate problem</i>	<i>fairly bad problem</i>	<i>severe problem</i>
1. Nasal congestion or stuffiness	0	1	2	3	4
2. Nasal blockage or obstruction	0	1	2	3	4
3. Trouble breathing through my nose	0	1	2	3	4
4. Trouble sleeping	0	1	2	3	4
5. Unable to get enough air through my nose during exercise or exertion	0	1	2	3	4

Fig. 2. Nasal obstruction symptom evaluation (NOSE) scale.

surgery. The senior author has used a novel intranasal stent fashioned from a nasopharyngeal airway tube in an attempt to prevent postoperative narrowing of the nasal airway after alar batten placement in functional rhinoplasty and restenosis after repair of obstructive nostril cicatrix. The present investigation aimed to determine the safety and efficacy of the use of these stents in the postoperative period.

METHODS

The investigation studied seven patients who used intranasal stents at night-time postoperatively. Six of the patients underwent functional rhinoplasty with placement of alar batten grafts for the treatment of nasal obstruction caused by internal nasal valve insufficiency and dynamic supra-alar lateral wall collapse, and one patient underwent composite grafting for repair

TABLE I.
Summary of Patient Responses to Questionnaire.

Subject	Preoperative (NOSE score)	At Intranasal Splint Removal	Three Mo. Postdiscontinuation of Splint
1	75	35	40
2	55	15	5
3	75	20	30
4	70	40	35
5	60	15	25
6	80	0	0
7	55	5	15
Mean	67.14	18.57	21.43
SD	10.35	14.63	15.20
Paired t test, <i>P</i> value	Preop vs. splint removal		0.0002
	Preop vs. 3 mo. postintranasal splint removal		0.0003
	At splint removal vs. 3 mo postdiscontinuation of splint		0.386

NOSE = nasal obstruction symptom evaluation.

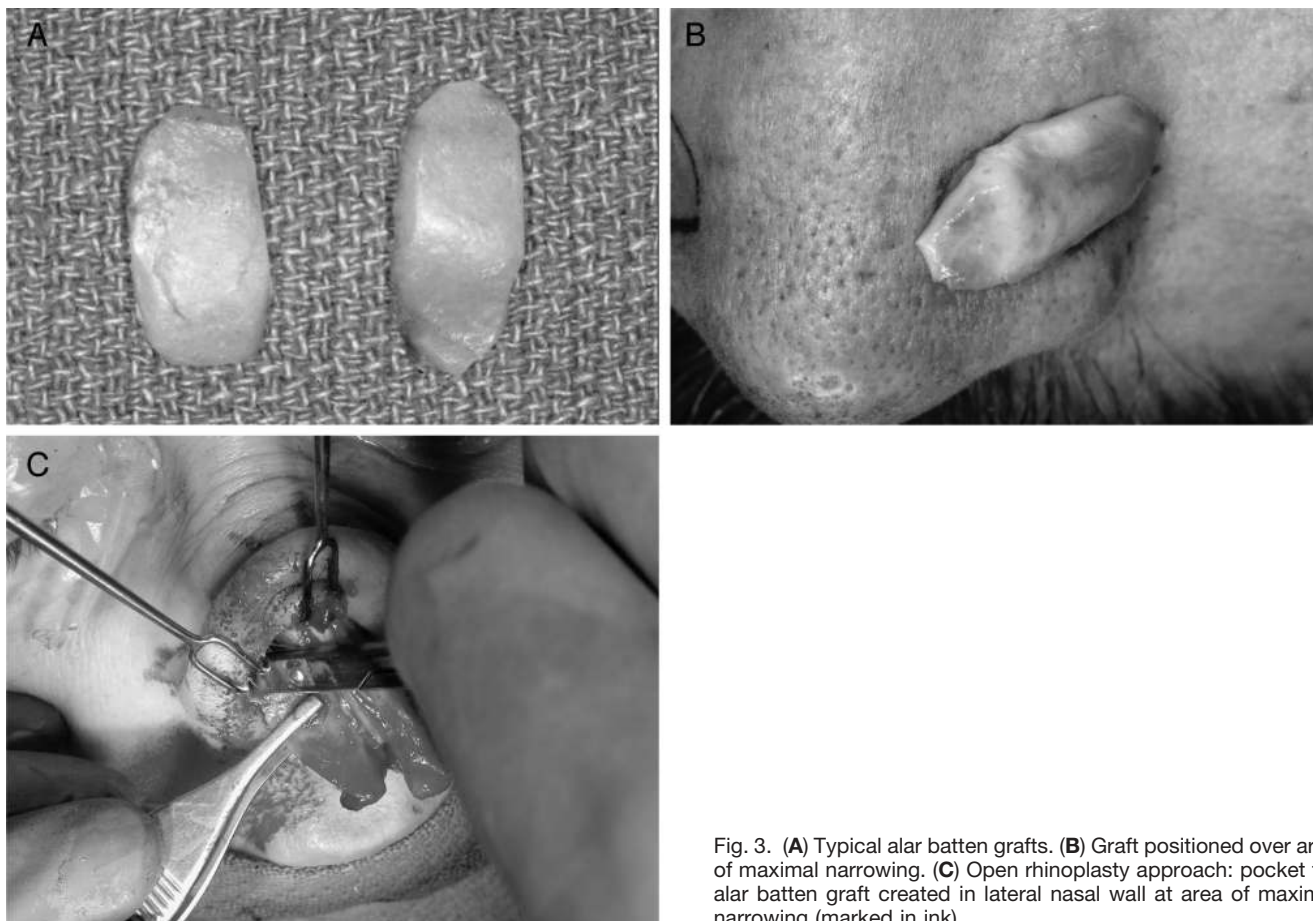


Fig. 3. (A) Typical alar batten grafts. (B) Graft positioned over area of maximal narrowing. (C) Open rhinoplasty approach: pocket for alar batten graft created in lateral nasal wall at area of maximal narrowing (marked in ink).

of a unilateral nostril stenosis. The period of stent use varied according to the degree of narrowing of the surgical site. Stents were initiated 1 week after surgery after any sutures and external splints were removed. Stent use was terminated when it was deemed that a satisfactory degree of nasal airway stabilization had occurred: if the airway opening remained stable qualitatively for several weeks after stent removal, further use was not continued. Stents were reintroduced in one rhinoplasty patient for an additional 6 weeks because of mild narrowing observed after initial stent removal.

Stents were fashioned from standard nasopharyngeal airway tubes (Kendall, Mansfield, MA) (Fig. 1). The size of the nasopharyngeal airway tube chosen was chosen so that the overall circumference of the stent would be slightly larger than the internal circumference of the nostril and nasal vestibule. These tubes are widely available in sizes ranging from 22 French to 36 French. A segment of the tube was then cut with heavy scissors to fashion a soft plastic cylindrical stent. The length of the stent was typically about a centimeter in length but could be varied on the basis of individual anatomy. Each patient was instructed on stent insertion: each stent would be folded in half along the circular cross-section and then folded again. While in this doubly folded configuration, the stent would then be inserted into the nostril and nasal vestibule, with the end of the stent being stabilized by the nostril margin. On releasing the stent, it would unfold into its open circular orientation. When properly sized, the stents expand the nostril opening, vestibule, and lateral nasal wall.

Patients completed a questionnaire inquiring about the ease of use, discomfort, presence of infection, and ability to breathe with these nasal stents. The questionnaires were completed at

the conclusion of each patient's period of stent use (8–25 weeks, average of 17 weeks). Patient also completed the NOSE (nasal obstruction symptom evaluation) scale preoperatively, after discontinuation of nasal stent (8–25 weeks, average of 17 weeks), and approximately 3 months after stent removal (Fig. 2). The rhinoplasty patients were also evaluated for dynamic lateral nasal wall collapse at the time of stent removal and approximately 3 months after stent removal.

The NOSE scale (Fig. 2) was developed by Stewart et al.⁵ as a subjective evaluation to be used in the postoperative period as a measure of surgical outcomes and success. This scale was first used in septoplasty patients but is applicable to many different types of nasal surgery to correct obstruction.⁶ The scale uses a questionnaire with five items to be evaluated on a scale of 0 to 4. These items include nasal congestion or stuffiness, nasal blockage or obstruction, trouble breathing through the nose, trouble sleeping, and unable to get enough air through the nose during exercise or exertion. The results of the NOSE scale based on patient evaluation of the postoperative success can also be measured against the evaluation by the surgeon of the postoperative outcome (8–25 weeks, average of 17 weeks). The items measured using the NOSE scale have been demonstrated to show a unified construct with Spearman correlation coefficients greater than 0.40.⁶ The response sensitivity of this scale is also very high, indicating that subtle changes in the patient's status will be detected. The higher scores are relative to a higher degree of nasal congestion. The NOSE scale is brief, valid, reliable, and responsive to change in clinical status. It can be easily used by clinicians for prospective trials and given repeatedly.

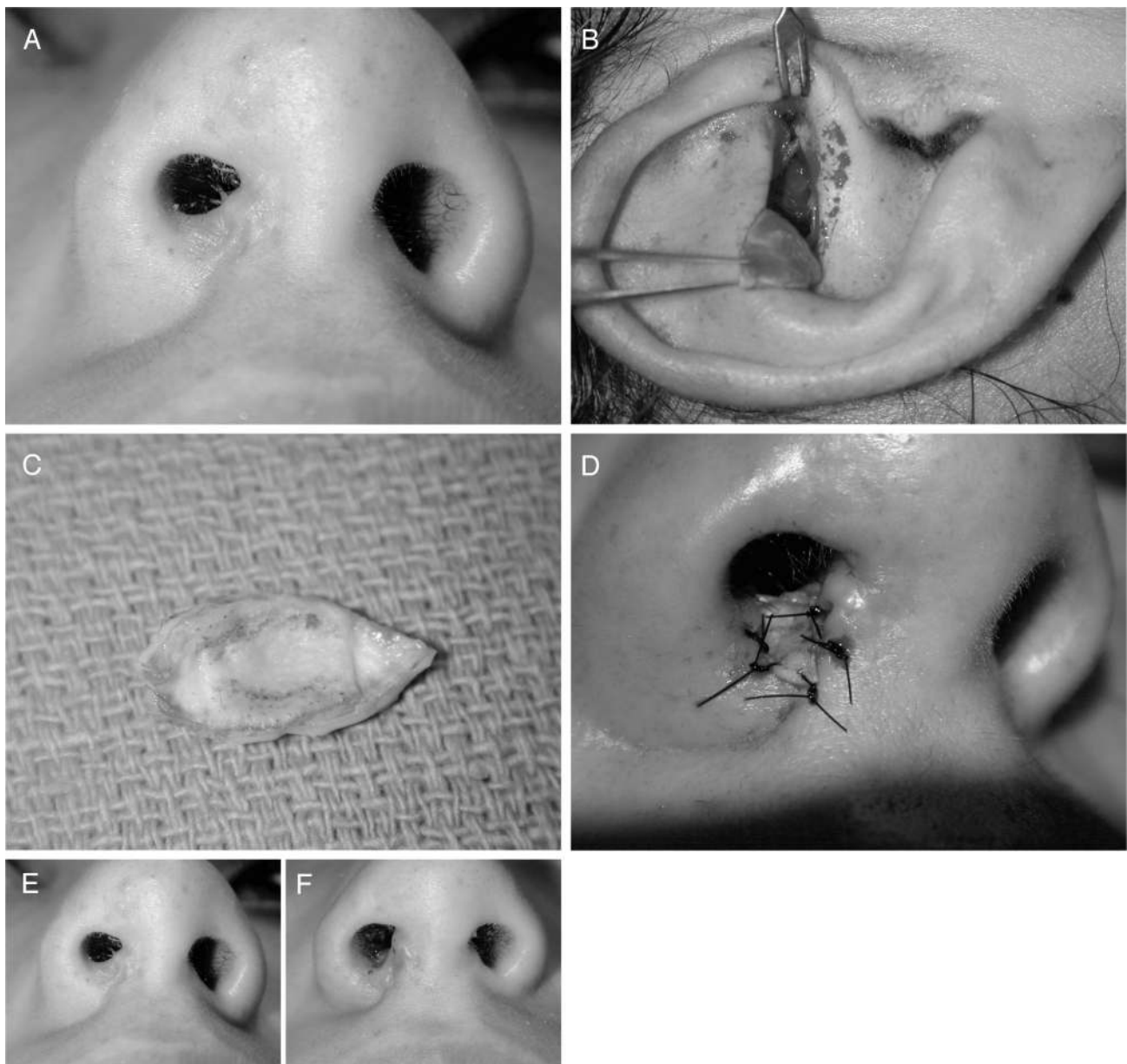


Fig. 4. (A) Area of scar involves the entire right nasal sill and lateral columella. Fifty percent of the inner circumference of the nostril is involved, and the cross-sectional area has been reduced to approximately 30% of the opposite nostril. (B). Entire cavum concha harvested as a composite graft of skin and cartilage. (C) Skin excised from each end of the elliptical graft to leave a central skin island flanked by cartilaginous flanges. (D) Graft inset into reconstructed nostril sill. The surrounding scar is pushed down to the level of the graft thus restoring normal position of the nostril floor and normal area of the nostril aperture. (E) Preoperative. (F) Four months postoperative. (E, F) The nostril size and shape is restored. Residual scar tissue on either side of the graft is being treated with serial steroid injection and planned secondary incision. Nasal stent was used at night for approximately 6 months.

RESULTS

NOSE scores were calculated by tabulating the scores from 1 to 4 in five categories and multiplying the total by 20 to achieve a result from 0 to 100. Preoperative NOSE scores averaged 67.1 (SD 10.4), 18.6 (SD 14.6) at the time of splint removal, and 21.4 (SD 15.2) at 3 months after discontinuation of intranasal stent. Paired t test analysis showed significant differences between the NOSE scores preoperatively as compared with the time of splint removal ($P = .0002$) (8–25 weeks, average of 17

weeks) or 3 months after splint removal ($P = .0003$). No significant difference was determined to exist between the NOSE scores at the time of splint removal versus 3 months afterward ($P = .39$) (Table I). All six functional rhinoplasty patients demonstrated visible dynamic wall collapse preoperatively. No appreciable dynamic supralar lateral wall collapse with inspiration was noted immediately after stent removal or 3 months after stent removal. All patients overall reported no to minimal discomfort, no to minimal obstruction of nasal breathing, and

TABLE II.
Summary of Patient Surveys at Completion of Study.

Difficulty of Use/Application	Presence of Postoperative Infection	Discomfort	Obstruction to Breathing
4 very easy to place	7 no	0 severe	0 severe
2 somewhat easy to place	0 yes	0 moderate	0 moderate
0 somewhat difficult to place		0 mild	0 mild
1 very difficult		2 minimal	4 minimal
0 impossible to place		5 none	3 none

no infections with the use of the stents. Six of seven patients reported that stents were used with minimal to mild difficulty. One patient reported difficulty with application in terms of attempts to insert the stent (Table II).

DISCUSSION

Static narrowing of the internal nasal valve area is caused by crowding of its anatomic components. This may involve malposition, hypertrophy, or deviation of the nasal septum, upper lateral cartilages, lateral nasal wall, inferior turbinates, or nostril floor. Dynamic insufficiency of this valve is caused by a flaccid lateral nasal wall that may collapse when a critical transnasal pressure is reached. Surgical options address this problem by strengthening the airway which is most susceptible to collapse.

The goal of surgery for nasal valve insufficiency or nasal stenosis is to widen and strengthen the portions of the airway that are liable to collapse during inspiration. Alar batten grafts are used when patients have pronounced supra-alar pinching and supra-alar lateral wall weakness. Although the shape of the native ala is determined by fibrofatty tissue, cartilage grafts can be placed there to increase support and width. These grafts are most typically harvested from septal or conchal cartilage (Fig. 3).

Nostril stenosis occurs because of the overreaction of the wound healing process, resulting in scar contracture. The impetus for this cascade of events can be traumatic or iatrogenic. Surgery to correct the defect can also result in a worsening of the original problem. The use of grafts that can stent open the lateral nasal wall and prevent its collapse are a reliable solution. These grafts are most commonly taken from conchal or septal cartilage, which provides enough surface area and is flexible yet strong. These grafts can be placed in the area of scar contracture to widen the nostril opening and compress the excess scar tissue (Fig. 4).

Postoperative scar contracture occurs in any surgical site because of a cascade of events in wound healing and maturation. Excessive or problematic scar contracture can be caused by problems inherent in the wound healing process: abnormalities in cell migration, proliferation, and inflammation and in the synthesis and secretion of extracellular matrix proteins, cytokines, and the remodeling process.⁷ The location of the wound and subsequent scar, however, will determine the cosmetic and functional consequences. Scar contracture in the nasal airway, which is

narrow, enclosed, and vital for airflow, carries obvious implications. Although surgical and nonsurgical treatment options exist to treat troublesome scar formation, prevention is clearly a better option.

The use of nasal stents to prevent nasal scar contracture and postoperative narrowing has been used in the field of neonatology and in the care of burn inhalation victims. In particular, stents have been used in the adult burn patients with obstructive nasal scarring secondary to inhalation injury. The use of a nasal trumpet orthosis made of semirigid thermoplastic material is readily available in the clinical setting and serves to ensure adequate respiratory exchange in these patients.⁸ The stent is designed to fit from the nasal choanae to the external rim of the nares and is worn at all times with daily cleaning. These devices have been reported to be effective in patients who have suffered from inhalation injury but have not been reported in the population of nasal reconstruction patients.

The present study demonstrated that a novel nasal stent fashioned from a nasopharyngeal airway tube is a safe and convenient adjunct available to patients after nasal surgery. The length of time that the nasal stents were used varied according to the individualized response to the device. The stents were used until it was demonstrated that the surgical site in the nasal airway would not narrow for several weeks after stent removal. All but one patient reported that difficulty in stent placement was "minimal" to "mild." One patient reported placement was "difficult," but she was an elderly patient with rheumatoid arthritis. Stent placement was easily performed for her when placed by another individual. All patients overall reported minimal discomfort, minimal or moderate obstruction of nasal breathing, and no infections with the use of the stents. NOSE scores showed a significant improvement at the time of stent removal and 3 months after stent removal as compared with the preoperative period. The observation that no further significant narrowing occurred after stent removal may suggest that the beneficial effects of the stents may endure after their removal once the wound and scar matures. It is not possible to draw conclusions about the exact role of these stents in widening or strengthening the nasal airway against scar contracture because no comparative control arm was used. However, the study did demonstrate that these devices are safe and relatively well-tolerated by patients. Future studies will be directed toward determining the independent effect of these devices on the stabilization of these postnasal-surgery healing sites.

At present, the senior author does not use stents on all patients undergoing nasal surgery. Selection of patients for stent use should be based on an assessment of the risk of postoperative collapse. It is our opinion that all patients with surgical correction of nostril stenosis would benefit from stent use given the high rate of restenosis after surgery.

Although not all functional rhinoplasty patients are appropriate for this therapy, those individuals who undergo alar batten grafting and have persistent airway impingement of the lateral nasal wall would appear to benefit. These patients may have a narrow nasal geometry predisposing to more severe supra-alar lateral wall col-

lapse. In this group of patients, placement of an alar batten graft may simply push the internal aspect of the lateral nasal wall inward rather than stabilize it outward. Placement of a stent in the postoperative period may allow the alar batten graft and supra-alar lateral wall to "heal" and become fixated in a relatively lateral position.

Revision functional rhinoplasty patients represent a second group of individuals for whom postoperative stent use may be beneficial. These individuals may have scar replacing the normal pliable tissue of the supra-alar lateral nasal wall. In particular, after reduction rhinoplasty consisting of aggressive cephalic trim, dome division, or lateral crural resection, the supra-alar lateral nasal wall may have become medialized and fixed into this position with dense scar. Again, an alar batten graft alone may not be sufficiently strong enough to overcome the memory of the scarred supra-alar lateral wall.

The use of these stents carries certain cosmetic implications. With prolonged and aggressive use, they may create a risk of a cosmetically objectionable increase in overall width of the alar lobules and supra-alar crease region. Although it is expected that alar batten graft placement will widen these areas even without stent use, in most situations, this additional width will partially or completely resolve over time as the constant repeated forces of inspiratory negative pressure and scar contracture act on these sites. But as this "normalization" occurs, the nasal airflow may gradually decrease. This highlights a conundrum for certain patients in functional rhinoplasty in which function and cosmesis are at odds with one another: the problematic situation in which each millimeter of additional width improves airflow but in the eyes of the patient, compromises appearance.

Ideally, the patient and surgeon must find a balance in prioritizing the importance of function and appearance for each patient and each nose. Although some individuals wish for maximization of nasal breathing at a cost to cosmesis (these individuals may be happy with very large, strong, curved alar batten grafts laterally placed to be braced by the piriform aperture), most patients have some

concern for the esthetic implications the grafts will have on nasal width. This balance may be controlled to some degree with the technique used in surgery (size, dimensions, and position of grafts); however, the use of postoperative stents may serve as a valuable adjunctive measure to fine tune this process. Essentially, with frequent follow-up and careful observation, the use of the stents can be titrated against the forces of inspiratory negative pressure and contracture so as to find the desired balance of form (width of nasal airway) and function (airflow).

CONCLUSION

The use of the nasal stents introduced in this report in the postoperative period represents a novel application of a commonly available device in a relatively noninvasive manner. These stents may serve to decrease the incidence of scar contracture and decrease the likelihood of later revision surgery.

BIBLIOGRAPHY

1. Kern EB. Surgical approaches to abnormalities of the nasal valve. *Rhinology* 1978;16:165–189.
2. al-Qattan MM, Robertson GA. Acquired nostril stenosis. *Ann Plast Surg* 1991;10:382–386.
3. Otley CC. Alar batten cartilage grafting. *Dermatol Surg* 2000;10:969–972.
4. Sharon-Buller AG, Savion I, Sela M. Technique for fabrication of splint preventing postsurgical restenosis in choanal atresia. *J Prosthet Dent* 2003;90:301.
5. Stewart MG, Smith TL, Weaver EM, et al. Outcomes after nasal septoplasty: results from the Nasal Obstruction Septoplasty Effectiveness (NOSE) study. *Otolaryngol Head Neck Surg* 2004;130:283–290.
6. Stewart MG, Witsell DL, Smith TL, et al. Development and validation of the Nasal Obstruction Symptom Evaluation (NOSE) scale. *Otolaryngol Head Neck Surg* 2004;130:157–163.
7. Shin D, Minn KW. The effect of myofibroblast on contracture of hypertrophic scar. *Plast Reconstr Surg* 2004;113:633–640.
8. Johnson J, Candia J, LaTrenta G, et al. A nasal trumpet orthosis to maintain nares openings and respiratory function for patients with facial burns: a case report. *J Burn Care Rehabil* 1992;13:677–679.