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My Surgery of the nasal valve

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Abstract. We discuss the physiopathology and relevant anatomy of the nasal valves – internal and external – paying particular attention to the dynamics of the airflows in this area. We describe and comment on methods for medical examination, anterior rhinoscopy, endoscopy and fibrescopy of the valve, as well as the causes and sites of nasal valve dysfunction. We propose a review of the various treatments, medical and surgical, with a special emphasis on nasal valve surgery. Surgical techniques commonly used by the authors in daily practice for nasal valvuloplasty (such as spreader grafts and Z-plasty of the nostrils) are discussed and illustrated in depth. Some one-year postoperative results are presented and discussed.

Introduction

The nose is responsible for almost two-thirds of the resistance to airflow in the respiratory airways. Most of this resistance is located in the anterior part of the nose – in the nasal valve – which acts as a flow limiter.

In 1903, Mink[1] was the first to describe this area, which is divided into internal and external zones. The external nasal valves result from the junction of the columella, which is medially situated, and from – laterally on both sides – the floor of the nostril and the caudal rim of the nasal wing. The internal nasal valve accounts in normal breathing subjects for most – once again about two-thirds – of nasal resistance. Anatomically, it is the narrowest part of the nose and is often referred to as the nasal valve.

The speed of the airflow during inspiration is at its highest in this area, especially in the isthmus nasi, along the septum itself and the foot of the septum. As a result, the suction effect due to Bernoulli's law – which regulates the relationship between the speed of a fluid in a tube and the interaction of this circulating fluid on the walls of the tube – creates a depression that exerts an attraction medially on the sides of the nostrils. For horizontal fluid flow, Bernoulli's equation states that pressure is reduced where the cross-sectional area is narrower. This means that the higher the speed, the stronger the suction effect.

This situation, which could lead to full alar collapse, is normally counterbalanced by opposing forces that keep the nostrils open: e.g. elasticity of the cartilages of the nasal pyramid, and the contraction of the dilatator nasi muscles. These muscles contract in a reflex during the inspiration period of the ventilation process (Figure 1). Electromyographic recordings in subjects breathing through both nostrils demonstrated a gradation of inspiratory alar dilator muscle activity with increased ventilation and with no evidence of inspiratory alar collapse. However, when the alar muscles were paralysed with lidocaine blocking of the facial nerve, alar collapse did occur.[2]

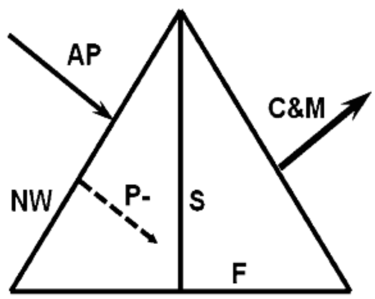

Figure 1
Forces in the valve area during inspiration. AP: Atmospheric Pressure. P-: Negative Pressure (suction effect). C&M: Counteraction of Cartilage elasticity and synchronous Muscle contraction. NW: Nasal Wing. S: Septum. F: Floor.

In the nasal valve, the aperture between the nasal septum and the caudal border of the upper lateral cartilage (ULC) or septolateral

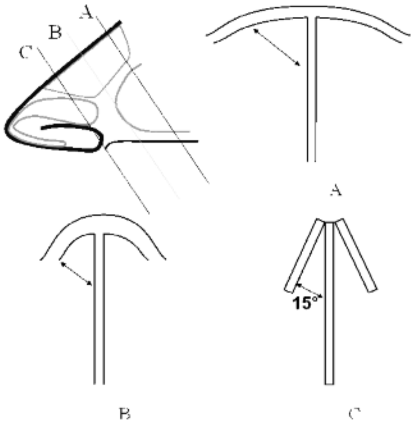

Figure 2
Aperture of angles in A, B and C sections are different. In C, the angle is about 15°.

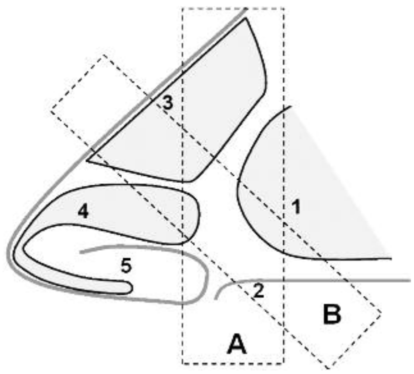

Figure 3
1: Head of the inferior turbinate. 2: Floor of the nasal fossa. 3: Upper lateral cartilage (triangular cartilage). 4: Lower lateral cartilage (crus lateralis). 5: Columella and crus mesialis. Sections following A or B always include the five components of the valve area. Medially, the septum and the nasal spine have to be added.

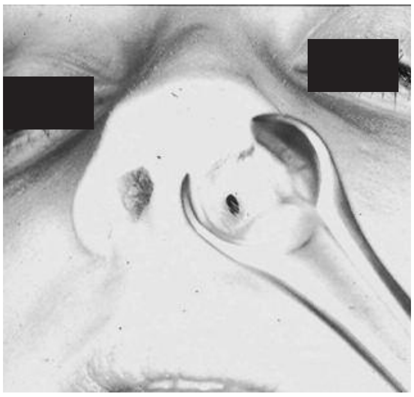

Figure 4
Stenosis of the left external valve due to a dog biting in a young lady.

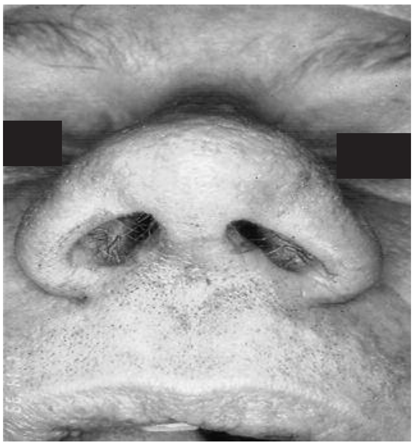

Figure 5
Moderate rhinophyma induces nasal obstruction by closing partially the nostrils.

cartilage has an opening angle of approximately 10-15° (Figure 2).

There are several ways to describe the anatomical structures involved in the valve area (Figure 3, sections A & B). Every approach includes the nasal septum, the nasal spine, the caudal border of the ULC, the head of the inferior turbinate, and the pyriform aperture and the tissues that surround it as parts of a kind of a "chicane" through which the airflow has to find its way to enter the nasal fossa.

Each one of those structures can influence and disturb the incoming airflow.

Historical background

Mink developed his concept further in 1920, suggesting that the greatest area of resistance was in the limen nasi, which is the union of the lobular cartilage and ULCs.

In 1970, Bridger and Proctor[3] wrote about a "flow-limiting segment" that included the limen nasi and the pyriform aperture. In 1983, Haight and Cole[2] continued Bridger and Proctor's studies and demonstrated that maximum nasal resistance was located near the pyriform aperture and that it may depend on vasodilatation in the head of the inferior turbinate.

Causes of nasal obstruction arising from the valve

External nasal valve obstruction or collapse can be found in patients with a history of trauma (Figure 4) or surgery but such a condition may also occur without a history of this kind. These patients commonly present with an over-projected nose with very narrow nostrils. In some rare cases, one finds an extremely wide columella.

Very thick wings are encountered in many cases of rhinophyma, in which expanding volume may close the nostrils, at least partially. It can also weigh down the ULCs medially, reducing or closing the angle of the isthmus nasi (Figure 5).

Internal nasal valve obstruction can be broken down according to the structure or the function responsible for the collapse or nasal obstruction (Table 1). In many cases, more than one structure or function is affected. The most common cause is probably septal deviation, as seen in the image below (Figure 6). The second cause is collapse secondary to rhinological surgery, especially after the removal of the nasal roof in reduction rhinoplasty. Khosh *et al.*[4] found, in 53 patients, the following causes of nasal valve collapse: previous rhinoplasty

Table 1
Internal nasal valve pathology

Abnormality	Cause and site	Aetiology	Suggested treatment(s)
Deviations of the nasal septum	Lower and superior edge deviations Crocked nose Full deviation	Surgery, Trauma, Idiopathic	Septoplasty Rhinoseptoplasty Spreader grafts
Narrowing or closure of the angle of the isthmus nasi	Over-long upper lateral cartilages Hypertrophic scroll Large sesamoid cartilages Paradoxical curvature of the lower lateral cartilage Tension noses Over-projected narrow nose	Idiopathic Trauma, Idiopathic Idiopathic	Spreader grafts Sesamoids and scroll removal Upside down self grafting of the lower lateral (reverse grafting) CO^2 laser bending Septoplasty Reduction rhinoseptoplasty
Deviation of the columella (Figure 6)	Septum foot Nasal spine hypertrophy Both very common	Idiopathic, Trauma	Caudal septoplasty Careful partial spine removal
Procidence and hypertrophy of the lower turbinal head	Inflammation Hypertrophic rhinitis	Allergy, infection Alpha-adrenergic local medication abuse	Medical when appropriate Surgical (turbinoplasty)
Weakness of the lower lateral cartilages	Iatrogenic over-resection during tip surgery Idiopathic weakness of the cartilages	Iatrogenic surgery Idiopathic ageing	Alar batten grafts Conchal cartilage partial or full grafts Alar batten grafts Z-plasty of the nostrils
Scars and stenosis in the valve (Figure 6B)	Variable location Rarely full stenosis	Surgery (Figure 7), trauma Chemical cautery Biting	Surgery Scar removal, Z-Plasty Free skin grafting
Narrow vestibular roof "Soft nose"	Dorsum over-resection Rhinophyma (Figure 5)	Iatrogenic surgery Dermatological disease	Spreader grafts Medical when appropriate CO^2 laser surgery
"Narrow nose"	Narrow pyriform aperture (osseous) Very narrow floor of the nostrils (soft tissues)	Idiopathic Idiopathic	Surgical enlargement in a degloving approach Z-Plasty of the nostrils
Neural pathologies	Paralytic alar collapse Lack of coordination of muscle contraction	Facial palsy Parkinson's disease	Medical when appropriate Surgical

(79%), nasal trauma (15%), and congenital anomaly (6%).

Table 1 summarises the causes and sites of nasal valve dysfunctions, and their common treatments or the "suggested" treatments – mainly surgical – we are used to perform. When necessary, multiple surgical techniques be used in the same case when multiple abnormalities are present at the same time.

Because it is the narrowest part of the nose, the nasal valve can be affected by minute alterations in the nasal anatomy that would not be important in other areas of the nasal fossae.

When there is total closure of the angle between the septum and upper lateral cartilage, we use the term "virtual isthmus nasi".

Septum

Deviations of the caudal edge of the septum are the most common cause of alar collapse and of valve dysfunction. They are secondary to trauma and iatrogenic surgery, or idiopathic, or caused by a disturbance in the growth of the septum. The septum can be overly thick in the valve area.

Paradoxically, an absence of cartilage in this area due to local over-resection of the septum leaves a flaccid septum that can move like a flag during inspiration.

Upper lateral cartilage

Long and/or thick cartilage can compromise an adequate aperture. The cartilage can also be twisted, deflected, paradoxically bent, or associated with excessive inversion (scroll) of the caudal border.[5] Abundant and large sesamoid cartilages at the junction of the upper

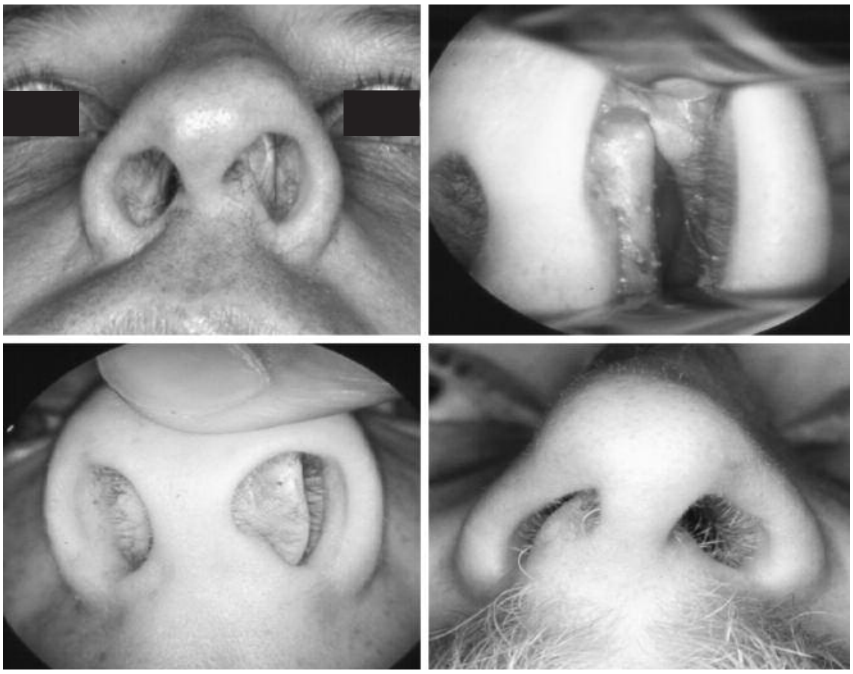

Figure 6
Common deformities of the septum and the columella. A and C: posttraumatic deviations to the left. Note that the foot of the crus mesialis is attracted by the caudal deviation of the septum. B: Protruding remnants of caudal cartilage and hypertrophic scars after incision for septoplasty. D: Wide columella deviated to the right due to hypertrophy of the left side of the anterior nasal spine of the maxillary bone.

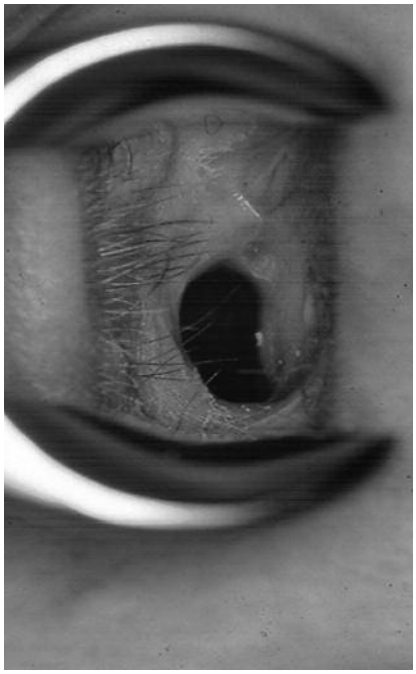

Figure 7
Heavy iatrogenic scars in the isthmus nasi area due to inadequate rhinoplasty that was corrected by a free mucosal graft harvested from the mouth.

and lower cartilages also frequently result in virtual isthmus nasi. A lack of cartilage, either congenital or iatrogenic, can produce a flaccid valve that collapses during inspiration.

Lower lateral cartilage

Over-resection during rhinoplasty can weaken the cartilage and cause pinching and inspiratory collapse.

Ageing is also a cause of weakening of the tissues.

Deformation of the cartilage can result from trauma or congenital malformations of the cartilage.

Inferior turbinate

Hypertrophy of the inferior turbinate, the head of which enters the valve area, can also significantly increase nasal resistance.[2] By comparison, the body and tail of the lower turbinate play minor roles in nasal resistance. The hypertrophy can be due to mucosal inflammation or, more rarely, to hypertrophy of the bony turbinal lamella.

Mucosa and skin

Trauma or previous iatrogenic surgery or cautery (chemical) can create webs in the valve area (Figure 7). The tissue can also be too thick, reducing the lumen of the valve.

This can be a result of inflammation or hypertrophy in inflammatory diseases.

Pyriform aperture

Although this is not common, some patients may have deformities of the pyriform aperture that reduce the size of the nasal valve. Brown et al. were the first to describe congenital stenosis of the pyriform aperture in 1989.[6] Other reports have followed.[7]

Lateral osteotomies are a more common cause of obstruction, more precisely the "low-to-low" lateral osteotomies.[8,9]

Hump removal in reduction rhinoplasty

Rhinoplasties can frequently disturb the valve. When the hump is very large, its removal may disrupt the ULCs from the septal border in the "T-shaped" area.[10,11] Resection of the T-shaped (Figure 2, section B) area of the dorsal border of the septum often produces a narrower area in the roof. The mucosa has to be protected during surgery to avoid webbing of the valve.

Clinical presentation

Patients mainly complain of nasal obstruction and, less frequently, of some crusting locally and some epistaxis, especially when associated with septal deviation.

The Cottle manoeuvre allows for the reasonable evaluation of valve dysfunction. The cheek is pulled laterally with 1-2 fingers in order to open the valve. The patient is asked to breathe and to state whether breathing improves. Very often, patients do the Cottle manoeuvre by themselves and frequently report the results to the physician.

During conventional anterior rhinoscopy using a nasal speculum, the shape of the nasal valve is definitely disturbed, even if the examination is performed by very expert hands. Diagnosis can be difficult if the physician does not visualise the valve properly. The use of an endoscope or a fiberscope prevents the distortion of the valve and allows for a perfect evaluation of the area.

Work-up

CT scanning is expensive and should not be considered a substitute for a comprehensive physical examination.

Anterior and posterior active rhinomanometry, when substracting the two curves, can be used to measure the resistive value of the nasal valve.[12]

Acoustic rhinometry provides information about the cross-sectional area of the nose. Results from the anterior portion of the nose are more accurate than results from the posterior portion, making this test particularly suitable for evaluating the valve and particularly the symmetry of both valve areas.[13]

Treatment

Medical Treatment

Inflammation of the mucosa covering the valve (secondary to allergic rhinitis or infection, for example) has to be treated adequately.[14]

Surgical Treatment

Several techniques are used to correct a stenotic or collapsed nasal valve (Table 1). Depending on the type of pathology, the surgeon can opt to use one method or to combine several methods.[4,15-22] The techniques range from sutures to the application of grafts. The common goal is the opening of the valve, restoring the appropriate local anatomy and removing webs and scars. We generally treat rhinophyma with the CO_2 laser as described by Shapshay and al. in 1980.[23]

A detailed explanation of each technique is beyond the scope of this article.

So we will be concentrating on, and discussing in more detail, three techniques we use several times each week as routine procedures. When indicated, a conventional septoplasty and/or a reduction of the 5 to 7 first millimetres of the lower turbinal heads and/or outfracture of the inferior turbinate are also performed.

Spreader grafts

Originally described by Sheen for the reconstruction of the roof of the middle nasal vault following rhinoplasty, this technique became very popular for correcting valve insufficiency.[16,24]

The goal is to widen the cross-sectional area of the nasal valve in the critical area of the isthmus nasi in an attempt to reshape its opening to a regular aperture angle of 10 to 15 degrees. The technique also allows for the strengthening of the cephalic edge of the septal cartilage in a straight position during the same steps. This is very useful in rhinoplasties to correct crocked and twisted noses.

Rhinoseptoplasty is performed in an open approach under general anaesthesia. Grafts are usually harvested from the septal cartilage. When there is not enough cartilaginous material for grafting from the septum, as may be the case in revision surgery after previous septal surgery, or a history of septal abscess, pieces of cartilage from the auricle can be used, usually from the concha. Pieces of cartilage are trimmed to an adequate size depending on the corrections to be achieved from the functional and aesthetic points of view. The maximum length (Figure 8) is about 18 millimetres (for example the length of the inner edge of the upper lateral cartilage). We recommend not using grafts shorter than 5 to 6 millimetres in order to prevent instability of the graft after suturing to the septum. The key point in functional correction is to have a piece of graft at least 3 millimetres up and 3 millimetres down to the caudal edge of the upper

Figure 8
Size of the cartilage grafts from the septum.

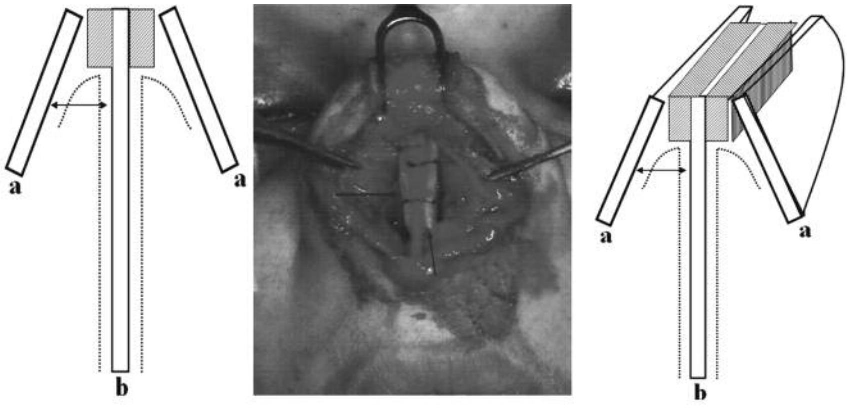

Figure 9
Spreader graft (blue arrows and grey shading) are set in place and sutured to the septum (b) with non-resorbable 5O in order to widen the isthmus nasi angle opening. ULCs (a) are held in forceps on the picture and will be sutured together.

lateral cartilage at its insertion in the septum (Figure 9). ULCs are sectioned from the septum to the nasal bones at the highest point and grafts are put into place and sutured with permanent 5O stitches. The ULCs are then sutured overall with permanent 5O. The aesthetic goals are achieved in the same procedure in accordance with pre-operative computer morphing.

The steps in the surgical procedure are summarised in Table 2. Patient examples are shown in Figures 10 and 11, with pre-operative pictures and post-operative results pictured one year after open rhinoseptoplasty. These results provide an excellent balance between functional and aesthetic results.

Conchal cartilage butterfly grafts

This graft was found useful by Friedman and Cook[15] in primary rhinoplasty. It has been used traditionally for secondary surgery when too much ULC has been resected. The technique involves removing a piece of conchal cartilage, trimming it to the size of the dorsal defect, and bevelling the border to smooth the contour of the dorsum. It is applied through an intercartilaginous incision over the ULCs or through an open approach when necessary. The concave side of the conchal cartilage faces the ULCs. So the upward pull of the two graft ends opens the valves like a spring.

Table 2
Steps in the surgical procedure

1. Open approach
2. Graft harvesting and sizing
3. Setup, fixation and suture of the upper lateral cartilages
4. Suture of the skin and mucosa and gauze packing
5. Dressing and cast

Z-Plasty of the nostrils

This technique can be performed easily under local anaesthesia in day-case surgery (Figure 12) and is therefore particularly helpful in cases of contra-indication for general anaesthesia and also in elderly people, who are generally less eager about perfect aesthetic results.

It can also be useful as a rescue technique when other techniques fail or fail to achieve good functional results. The main result is a very wide opening of the nostrils from the floor, which has to be explained very carefully to the patient and demonstrated by pre-operative morphing.

Discussion

Functional surgery of the nasal valve very often implies aesthetic modifications. It must therefore comply with the same rules that apply to purely aesthetic rhinoplasty. We suggest that, as with conventional rhinoplasty, the aesthetic project should be discussed in extensive with the patients, with the help of pre-operative photography or computerised morphing. This is obviously of the greatest importance when the patient is asking for aesthetic modifications to complement the functional surgery. In these cases, one should always keep in mind that the first goal of the surgery is functional and therefore temper aesthetic over-expectations from the patient that could compromise function restoration.

A good balance between aesthetics and function is necessary. So the surgeon for both aspects of the procedure must have a comprehensive knowledge of the

Figure 10
Pre-operative pictures (above) and post-operative results one year after open rhinoseptoplasty in a case of crocked nose (A) in a young male subject. Note the septal deviation (dotted line) which was corrected by spreader grafts together with the valve dysfunction.

Figure 11
Pre-operative picture (above) and post-operative (below) results with spreader grafts in a young lady. The tip profile was reshaped using the McCullough technique. Note the moderate enlargement of the middle third due to the grafting.

Figure 12
Z-Plasty of the nostrils (steps clockwise starting in the upper left picture).

principles of rhinoplasty. In other words, there should not be a simple juxtaposition of separate functional and aesthetic surgical procedures.

Conclusions

Functional surgery of the nasal valve is difficult because normal breathing function depends on millimetre tolerances. Long and precise training in the functional surgery of the nose and in rhinoplasty, including the open approach, is certainly necessary. A correct and full diagnosis of abnormalities and the concomitant pathologies – surgery without adequate treatment for allergy would, for example, be absurd in allergic patients – is needed prior to surgery, with a careful examination of the nose using endoscopy or fibrescopy of the nose and the valve area. A comprehensive workup is also required, with active anterior and posterior rhinomanometry and acoustic rhinometry to complement the physical examination.

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