The Journal of Laryngology & Otology (2009), ***123***, *945–951.*

doi:10.1017/S0022215109005283

Review Article

Management of the narrow nose

H Wallace, S Sood, A Rafferty

Abstract

Nasal obstruction is one of the most common complaints in the otolaryngology clinic. It can be a complex problem and may be multifactorial. Nasal valve dysfunction can be a cause of nasal obstruction, particularly in patients who have undergone previous reduction rhinoplasty. The exact site of the nasal valve is contentious and is frequently subdivided into the internal and external nasal valves. Accurate assessment is crucial for correct diagnosis and management planning. Various surgical and non-surgical techniques for addressing the problem of nasal valve collapse have been described in the literature. The choice of technique will depend on the causative pathology, availability of graft material, surgical experience and patient preference.

Key words: Nasal Obstruction; Nasal Cavity; Otorhinolaryngologic Surgical Procedures

Introduction

The term 'narrow nose' has both functional and aesthetic connotations. Functionally, the narrow nose can cause symptoms of nasal obstruction due to a narrow nasal valve. Cosmetically, the middle third of the nose may be overly narrow, with a pinched appearance and visible collapse of the lateral walls on inspiration.

The exact site of the nasal valve is contentious. A review of the literature revealed a range of interpretations and definitions regarding the nasal valve region.[1]

In this review, we describe the aetiology and clinical findings in patients with symptoms relating to a narrow nose, and we present an up-to-date review of the treatment options available.

Anatomy

The nasal valve is frequently subdivided into the internal and external nasal valves. The internal nasal valve is defined as the caudal margin of the upper lateral cartilage, the nasal septum and the floor of the nose. The angle between the upper lateral cartilage and the septum, i.e. the nasal valve angle, normally ranges from 10 to 15°. If the inferior turbinate is large, it can contribute to the boundaries of the internal nasal valve (Figure 1).[2] The external nasal valve refers to the lateral crus of the lower lateral cartilage and the surrounding soft tissues.[1]

The upper lateral cartilages are in continuity with the septal cartilage and are well supported at their attachment to the nasal bones; however, they have relatively poor support laterally as this area comprises soft tissue and sesamoid cartilages. They may also show an inward curling which can contribute to narrowing of the nasal valve region.[3] The lower lateral cartilages encompass the nostrils and are attached laterally to the piriform aperture by dense fibrofatty tissue. If the lateral component of the lower lateral cartilage is poorly supported or is medially displaced, then the lateral wall may collapse on inspiration.[4]

The scroll area is where the upper and lower lateral cartilages interrelate. Three different configurations are possible. Commonly, the cephalic edge of the lower lateral cartilage overlaps the caudal edge of the upper lateral cartilage (Figure 1).

Physiology

The resistance of the nasal valve area is dependent not only on its static anatomical components but also on its dynamic components. The state of engorgement of the anterior end of the inferior turbinate has a significant effect on nasal resistance. Cole described the nasal valve as the area of maximal airway resistance in the nose, emphasising the importance of the erectile soft tissue elements of the nose.[5] Decongestants can produce a 50 per cent reduction in nasal resistance by stimulating α-adrenergic receptors on the nasal mucosa, leading to vasoconstriction of local vessels and reduction of mucosal oedema (Figure 2).[6]

Another important factor is the tendency of the nasal valve to collapse at high airflow rates.[7] The cross-sectional area of the nasal valve accounts for

From the Department of Otolaryngology, Bradford Royal Infirmary, UK.
Accepted for publication: 24 December 2008. First published online 17 April 2009.

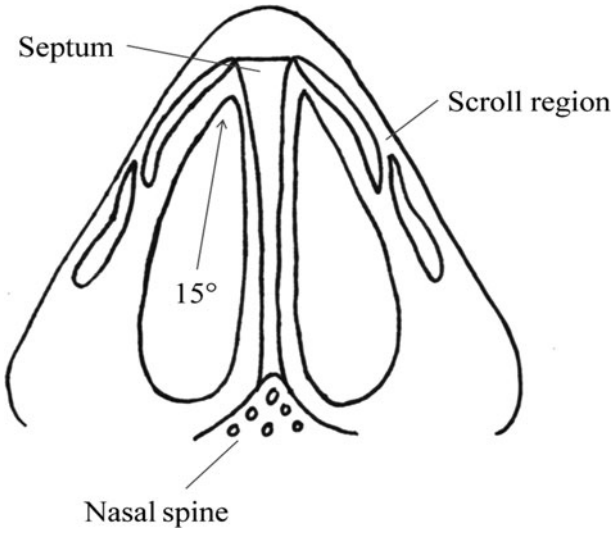

FIG. 1
The internal nasal valve.

up to 50 per cent of the nasal resistance in the upper respiratory tract. The valve area will determine the degree of Bernoulli effect; this principle states that the pressure drop is inversely proportional to the square of the cross-sectional area. As rate of airflow through the valve increases the pressure inside the valve decreases, thereby increasing the likelihood of nasal valve collapse. By this principle, some degree of nasal valve collapse is normal with deep inspiration, but individuals with weakened cartilage support or narrow nasal valves are more prone to airflow-induced nasal valve collapse.[8]

Physiological studies of intranasal pressure measurements have shown the 'flow limiting segment' corresponds to the piriform aperture.[9] Some degree of pressure drop does occur over the cartilaginous portion of the nose, but the majority occurs in the first several millimetres of the bony nasal cavum starting at the piriform aperture.[10]

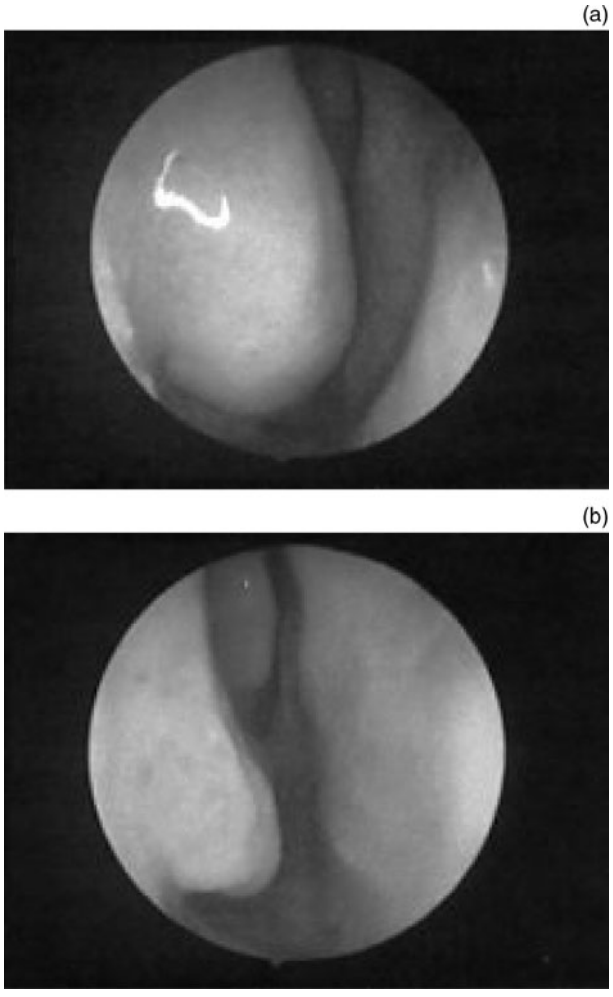

FIG. 2
Nasal valve region (a) before and (b) after decongestant.

Pathology

Nasal obstruction is very common, with septal deviations and turbinate hypertrophy causing the majority of airway problems (Table I). In patients who are still symptomatic despite maximal medical therapy and/or seemingly successful surgery to the nasal septum and/or turbinates, alternative reasons for their symptoms must be considered. Deficiencies in anterior nose support may result from ageing, trauma, iatrogenic causes, inflammatory and autoimmune disease, and, less commonly, from a congenital cause.[11]

Internal nasal valve collapse may be seen after previous reduction rhinoplasty when a large portion of the cartilaginous hump has been removed, thus reducing the stability between the upper lateral cartilages and the septum, or in older patients with weakening of the supportive structures of the nose.[2] The classic 'tension nose' patient with short nasal bones, weak upper lateral cartilages, a nasal valve angle of less

TABLE I
CAUSES OF NASAL OBSTRUCTION

Congenital	Acquired
Structural	*Structural*
Septal deviation	Deviated nasal septum
Piriform aperture stenosis	Hypertrophic turbinates
Choanal atresia	Nasal valve disorder
	Rhinitis
	Allergic
	Infective
	Non-allergic
	Vasomotor
	Iatrogenic
	Reduction rhinoplasty
	Pharmacological
	Rhinitis medicamentosa
	β-blockers, NSAIDs, etc
	Endocrine & metabolic
	Pregnancy
	Hypothyroidism
	Inflammatory
	Sarcoidosis
	Wegener's granulomatosis
	Neoplastic
	e.g. Angiofibroma, carcinoma

NSAIDS = non-steroidal anti-inflammatory drugs

https://doi.org/10.1017/S0022215109005283 Published online by Cambridge University Press

than 10–15° and thin overlying skin is particularly at risk of valve collapse following rhinoplasty.[12]

External nasal valve collapse is less common, and may be caused by overly aggressive resection of the lower lateral cartilages. Certain patients may also be predisposed to external nasal valve collapse, such as those with narrow, slit-like nostrils, a projecting tip and thin alar sidewalls, or those with caudal septal deflections.[13] Vestibular stenosis is an uncommon cause of nasal obstruction, usually resulting from scar formation following nasal surgery.

Nasal piriform aperture stenosis is an uncommon cause of nasal obstruction. The aetiology may be congenital, developmental or traumatic. Patients tend to have a narrow nasal base with slit-like nostrils. Diagnosis can be confirmed on axial computed tomography (CT) imaging.[14]

Assessment

Nasal obstruction can be multifactorial; thus, a thorough history and examination are necessary in order to identify the aetiology and to devise a successful treatment plan.

The cosmetic appearance of the nose may be of a pinched tip deformity which collapses on inspiration (Figure 3). There may be evidence of previous trauma or rhinoplasty. In older patients, it is not uncommon to see a ptotic tip or supratip dorsal hump caused by senile loss of tip support.[13]

Internal examination allows assessment for mucosal disease, turbinate hypertrophy and septal deviation. Inspection of the nasal valve area should also be done without a speculum, which may distort the valve angle and thereby prevent differentiation between internal and external nasal valve collapse.[12] On forceful inspiration, the patient's symptoms are exacerbated, with collapse of the nasal valve area and resultant obstruction.[13]

Cottle's manoeuvre (i.e. superolateral traction on the nasofacial groove) will relieve nasal obstruction if there is internal valve collapse (Figure 4). Elevation of the valve area by lifting the lateral crus superolaterally away from the septum with a cotton bud confirms the Cottle's manoeuvre result.[15]

If decongestion of the nose completely relieves obstruction, valve collapse is unlikely and medical management is indicated. Rigid endoscopy is recommended to exclude other causes of nasal obstruction such as post-nasal space lesions.

Acoustic rhinometry is a non-invasive, reliable, objective method which can be used to determine the cross-sectional areas of the nasal cavity as a function of the distance from the nostril. Results correlate well with those of CT, rhinomanometry and direct measurements using saline. Acoustic rhinometry is not routinely used in clinical practice but does have an established role for clinical and basic science research.[1,11]

Management

Non-surgical treatment

It is important to consider a trial of medical treatment before undertaking any surgical intervention. Nasal steroid sprays, ensuring good compliance, should effectively treat rhinitis, which is a very common finding in the general population.[16]

Non-surgical techniques to address nasal valve collapse include the use of external adhesive strips and internal nasal springs that physically hold open the nasal valve (Figures 5 and 6). To many patients, these may be uncomfortable and cosmetically

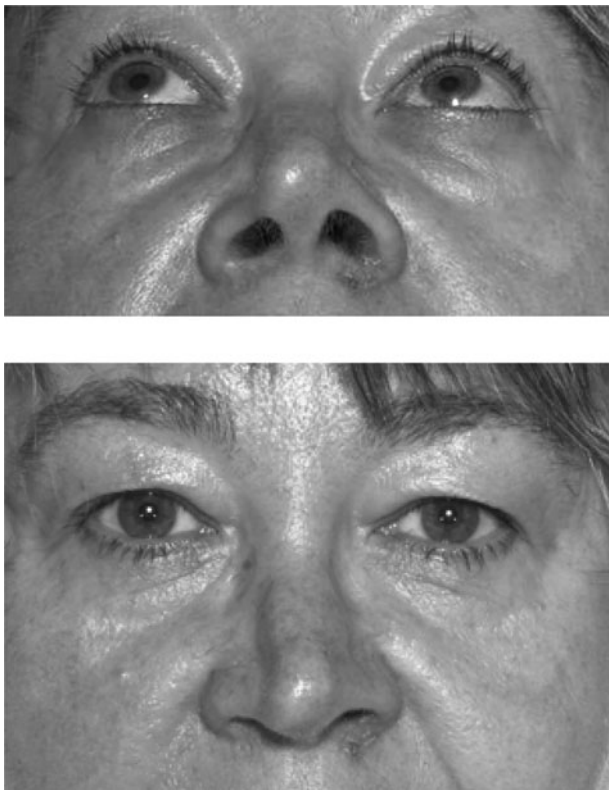

FIG. 3
Unilateral (right) alar collapse on inspiration.

FIG. 4
Cottle's manoeuvre.

https://doi.org/10.1017/S0022215109005283 Published online by Cambridge University Press

FIG. 5
Alar dilator device.

unacceptable options. However, in those individuals who are unfit for or unwilling to undergo surgical intervention, they can offer some symptomatic relief. Roithmann *et al.* reported that the nasal valve area was smaller in patients with post-rhinoplasty nasal obstruction compared with those with healthy nasal cavities, as shown by acoustic rhinometry; furthermore, they showed that external dilatation was an effective therapeutic approach resulting in a significant increase in the minimum cross-sectional area of the nasal cavities.[17]

Viaman *et al.* described the treatment of nasal valve collapse using high frequency transcutaneous and intranasal electric stimulation of nasal muscles in order to strengthen the nasal valve walls.[18] This treatment initially resulted in significant subjective benefit and objective improvement on rhinomanometry, compared with a placebo. Treatment was well tolerated. However, when treatment was stopped, there was a rapid return to the pre-treatment state (as assessed by rhinomanometric data).

Surgical treatment

Methods of correcting internal nasal valve collapse focus on repositioning the upper lateral cartilages or adding structural grafts to support the lateral nasal wall.[2] External nasal valve collapse can be repaired by realigning cephalically placed lateral crura and placing structural grafts into the alar lobule to provide support and prevent collapse. The choice of technique depends on aetiology, extent of collapse, the experience or preference of the treating ENT specialist, and the patient's preference.

FIG. 6
External nasal dilator strip.

Internal nasal valve collapse. (1) The use of spreader grafts were popularised by Sheen. This technique addressed internal nasal valve collapse, following reduction of a high bony-cartilaginous dorsum by lateral augmentation with autogenous cartilaginous grafts sited paramedially to the septum. These grafts spread the upper lateral cartilages away from the septum and increased the width and strength of the nasal valve, reducing its tendency to collapse. Aesthetically, spreader grafts restore width to a pinched, narrow nose. They can be placed using either a closed[19] or an open[12] approach. Submucoperichondrial pockets extending cephalad past the caudal arch of the bony pyramid are developed on both sides, and grafts are placed and secured between the dorsum of the septum and the medial border of the upper lateral cartilages. Khosh *et al.* reported that 22 of 25 (88 per cent) patients with internal nasal valve dysfunction had subjective improvement of nasal obstruction following nasal valve reconstruction with spreader grafts.[20] A modification of this technique, the upper lateral splay graft, has been described by Guyuron *et al.*[21] A conchal cartilage graft is placed deep to the upper lateral cartilages via an open approach and spans the dorsal septum. The authors report that the intrinsic spring in the graft elevates the upper lateral cartilages, thus correcting the middle vault collapse and widening the internal nasal valve; however, they caution that there can be excessive widening of the nasal dorsum.

(2) The use of spreader flaps has been described by Gruber *et al.* as an alternative to the classic spreader graft technique for reconstruction of the middle third of the nose.[22] In open rhinoplasty, the upper lateral cartilage is released from the cartilaginous septum and nasal bone and rolled up on itself to create a spreader flap that is sutured to the dorsal septum. Gruber *et al.* reported that, of 21 patients who underwent the procedure, only one had an inadequate nasal width post-operatively.

(3) A spreader graft injection has recently been described for management of internal nasal valve collapse. Calcium hydroxyapatite is injected into the submucoperichondrial and/or submucosal plane at points on the upper lateral cartilage and at the junction of the dorsal septum and upper lateral cartilage, in order to lateralise and strengthen the upper lateral cartilage. Nyte has reported early successful treatment in 23 patients.[23]

(4) A conchal cartilage butterfly graft has been used by Stucker and Hoasjoe to repair the internal nasal valve: a butterfly-shaped piece of conchal cartilage was placed across the supratip area in order to

https://doi.org/10.1017/S0022215109005283 Published online by Cambridge University Press

increase resistance at the scroll area.[24] Fifty-six patients with lateral nasal wall collapse underwent the procedure. All patients reported subjective improvement in nasal airway breathing, and 53 patients reported improvement in the appearance of their nose. Stucker and Hoasjoe advocated the technique for managing severe cases of post-rhinoplasty lateral wall collapse. The technique necessitates an external approach, a second operative site and potentially significant aesthetic change to the nose. Clark and Cook have reported a similar technique for alleviation of post-rhinoplasty internal nasal valve dysfunction, involving placement of a smaller graft through a closed approach.[25] Seventy-two patients with two years' minimum follow up reported significant subjective improvement of nasal obstruction, with 70 patients (92 per cent) reporting complete resolution. Sixty-two patients (86 per cent) reported an improvement in the appearance of their nose.

(5) The use of alar batten grafts has been described by Toriumi *et al.* for internal nasal valve or external nasal valve repair.[2] A strip of cartilage shaped to span from the piriform aperture to the lateral crura is placed in a subcutaneous pocket at the point of maximum lateral nasal wall collapse, using either an open or endonasal approach. Following alar batten grafting, 45 of 46 patients experienced improvement in nasal obstruction. Initial post-operative fullness in the supra-alar region decreased with time, with a reported overall improvement in the cosmetic result. Millman undertook a retrospective review of 21 patients who had undergone alar batten grafting and reported a 100 per cent improvement in nasal obstruction, with six of the 21 reporting minor aesthetic fullness at 12 months' follow up.[13]

(6) Implants made from porous polyethylene (a non-resorbable synthetic material which permits in-growth of fibrous tissue inside and around it) are now commercially available. These implants come in a wide variety of preformed shapes and are commonly used for facial reconstruction. Such implants are available for internal nasal valve and external nasal valve collapse. For internal nasal valve collapse, a lateral implant or a porous polyethylene spreader graft can be used. For external nasal valve collapse, a porous polyethylene batten implant is available. Ramakrishnan *et al.* evaluated the long term outcome of correction of nasal valve collapse with porous polyethylene implants in 12 patients.[26] Complete resolution of nasal symptoms was reported in nine (75 per cent) patients at five year follow up. However, there was significant post-operative infection, implant extrusion (21 per cent; four of 12 patients, five of 24 implants) and need for revision surgery (42 per cent). In contrast, Gurlek *et al.* used porous polyethylene as nasal spreader grafts in 15 patients with internal nasal valve collapse, and reported neither complication nor recurrence of airway obstruction.[27]

(7) Piriform aperture surgery is another alternative for treatment of internal nasal valve collapse. Internal valve collapse due to a narrow piriform aperture is often associated with a prominent soft tissue web from the caudal edge of the upper lateral cartilage to the floor of the nose. Woodhead described removal of bone to widen the piriform aperture, combined with a Z-plasty to lengthen the web to allow the inferior nasal wall to lateralise.[28] Complications included one case of denervation of the lateral incisor. This author had a personal series of seven patients who had undergone widening of the piriform aperture, of whom five had had good results at six month follow up. One patient reported no improvement, and one reported minimal improvement with temporary numbness of the incisors.

(8) The use of nasal valve suspension was first reported by Paniello, who described a technique involving suspension of the nasal valve to the orbital rim for patients with symptomatic nasal valve collapse. The medial orbital rim is exposed through a transconjunctival incision, and sutures placed through the mucosa either side of the region of collapse are then passed deep to the facial skin and muscles and secured at the orbital rim, either to the orbital periosteum or to a fixation screw. All 12 patients in Paniello's study reported improvement in nasal breathing. Mild widening of the middle third of the nose was noted in six patients. Complications included temporary epiphora and conjunctival suture granuloma.[29] Friedman *et al.* modified Paniello's technique, utilising a skin crease incision at the infraorbital rim and a bone anchor to secure the suture.[30] Persistent partial collapse was reported in five of 86 patients; two patients required revision surgery and one patient developed an abscess. Infra-orbital fullness at the level of the bone anchor was noted, but no patients reported significant cosmetic problems.

(9) Repositioning of the upper lateral cartilages may be used in patients with internal nasal valve collapse, or those at risk of developing it following reduction rhinoplasty. Horizontal mattress bending sutures are used to allow the upper lateral cartilage to curve outwardly into the internal nasal valve area. This technique involves an external approach with placement of mattress sutures and reattachment of upper lateral cartilages to the septum to create a T-shaped configuration of the nasal vault. Ozturan *et al.* assessed the efficacy of this technique to prevent post-operative internal nasal valve collapse in patients with tension nose undergoing reduction rhinoplasty or septorhinoplasty. They reported a statistically significant post-operative improvement in the mean nasal valve angle. Patients and surgeons were satisfied with the cosmetic appearance, and no patients developed post-operative nasal obstruction. Ozturan and colleagues concluded that this method avoided post-operative nasal valve stenosis, but they did not assess its efficacy in treating established internal nasal valve collapse.[31]

External nasal valve collapse. (1) The lateral crural J flap repair for external nasal valve collapse was reported by O'Hallorhan.[15] This author proposed that external nasal valve collapse was due to weakening of the fibroareolar tissue connecting the lateral

https://doi.org/10.1017/S0022215109005283 Published online by Cambridge University Press

crus to the piriform aperture, with resultant prolapse of the lateral crura towards the septum and consequent narrowing of the nasal valve. A J-shaped, superiorly and medially based, chondrocutaneous flap is pulled laterally and caudally and excess tissue is excised, in order to correct the functional impairment as well as the cosmetic pinching deformity often associated with external nasal valve collapse. Early results showed subjective improvement in nasal airflow and improvements in cosmetic appearance, with reduced pinching. Interpretation of results is difficult as 10 patients had simultaneous septal, turbinate or sinus surgery.

(2) Repositioning of the lateral crus using a suture technique aims to produce superolateral rotation of the lateral crus, thus increasing the cross-sectional area of the nasal valve and providing additional support for the lateral wall of the nasal vestibule. The lateral crus is mobilised using a delivery technique, the piriform aperture is exposed, and a suture is placed through a drill hole in the piriform aperture and the distal part of the lateral crus. Menger reported improved nasal breathing in all seven patients undergoing this technique.[4] Minor aesthetic changes were noted, with slight upward rotation of the nostril. A similar technique used to manage external nasal valve collapse involves upward rotation of the lateral crus.[12] The lateral crus is repositioned in a pocket deep to the upper lateral cartilage and is secured with sutures. Additional resection of a cephalic strip of lower lateral cartilage reduces the likelihood of a bulky tip.

(3) Alar rim reconstruction was reported by Troell *et al.*, who described a technique to address external and internal nasal valve collapse by placement of cartilage struts in subcutaneous pockets along the inner aspect of the alar rim, in order to provide structural support to the nasal rim and valve area.[32] When adequate septal cartilage was not available, irradiated cartilage was the preferred graft material. Thirty-nine patients with a positive Cottle's manoeuvre underwent the procedure, which used homologous, irradiated costal cartilage. Eighty-seven per cent were reported to be free of obstruction post-operatively. No comment was made on the aesthetic results of the surgery. There are concerns about resorption and extrusion of homograft cartilage implants; in addition, there is the potential for transmission of infection. It is therefore preferable to use autologous cartilage whenever possible.

(4) The alar strut graft technique, initially described by Gunter and Friedman, involves the placement of a cartilage graft deep to the lower lateral cartilage.[33] Using an open approach, a mucosal pocket is created and a cartilage strut is sutured to the deep surface of the lateral crus, overlapping the piriform aperture. Kalan *et al.* assessed the functional and cosmetic results of this technique in 17 patients undergoing treatment for external nasal valve collapse.[34] At 18 months' follow up, all patients had subjective relief of nasal obstruction and were satisfied with the cosmetic result.

Conclusion

Although the functionally narrow nose is not a common problem, it presents a significant challenge when it does occur. Proper diagnosis is imperative in order to clearly establish the site of the problem; there may be more than one to address. The choice of surgical technique will depend on the causative pathology, graft material availability, surgical experience and patient choice. As reductive rhinoplasty is a common cause of internal valve collapse, thought must be given to preventing this when performing primary rhinoplasty surgery.

References

1 Wexler DB, Davidson TM. The nasal valve: a review of the anatomy, imaging and physiology. *Am J Rhinol* 2004;**18**:143–50
2 Toriumi DM, Josen J, Weinberger M, Tardy ME. Use of alar batten grafts for correction of nasal valve collapse. *Arch Otolaryngol Head Neck Surg* 1997;**123**:802–8
3 Bruintjes TD, Van Olphen SF, Hillen B, Huizing EH. A functional anatomical study of the relationship of the nasal cartilages and muscles to the nasal valve area. *Laryngosocope* 1998;**108**:1025–32
4 Menger DJ. Lateral crus pull-up. A method for collapse of the external valve. *Arch Facial Plast Surg* 2006;**8**:333–7
5 Cole P. The four components of the nasal valve. *Am J Rhinol* 2003;**17**:107–10
6 Haight JS, Cole P. The site and function of the nasal valve. *Laryngoscope* 1983;**93**:49–55
7 Kasperbauer JL, Kern EG. Nasal valve physiology: implications in nasal surgery. *Otolaryngol Clin North Am* 1987;**20**:699–719
8 Schloser RJ, Park SS. Functional nasal surgery. *Otolaryngol Clin North Am* 1999;**32**:37–51
9 Bridger GP, Proctor DF. Maximum nasal inspiratory flow and nasal resistance. *Ann Otol* 1970;**79**:481–8
10 Jones AS, Wight RG, Stevens JC, Beckingham E. The nasal valve: a physiological and clinical study. *J Laryngol Otol* 1988;**102**:1089–94
11 Grymer LF. Reduction rhinoplasty and nasal patency: change in the cross sectional area of the nose evaluated by acoustic rhinometry. *Laryngoscope* 1995;**105**:429–315
12 Nolst Trenite GJ. Nasal valve surgery: a modified Z-plasty. In: Nolst Trenite GJ, ed. *Rhinoplasty. A Practical Guide to Functional and Aesthetic Surgery of the Nose*. The Hague: Kulger Publications, 1993;75–8
13 Millman B. Alar batten grafting for management of the collapsed nasal valve. *Laryngoscope* 2002;**112**:574–9
14 Erdem T, Ozturan O, Erdem G, Akarcay M, Cem Miman M. Nasal pyriform aperture stenosis in adults. *Am J Rhinol* 2004;**18**:57–62
15 O'Halloran LR. The lateral crural J flap repair of nasal valve collapse. *Otolaryngol Head Neck Surg* 2003;**128**:640–9
16 Weiner J, Abrahamson M, Puy R. Intranasal corticosteroids versus oral H1 receptor antagonists in allergic rhinitis: systematic review of randomised controlled trials. *BMJ* 1998;**317**:1624–9
17 Roithmann R, Chapnik J, Zamel N, Menna Barreto S, Cole P. Acoustic rhinometric assessment of the nasal valve. *Am J Rhinol* 1997;**11**:379–85
18 Viaman M, Shlamkovich N, Eviatar E, Segal S. Treatment of nasal valve collapse with transcutaneous and intranasal electrical stimulation. *Ear Nose Throat J* 2004;**83**:757–62
19 Sheen JH. Spreader graft: a method of reconstructing the roof of the middle nasal vault following rhinoplasty. *Plast Reconstr Surg* 1984;**73**:230–9
20 Khosh M, Jen A, Honrado C, Pearlman S. Nasal valve reconstruction. *Arch Facial Plast Surg* 2004;**6**:167–71
21 Guyuron B, Michelow B, Englebardt C. Upper lateral splay graft. *Plast Reconstr Surg* 1998;**102**:2169–77
22 Gruber RP, Park E, Newman J, Berkowitz L, Oneal R. The spreader flap in primary rhinoplasty. *Plast Reconstr Surg* 2007;**119**:1903–10

23 Nyte C. Spreader graft injection with calcium hydroxyapatite: a non surgical technique for internal nasal valve collapse. *Laryngoscope* 2006;**116**:1291–2
24 Stucker FJ, Hoasjoe DK. Nasal reconstruction with conchal cartilage. Correcting valve and lateral nasal collapse. *Arch Otolaryngol Head Neck Surg* 1994;**120**:653–8
25 Clark J, Cook T. The butterfly graft in functional secondary rhinoplasty *Laryngoscope* 2002;**112**:1917–25
26 Ramakrisnan JB, Danner CJ, Yee SW. The use of porous polyethylene implants to correct nasal valve collapse. *Otolaryngol Head Neck Surg* 2007;**136**:357–61
27 Gurlek A, Celik M, Fariz A, Ersoz-Ozturk A, Eren AT, Tenekeci G. The use of high-density porous polyethylene as a custom-made nasal spreader graft. *Aesth Plast Surg* 2006;**30**:34–41
28 Woodhead CJ. Piriform aperture surgery for alar collapse. *Clin Otolaryngol* 1995;**20**:74–9
29 Paniello RC. Nasal valve suspension. An effective treatment for nasal valve collapse. *Arch Otolaryngol Head Neck Surg* 1996;**122**:1342–6
30 Friedman M, Ibrahim H, Syed Z. Nasal valve suspension: an improved, simplified technique for nasal valve collapse. *Laryngoscope* 2003;**113**:381–5
31 Ozturan O, Cem Miman M, Kizilay A. Bending of the upper lateral cartilages for nasal valve collapse. *Arch Facial Plast Surg* 2002;**4**:258–61
32 Troell RJ, Powell NB, Riley RW, Li KK. Evaluation of a new procedure for nasal alar rim and valve collapse: nasal alar rim reconstruction. *Otolaryngol Head Neck Surg* 2000;**122**:204–11
33 Gunter JP, Friedman RM. The lateral crural strut graft: technique and clinical applications in rhinoplasty. *Plast Reconstr Surg* 1997;**99**:943–52
34 Kalan A, Kenyon G, Seemungal T. Treatment of external nasal valve (alar rim) collapse with an alar strut. *J Laryngol Otol* 2001;**115**:788–91

Address for correspondence:
Miss H Wallace,
1 Chaly Fields,
Boston Spa LS23 6BE, UK.

E-mail: hcwallace@gmail.com

Miss H Wallace takes responsibility for the integrity of the content of the paper.
Competing interests: None declared