Nasal Valve Surgery for Nasal Obstruction: A Systematic Review

Abstract
Nasal obstruction is a common presentation at rhinology clinics. Aetiologies can widely vary from inflammatory, mechanical obstructive to structural/anatomical causes of nasal obstruction. Nasal valve collapse is a recognised cause of nasal path obstruction, whether presenting as the sole causative or as an addition to another obstructive aetiology. The identification of this cause of obstruction is essential in order to plan patients’ management.

In this article we aim to describe the anatomy, physiology and pathophysiology of the nasal valve area. Then we highlight what the commonly found surgical methods of addressing this issue in literature, and the documented outcomes.

Keywords
Alar, Collapse, Graft, Rhinoplasty, Nasal valve.

Introduction
Nasal obstruction is a common symptom seen in Rhinology clinics. The aetiology can range from physical obstruction (nasal polyps or sinonasal tumours), mucosal pathologies (rhinitis) to more structural problems such as septal deviation or nasal valve collapse. In a review of 500 patients, Elwany and Thabet found that nasal valve dysfunction has a role to play in 13% of patients complaining of nasal obstruction.1

This systematic review focuses on nasal obstruction corresponding to the nasal valve, and summarises the choices of treatments available for nasal valve problems.

Anatomy
The term ‘nasal valve’ was first coined by Mink in 1903 to describe the slit-like opening of the junction between the upper lateral cartilages (ULC) and the lower lateral cartilages (LLC).2 It has great functional and aesthetic significance and has been the subject of numerous studies.3–5 It is customary to divide the nasal valve region into internal and external nasal valves.

The internal valve is defined as the angle between the caudal border of the upper lateral cartilages (ULC) and the lower lateral cartilages (LLC). The external valve is defined as the angle between the caudal border of the lower lateral cartilages (LLC) and the inferior turbinate.
cartilage (ULC) and dorsal septum, bounded laterally by anterior end of inferior turbinate and the remaining tissues surrounding the piriform aperture. An angle of less than 10-15° can cause nasal obstruction.6 The external valve is the entrance of the nares to the internal valve, and is composed of the alar rim, lower lateral cartilage (LLC), alar lobule, and nasal sill inferiorly.7 The complete function of the nasal valve remains uncertain, but it is widely accepted as a regulator of airflow and resistance as it is the most flexible and narrowest part of the nasal airway.8

Although semantically and anatomically separate, both internal and external nasal valves are usually involved in varying degrees in cases of excessive collapse during inspiration,9 either due to weakness of the structures and / or excessive negative airway pressure during inhalation.10

According to Poiseuille’s law, airflow is proportional to the radius of the nasal passages, raised to the fourth power. Thus a small change in the angle of the valve will have a large effect on airflow and resistance of the nasal cavity. When air flows through a narrow space, it speeds up and creates an inward pressure owing to the Bernoulli principle. This will cause in-drawing of any weakened area, forming nasal valve collapse.9

The nasal valve composition includes the caudal aspect of both the ULC, with connections to the septum and piriform aperture, and the LLC, with attachment to the ULC by the scroll. The nasal alar support is composed of the lateral crura of the LLC with medial crura extension, ligamentous connections to the nasal septum and the attachment to the ULCs. Deficiencies of support of the anterior nose usually result from aging, trauma, or postoperatively from rhinoplasty procedures.10

Aetiology of nasal valve dysfunction
Factors involved in the narrowing and collapse of the nasal valve include congenital flaccidity, trauma, previous surgery and ageing.

Constriction of the internal valve is a common reason for nasal obstruction in patients who have undergone rhinoplasty.11 Predisposing factors include full thickness mucocartilaginous transaction of each ULC from the septum, over-resection of the dorsal septum or ULC and mucosal scarring with synechia in the valve region.6 Reduction rhinoplasty intrinsically decreases the nasal airway area, with Grymer reporting a decrease of the internal valve cross-sectional area by 25% and the piriform aperture by 13%.10

Ageing also brings internal valve collapse as there is weakening of the muscular and fibrous support.9 Patients with internal valve collapse typically have a ‘pinching’ appearance or medial collapse of the supra alar region.7

External valve collapse is described as collapse of the nostril margin of the nose on moderate to deep inspiration.4 It is often seen in patients with narrow nostrils, a projecting tip and thin weak sidewalls, especially after over resection of the lateral crus of LLC.9 The commonest cause of alar rim collapse is previous surgery with over resection of the cephalic margin of the LLC.13 It also occurs in patients with weak, malpositioned or strangely-shaped lateral crura which are lying in a more cephalad position than usual.13 Just superior to the inferior turbinates, cephalad to the alar lobule, and posterior to the termination of the lateral crura,
rhinoplasty approach, as it allows direct visualisation of the middle third of the nose. The grafts can be harvested from the posterior septum or concha area, and the ULC is separated from the septum in order for graft placement.

André and Islam both described a variation whereby an endonasal approach was being used and without detachment of ULC. André described placing the graft as high as possible in a subperichondrial plane. Islam cut out a window on the dorsal septum so as to house the spreader.

General agreement exists about the positive effect of spreader graft on nasal patency. Improvement rates in nasal patency range from 81% to 100% (see Table 1 for summary of results). Ingels went one step further, demonstrating that spreader grafts do not only improve nasal airway, but also widen the middle third of the nose by 6%. This was measured using Adobe Photoshop pre- and post-operatively. Reassuringly in their study of 15 patients, none of them noticed this widening.

Three studies reported on a combination of techniques: spreader and batten grafts, and spreader and flaring sutures. Schlosser and Park used spreader grafts, alar batten grafts and flaring sutures in different combinations and did not present their result separately, was therefore not included in this review. However their cadaveric study in the same paper demonstrated that the combination of spreader grafts and flaring suture has the greatest impact on cadaveric nasal airway when measured with acoustic rhinomanometry.

2. Alar batten grafts
First described by Toriumi, alar batten grafts are a workhorse technique in functional rhinoplasty for widening and strengthening the supra-alar lateral nasal wall. Typically of curved septal or auricular cartilage of 1.5-2cm in length by 4-6mm in width, it has proven to be a valid technique for the treatment of both internal and external valve collapse.

There are a myriad of techniques describe for placement of alar grafts. The approach ranges from rim or marginal

### Table 1. Summary of studies using spreader grafts - Grouped as per techniques used

<table>
<thead>
<tr>
<th>Study</th>
<th>Technique used</th>
<th>Approach</th>
<th>Outcome measures</th>
<th>Success rate</th>
<th>Complications rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ziljker 1994</td>
<td>Spreader graft</td>
<td>Open</td>
<td>Nasal patency: Subjective assessed 10 point score</td>
<td>Nasal patency: 81% improved. Mean improvement 4.1 points</td>
<td>No major complications</td>
</tr>
<tr>
<td>Stal 2000</td>
<td>Absorbable spreader (Lactosorb)</td>
<td>Not specified</td>
<td>Nasal patency &amp; aesthetic: subjective report, not specified</td>
<td>100% improved. No recurrence even though graft absorbed.</td>
<td>None</td>
</tr>
<tr>
<td>André 2004</td>
<td>Spreader graft (subperichondrial plane)</td>
<td>Endonasal</td>
<td>Nasal patency: Subjective assessed 4 pt scale</td>
<td>44% optimal, 44% improved</td>
<td>5.6% infection</td>
</tr>
<tr>
<td>Ingels 2008</td>
<td>Spreader</td>
<td>Open</td>
<td>Nasal patency &amp; Aesthetic: Subjective assessed VAS, Adobe workshop photograph analysis of dorsal width.</td>
<td>Nasal patency: mean VAS increased by 3.4 points. Mean dorsal width increased by 6%. Not noticed subjectively</td>
<td>Not documented</td>
</tr>
<tr>
<td>Scutio 1999</td>
<td>Spreader graft &amp; ULC suspension suture</td>
<td>Open</td>
<td>Nasal patency: Subjective assessed 10 point score</td>
<td>Nasal patency: 100% improved. Mean improvement 4.4 points</td>
<td>Not documented</td>
</tr>
<tr>
<td>Khosh 2004</td>
<td>Spreader, Batten or both</td>
<td>Either</td>
<td>Nasal patency &amp; aesthetic: Subjective assessed VAS, Report, not specified.</td>
<td>Nasal patency: spreader 88% improved. Batten 100%. Both 93%.</td>
<td>4% synechiae.</td>
</tr>
<tr>
<td>Faris 2005</td>
<td>Combined Spreader and Batten</td>
<td>Open</td>
<td>Nasal patency: Subjective assessed VAS. QOL: Subjective assessed 3 point scale.</td>
<td>Patency: mean improvement 55mm. QOL: mean improvement 49mm.</td>
<td>8.7% - 1 graft reabsorption 1 graft migration</td>
</tr>
</tbody>
</table>
incisions, endonasal incision or external rhinoplasty approach. More recently Deroee et al described their 2mm stab incision in the alar-facial groove and blunt dissection to create a pocket. The incision could not be recognised by plastic surgeons rating digital photographs in 86% of patients when compared with the marginal incision.27

The alar batten graft can be on-lay or under-lay in relation to the LLC, or in the alar fibro-fatty tissue caudal to the lateral crura. Some authors sutured the graft to the LLC; some left it tucked in its pocket (see summary in Table 2). In the underlay technique, care is taken to leave a strip of vestibular skin attached along the caudal border of the LLC.5, 28

Most studies used either autologous septal or auricular cartilage as graft material. Auricular cartilage can be a more superior choice as it provides better contour due to its curvature.5, 7 The graft is bevelled at the edges, and at least one side of the perichondrium is retained to minimise absorption.5, 7, 28 André et al. in their series of 27 patients found no difference in outcome concerning graft material or approached used.28

Placement of graft is at the supra-alar collapse near caudal margin of ULC for internal valve collapse, and caudal to lateral crura in external valve collapse. For the on-lay method, the main concern is aesthetic change to the nose; for the under-lay method, this may simply push the internal aspect of the lateral nasal wall inward.12

Collectively the studies showed 65% to 96% of improvement in their subjective nasal patency score. Anterior active rhinomanometry improved by 341,27 and significant improvement in NOSE score.27 Faris et al used a combination of spread and batten grafts, and showed there was significant subjective improvement of nasal patency and QOL when compared to their preoperative VAS scores. Of their patients, 96% claimed to not notice any post op change in the appearance of their nose.19 In Kalan’s study, patients’ scoring on post-operative cosmetic outcome was found to be higher than those of the surgeons.13

In 2011, Khalil et al.58 described their technique of using alar batten grafts. Alar battens were placed to overlap the junction of the ULC & LLC (scroll area). They fashioned small insertion pocket superficial to the ULC and overlying the upper half of the LLC. The batten is initially pushed cephalically to sit in the upper segment of the pocket lateral to the ULC, and then is ‘massaged’ externally downwards to overlap the upper rim of the LLC too.

They assessed outcomes using two separate cohorts using a global outcome of improvement reported by the patients and the direct post operative observations of the clinician. In their first cohort (immediate and intermediate follow-up) 98 % of patients had either complete or partial relief of their symptoms (88% and

### Table 2. Summary of techniques used in Alar Batten studies

<table>
<thead>
<tr>
<th>Study</th>
<th>Approach</th>
<th>Onlay / Underlay</th>
<th>Sutured / Tucked in</th>
<th>Outcome measures</th>
<th>Success rate</th>
<th>Complication Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Toriumi 1997</td>
<td>Either</td>
<td>Caudal to LLC, extend to piriform aperture</td>
<td>Tucked in</td>
<td>Nasal patency: subjective assessed 5 point scale</td>
<td>Patency: 98% improved, mean 2.5 points</td>
<td>2.2% - intranasal scarring</td>
</tr>
<tr>
<td>Kalan 2001</td>
<td>Open approach</td>
<td>Underlay, Graft extended to lateral of piriform aperture</td>
<td>Sutured to LLC</td>
<td>Nasal patency: subjective VAS 10 point scale, Aesthetic: VAS 10 point scale.</td>
<td>Patency: 82% improved, Aesthetic: pts scale score higher than surgeon’s</td>
<td>Not documented</td>
</tr>
<tr>
<td>Becker 2003</td>
<td>Marginal incision</td>
<td>Caudal to LLC.</td>
<td>Tucked in</td>
<td>Nasal patency: Subjective reporting. Not specified.</td>
<td>96% improved</td>
<td>Not documented</td>
</tr>
<tr>
<td>Faris 2006</td>
<td>Open approach, Combined batten &amp; spreader. Submucosal pocket cephalic to caudal of ULC</td>
<td>Overlay</td>
<td>Sutured to septum</td>
<td>Nasal patency: Subjective assessed VAS. QOL: Subjective assessed VAS, Aesthetic: Subjective assessed 3 point scale.</td>
<td>Patency: mean improvement 55mm. QOL: mean improvement 49mm.</td>
<td>8.7% - 1 graft re-absorption 1 graft migration</td>
</tr>
<tr>
<td>André 2006</td>
<td>Either. If endonasal – rim / marginal incision</td>
<td>Underlay. Graft extend to beyond piriform aperture</td>
<td>Sutured to lateral crura</td>
<td>Nasal patency: Subjective rating 4 point scale.</td>
<td>65% optimal or improved breathing, 2% worse</td>
<td>None</td>
</tr>
<tr>
<td>Cervelli 2009</td>
<td>Open approach</td>
<td>Underlay, caudal to LLC</td>
<td>Sutured to lateral crura</td>
<td>Nasal patency: subjective rating 5 pt scale. RMM, Aesthetic: Photo rating by pt and surgeon.</td>
<td>Patency: improved by 2.5 points. RMM improved by 341.</td>
<td>3.75% hypertrophic scar. 15% oedematous tip, settled down. 1.25% graft migration. 1.25% skin necrosis</td>
</tr>
<tr>
<td>Deroee 2011</td>
<td>Alar-facial stab</td>
<td>Pocket in alar fibrofatty area</td>
<td>Tucked in</td>
<td>ROE. NOSE. Aesthetic: Photos rated by surgeon</td>
<td>ROE &amp; NOSE: sig improvement. Aesthetic: 80%-86% of pts has scar that surgery can’t identified.</td>
<td>None</td>
</tr>
<tr>
<td>Khalil 2011</td>
<td>Endonasal - intercartilaginous</td>
<td>Onlay</td>
<td>Tucked in</td>
<td>Nasal patency: subjective reporting, objective assessment</td>
<td>Patency: 88% resolution, 10% modest improvement</td>
<td>8% temporary facial swelling, 6% fullness of side wall, 2% extrusion</td>
</tr>
</tbody>
</table>

RMM = Active anterior rhinomanometry; ROE=Rhinoplasty outcome evaluation instrument. NOSE= Nasal obstruction symptoms evaluation.
10% respectively). A further cohort (to assess long term outcomes) showed improvement in 94% of patients’ symptomatology (56% complete and 38% partial). From their point of view the advantages of their technique are:

1. Quick and easy to master without significant complications.
2. Performed through an endonasal approach without visible scars.
3. Positioning the graft in the scroll area minimises cosmetic deformity.
4. Suitable for the treatment of either / both external / internal valve alar collapse.

3. Alar rim reconstruction graft

Similar to the alar batten, the alar rim graft is placed closer to and parallel to the rim rather than the lateral crura. Troell et al. believed that standard alar batten does little to support the nasal rim, and inserted their graft by a vestibule incision at the junction of the nares and nasal lobule. Their study revealed a 95% reported improvement of nasal patency, compared to 75% in the alar batten graft group.

Boahene uses a smaller strip of cartilage, 15-25mm long by 2-3mm wide, and a marginal incision to insert the cartilage into the alar rim. Their study only reported photographic outcome.

4. Butterfly graft

The butterfly graft over the nasal dorsum has been used in both secondary and primary rhinoplasty for internal valve collapse. Cartilage of approximately 1x2cm in size is usually harvested from the auricular concha. The graft is inserted into a sub-SMAS plane either via endonasal or open approach. The caudal end of the graft is sutured to the caudal end of ULC.

Three studies showed improved breathing in 80% to 100% of patients. In addition, Ackam et al showed 65% patients had improved or stopped snoring. However, 12-19% were dissatisfied with the cosmetic outcome of their nose, leading to Friedman cautioning about adequate preoperative explanation and managing patients’ expectations, as maintaining an aesthetic dorsum with a butterfly graft does possess a technical learning curve. Their advice is to bevel the edges of the graft, and to place crushed cartilage over the graft and dorsum to maintain its smoothness. Eight to nineteen percent of patients are also unhappy about the outcome of the ear.

With increased experience, the conchal butterfly graft can be both functionally and cosmetically outstanding, but care should be taken to emphasise on the potential aesthetic change of the nose and ear.

Methods using Suturing

Most suturing methods aim to enlarge the narrowed valve area, with the exception of Mendelsohn’s alar expansion suture, which claimed to both enlarge and strengthen the lateral wall if used concomitantly with a cartilage graft. Park’s flaring suture was used in conjunction with spreader graft placement.

1. Nasal valve suspension suture

Paniello pioneered the nasal valve suspension suture in 1996, whereby the ULCs were suspended by placement of a permanent suture at the site of collapse and traction laterally
anchoring to the maxillary periosteum. Friedman introduced the modification where a Mitek self-retaining screw is used as an anchor. Lee used a double suspension suture and anchored to a permanent stay suture infraorbitally. André did not use a stay suture, anchoring the suspension suture directly onto periosteum of inferior orbital rim. Friedman’s 2004 paper was included in this review but not his 2003, as this consisted only a description of his method.

Subjective symptoms were improved in 71% to 100% of patients. However Nuara noted that long-term satisfaction decreased to less than half of patients when followed up for more than a year. André similarly reported modest improvement leading them to conclude that the nasal valve suspension suture is not recommended as a first line treatment for valve insufficiency.

2. Flaring suture

The flaring suture is placed through the caudal aspect of the ULC in a vertical fashion, and then passed on the contralateral side in a similar fashion. The caudal end of the ULC is typically hidden under the scroll, and the lateral crura will have to be retracted inferiorly for sufficient exposure. Tightening of the mattress suture across the dorsum will result in the ULC “flaring” laterally, increasing the angle of the internal nasal valve.

Park used the flaring suture in conjunction with spreader grafts, via an open approach. All patients in his series reported breathing improvement.

Table 3. Summary of studies using Nasal Valve Suspension Sutures.

<table>
<thead>
<tr>
<th>Authors</th>
<th>Technique used</th>
<th>Approach</th>
<th>Outcome measures</th>
<th>Success rate</th>
<th>Complication Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Panieollo 1996</td>
<td>Nasal valve suspension sutures</td>
<td>Endonasal. Transconjunctival.</td>
<td>Nasal patency: Subjective assessed 10 point scale. RMM. AR. Photographic analysis</td>
<td>Nasal patency: 100%. RMM 83%. AR 33%. Increased MCA.</td>
<td>No major complication</td>
</tr>
<tr>
<td>Lee 2001</td>
<td>Nasal valve suspension sutures – modified. Bone anchored system</td>
<td>Infraorbital incision.</td>
<td>Nasal patency: Subjective rating: 3 point scale. Photographic document.</td>
<td>100% improved. 78% feels satisfied.</td>
<td>11% minor asymmetry of eye</td>
</tr>
<tr>
<td>Friedman 2004</td>
<td>Nasal valve suspension sutures. Bone anchored system</td>
<td>Endonasal incision. Infraorbital incision.</td>
<td>Nasal patency: Subjective reported, not specified. AR in 52 patients SNOT-20 in 52 patients</td>
<td>Nasal patency: 91.7%. AR 8.3%. No improvement. AR: 94%. Improved MCA. SNOT: 84% improvement of scores. Mean post op scores sig lower.</td>
<td>6.7% Complications – persistent pain, intranasal granuloma, infraorbital abscess.</td>
</tr>
<tr>
<td>Nuara 2007</td>
<td>Nasal valve suspension suture.</td>
<td>Infraorbital incision.</td>
<td>Nasal patency: Subjective reported, not specified.</td>
<td>Nasal patency: 82% improved, where 71% reported complete resolution at 1 week.</td>
<td>24% infection. 35% loss of suspension at 6-22 months</td>
</tr>
</tbody>
</table>

AR = acoustic rhinomanometry. RMM = Active anterior rhinomanometry. MCA = Minimum cross-sectional area. SNOT = Sinu-nasal Outcome Test.

Table 4. Summary of studies using other suture techniques.

<table>
<thead>
<tr>
<th>Authors</th>
<th>Technique used</th>
<th>Approach</th>
<th>Outcome measures</th>
<th>Success rate</th>
<th>Complication Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Park 1998</td>
<td>Flaring suture (in conjunction with spreader graft)</td>
<td>Open</td>
<td>Nasal patency: Subjective reported, not specified.</td>
<td>100% improved nasal patency.</td>
<td>Not documented.</td>
</tr>
<tr>
<td>Ozturan 2002</td>
<td>Horizontal mattress suture to bend ULC</td>
<td>Open</td>
<td>Endoscopic angle measure Aesthetic: Patient assessed VAS, Surgeon assessed VAS</td>
<td>Valve angle ↑ by 16.2° Aesthetic: No difference in cosmetic outcome between patient and surgeon</td>
<td>11.2% synechia</td>
</tr>
<tr>
<td>Mendelshohn 2006</td>
<td>Lateral expansion suture</td>
<td>Open</td>
<td>Nasal patency: Subjective assessed 10 point scale. Aesthetic: Subjective assessed 3 point scale.</td>
<td>Nasal patency: 94% improvement (significant). Aesthetic: 56% better, 44% no change</td>
<td>None</td>
</tr>
<tr>
<td>Dutton 2008</td>
<td>Intranasal Z-plasty</td>
<td>Endonasal incision</td>
<td>Nasal patency: Subjective assessed 10 point scale.</td>
<td>Nasal patency: Mean improvement of post operative score of 3.92 (significant) Aesthetic: no complaint</td>
<td>None</td>
</tr>
<tr>
<td>Rizvi 2011</td>
<td>Concealed lateralising suture</td>
<td>Endonasal incision. Lateral nasal wall incision.</td>
<td>Nasal patency: Subjective assessed, not specified</td>
<td>Nasal patency: 89.9% improvement</td>
<td>10.1% failure – suture unravelled, cut through, infection.</td>
</tr>
</tbody>
</table>
3. Lateral Mattress Bending suture
Using 5-0 polypropylene, Ozturan devised a horizontal mattress suture on each ULC without entering the mucoperichondrium. The tightened mattress suture causes the ULC to convert into a convex shape, thus increasing the internal valve angle.

Using pre and post op endoscopic photos to measure the internal valve angle, they showed there was statistically significant increase from \(9.1 \pm 4.2^\circ\) to \(25.3^\circ \pm 3.8^\circ\). 11% of patients had synechia, and no patients required revision surgery.

4. Alar expansion suture
Using an external rhinoplasty approach, the alar expansion suture passes through the lateral crus of LLC into the nasal vestibule, loops back through the mucosa and lateral crus, then passes over the septum to undergo the same manoeuvre on the opposite side. Tying of this suture gently opens up the lateral crura and nasal valve. If the lateral crus buckles, the suture is removed and reinforcement batten implants are placed on each side before re-suturing again.

Ninety-four percent of patients experienced good improvement in their airway, and the improvement is statistically significant. No complications were reported.

Mendelsohn claims to address both the problems of expanding the cross-sectional area and the issue of dynamic collapse by having a combination method of suturing plus grafting.

5. Z-plasty
Dutton described a Z-plasty based on an intercartilaginous incision as the central incision of the Z. Elevating the vestibule skin and transposing the anterior and posterior triangular flaps, this aims to increase the area of the valve region. They found improvement of mean post-operative scoring, which is significant.40 This technique is minimally invasive, no foreign body as valve suspension, but conceptually and technically can be challenging and require experience to master.

6. Concealed Lateralising Suture Technique
This is a variation of the nasal valve suspension suture. Rizvi and Gauthier improvised this technique to making a stab incision over the nasal bone laterally, anterior and inferior to the medial canthus. An endonasal intercartilaginous incision is also made. A 3/0 prolene suture is passed from the external incision under the SMAS layer, piercing the ULC, before looping back lateral to the ULC and emerging externally again inferior to the medial canthus.

They reported 10 year results in their later paper.42 The reported complete satisfaction rate was 89.9% with the improvement in their nasal airway. A 10.1% failure rate was due to the suture cutting through the ULC, unravelling, or to an infection.

Methods Involving Excision or Transposition

1. The J-flap
O’Halloran believes it is the loosening of the fibroareolar tissue lateral to the nasal valve that causes the prolapse of the lateral
implants as alar batten grafts, and pre-soaked the implants in Ramakrishnan et al. used prefashioned porous polyethylene

Methods using Implants

reported subjective improvement in nasal patency.

The outcome measures were not specified, but all patients

valve angle. He reported on 27 and 5 patients in each series.

and lateralises away from the septum, creating a wider internal

hydroxylapatite

Nyte reported his injection technique using calcium

increase in nasal flow in active anterior rhinomanometry.

reporting improved nasal patency, with statistically significant

of the ULC by postoperative scars which functioned to pull open

Kantas et al. explained that this technique resulted in strengthening

was exposed and a 2-3mm strip was excised off its caudal edge.

Using an incision at the caudal edge of ULC, dissection was

spread ofer the lateral crura to over and sutured in place.

Figure 12.

The J Flap

y

y

y

superior aspect of the medial ULC

2-3mm cephalic to the internal valve apex on the

surface of ULC

3-4mm from apex of internal valve on caudal medial

surface of ULC

1-2mm from apex of internal valve on caudal medial

surface of ULC

Alar batten grafts provide support to the lateral

aid in repositioning the ULCs, but fail to support the lateral

nasal walls. Alar batten grafts provide support to the lateral

nasal walls; they do not widen the middle vault. Butterfly

nasal walls. Alar batten grafts provide support to the lateral

narrowing of the nasal vault, but the technique frequently requires an open

approach and conchal cartilage harvesting, carrying a risk of cosmetic dissatisfaction. Upper lateral suspension procedure

is technically demanding and requires special equipment and

infra orbital incision. Some suture techniques (flare suture,

lateral expansion suture) claimed to be able to both widen

anterior rhinomanometry.

2. Excising ULC caudal edge

Using an incision at the caudal edge of ULC, dissection was
carried out on the supra and infraperichondrial plane. The ULC
was exposed and a 2-3mm strip was excised off its caudal edge.
Kantas et al. explained that this technique resulted in strengthening of the ULC by postoperative scars which functioned to pull open the nasal valve edge.\(^46\) Their results showed 65.1% of patient reporting improved nasal patency, with statistically significant increase in nasal flow in active anterior rhinomanometry.

3. Transposition\(^46\)

Armengot et al. proposed transposing the inferior edge of ULC from under the lateral crura to over and sutured in place.

Methods using Injections

Nyte reported his injection technique using calcium hydroxylapatite\(^49\) and hyaluronic acid\(^47\) to simulate the effect of spreader graft. The injections are performed under local anaesthetic and direct vision, in a submucoperichondrial and / or submucosal plane. The 3 points of injection proposed were:

- 1-2mm from apex of internal valve on caudal medial

surface of ULC

- 3-4mm from apex of internal valve on caudal medial

surface of ULC

- 2-3mm cephalic to the internal valve apex on the

superior aspect of the medial ULC

The ULC becomes supported with the injection material,
and lateralises away from the septum, creating a wider internal
valve angle. He reported on 27 and 5 patients in each series.
The outcome measures were not specified, but all patients
reported subjective improvement in nasal patency.

Methods using Implants

Ramakrishnan et al. used prefashioned porous polyethylene implants as alar batten grafts, and pre-soaked the implants in antibiotics.\(^48\) Turegan et al. fashioned a thin sheet of porous polyethylene into a saddle shape akin a conchal butterfly graft to correct dorsal deformity and internal valve collapse.\(^6\) Both groups demonstrated complete improvement in nasal patency as reported by patients; however 21% experienced extrusion and 17% infection in the former study.

Conclusion

Nasal valve insufficiency is a common cause of nasal airway obstruction, and can be a multidimensional problem. In some patients, a reduced cross-sectional area or an acute valve angle of less than 10° is the main cause. In others, it is the weak nasal sidewall causing their symptoms. Many techniques have been devised to correct the functional and cosmetic aspects of this problem, as summarised above. The aim of these techniques was to broaden the internal valve, and re-establish the stiffness of the lateral nasal wall, in an attempt to improve airflow at this area.

A thorough preoperative assessment is important to determine the cause of the nasal obstruction; this should include the static and dynamic structures. Septal deviation and nasal polyps aside, the angle of the internal valve and the state of the lateral nasal wall during dynamic inspiration should be assessed. Most authors from this review used the Cottle’s manoeuvre to assess alar obstruction, however there is concern that this can be non-specific as it enhances breathing even when nasal obstruction is a consequence of septum deviation or turbinate enlargement.\(^17\) Many also suggested tenting of the valve area internally with either a cotton-tip applicator or an ear curette, to more reliably determine the exact site of the obstruction. There is global emphasis on the importance of a detailed history of nasal symptoms and previous nasal surgery / trauma, Nasal medication and atopic state (including results of objective tests).\(^36\) Ideally, Patients who were considered for surgery should have had already optimum medical therapy to their nasal symptoms without a satisfactory relief.\(^50\)

The main aims of surgery to the nasal valves are threefold:\(^43\)

1. Increasing the septo-lateral angle if it was diminished

2. Stabilizing the free edge of the ULC to avoid its collapse

3. Strengthening the ULC and alar cartilages and increase resistance to negative pressure during inhalation.

The key in treating nasal valve obstruction is in the correct pre-operative diagnosis. Apart from differentiating between external and internal valve narrowing, it is also paramount to decide whether the valvular insufficiency arose from a static or dynamic cause. This will serve to guide treatment plan, as to whether a widening or strengthening solution is needed.

Most of the techniques above work only to solve one problem. Spreader grafts widen the middle nasal vault and aid in repositioning the ULCs, but fail to support the lateral nasal walls. Alar batten grafts provide support to the lateral nasal walls; they do not widen the middle vault. Butterfly grafts are useful for relieving obstruction of the middle nasal vault, but the technique frequently requires an open approach and conchal cartilage harvesting, carrying a risk of cosmetic dissatisfaction. Upper lateral suspension procedure is technically demanding and requires special equipment and infra orbital incision. Some suture techniques (flare suture, lateral expansion suture) claimed to be able to both widen
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and support the nasal valve. However it is possible that a combination of techniques may be necessary in some cases. The last consideration is the approach used, and the pre-operative counselling of patients. Many techniques had favoured an open approach, as it provides good access to the cartilage framework, but this leaves an external scar. Cartilage grafts used may also produce cosmetic alterations. Patients will need proper and detail explanation and counselling if unexpected post-operative disappointment is to be avoided.

Declaration of competing interests
Nothing to declare.

References