



Review Article

Septoplasty alone is not suitable for most structural nasal obstructions

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Abstract Septoplasty is widely used in the treatment of structural nasal obstructions, and it also has a good effect and a high degree of postoperative satisfaction. However, there a large number of structures demonstrate abnormalities related to structural nasal obstruction, including the external nose, maxilla, nasal cavity and paranasal sinus. Nasal septum deviation is only one signs of structural nasal obstruction and does not represent all possible structural abnormalities of the nasal cavity and its surrounding structure. Septoplasty is only performed to correct deviations of the nasal septum, which in many cases is obviously insufficient in restoring the symmetry of the nasal structure. Therefore, septoplasty alone is not suitable for the treatment of most structural nasal obstructions. Nasal ventilation expansion surgery, which typically covers more abnormal structural correction procedures than septoplasty, should be used when describing the treatment of structural nasal obstruction.

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Introduction

The nasal cavity performs important physiological functions, including warming, humidification, and filtering of the ventilated air, ciliary clearance, immunologic defence, and olfaction.¹ Normal nasal structure and anatomical morphology play an important role in maintaining normal nasal function. Structural abnormalities of the nasal cavity and its surrounding structure can lead to changes in airflow dynamics and nasal resistance known as structural nasal obstruction, which affects the ventilation, temperature regulation and humidification functions of the nasal cavity.

Septoplasty is widely used in the treatment of structural nasal obstruction. A large number of studies have shown that septoplasty has a good effect^{2,3}; van Egmond et al⁴ performed a randomized controlled trial (RCT) in this field and showed that septoplasty is more effective than nonsurgical management for nasal obstruction in adults with a septal deviation. However, there is some scientific understanding that I would like to emphasize. According to an analysis of structural nasal obstruction and nasal structural abnormalities, both the nasal cavity and its surrounding structures (including bone and soft tissue) can be structurally abnormal, resulting in structural nasal obstruction; thus, nasal septum deviation is only one of a number of main structural abnormalities. Therefore, it is necessary to recategorize functional septoplasty.⁵ Currently, a more accurate surgical name is needed to better generalize surgical procedures used to treat structural nasal obstruction while reflecting the purpose of the operation. The definition of nasal ventilation expansion surgery (NVES) can cover additional abnormal structural correction procedures and would not be limited to septoplasty.¹ NVES can be used to replace septoplasty when describing the treatment of structural nasal obstruction.

Nasal septum deviation is only one nasal anatomical abnormality that causes structural nasal obstruction

Nasal obstruction is the most common complaint in nasal clinics and seriously affects the quality of life of patients.^{6,7} Nasal obstruction may be acute or chronic, and can be caused by a variety of conditions, including rhinitis, chronic rhinosinusitis with or without nasal polyposis, medications, neoplasms and anatomical abnormalities.^{6,8} Patients with chronic nasal obstruction often have anatomical abnormalities of the nasal cavity and its surrounding structures. Nasal septum deviation (NSD) is the most common structural anomaly of the nasal cavity.⁹ However, some structural nasal obstruction patients may not present with deviation of the nasal septum. As a result of nasal development and nasal trauma, the structural changes in the nasal cavity and nasal sinuses can be very extensive^{1,10,11}; abnormalities of the nasal valve are due to deformities of the external nasal cartilage bracket (Fig. 1 and Fig. 2), and a series of changes can occur in different parts of the nasal cavity structure, including the middle turbinate, inferior turbinate, nasal septum, anterior ethmoidal complex and uncinata process.^{8,10,12} Moreover, these structural changes

may result in asymmetry between the sides of the nasal cavity, a decrease in total nasal ventilation, and, eventually, structural nasal obstruction. Hence, for patients complaining of nasal obstruction, all nasal structures that may contribute to the symptoms shown must be separately and carefully assessed to establish an appropriate treatment plan and thereby minimize the failure rate of surgery.⁹ Most of the time, NSD is one of a number of abnormal structures in structural nasal obstruction, not the only one. Rather than NSD, structural nasal obstruction should be considered the true disease in this case.

For patients with structural nasal obstruction, the objective evaluation of NSD is still difficult,¹³ especially because it is difficult to accurately determine the importance of NSD in the aetiology of the structural nasal obstruction. Anterior rhinoscopy and nasal endoscopy are considered the gold standards for the evaluation of NSD; however, these methods depend on the clinician's experience.¹⁴ In addition, the examiner's judgement of the precise location, deviation angle, and clinical impact on the patient of NSD can also be variable. Rhinomanometry and acoustic rhinometry have shown high sensitivity in assessing anterior NSD, whereas estimation of the deep septal deviations appear to be less accurate.¹⁴ Peak nasal inspiratory flowmetry (PNIF) has significant power to discriminate pathologic from healthy subjects.¹⁵ However, PNIF is unable to locate the narrowest point of the nasal obstruction. It is also influenced by collapsibility of the nasal valve. Andrews et al¹³ further demonstrated that PNIF does not correlate with the SNOT-22 disease-specific questionnaire. A national survey in the United Kingdom also showed that only 2% of respondents routinely used an objective assessment tool to evaluate nasal airflow/patency preoperatively.⁵ However, most patients with chronic nasal obstruction underwent clinical photography prior to undergoing surgery,⁵ because CT scans can provide a good means to understand the structural abnormalities of the nasal cavity and paranasal sinuses in patients with chronic nasal obstruction. Nevertheless, the angle of the NSD in the CT morphology was also unable to predict the severity of the nasal obstruction.¹⁴ This result once again shows the unparallel relationship between NSD and nasal obstruction. Therefore, we need to comprehensively evaluate nasal structural abnormalities in patients with nasal obstruction, not just those of the septal deviation.^{9,12}

Because the nasal structure varies greatly among different individuals,¹¹ it is necessary to individually evaluate abnormal nasal structures on a per patient basis. However, for a particular patient, what structural changes are considered abnormal? Which structures need to be modified? At present, there is no exact indicator for making these judgments. The complexity of structural factors that underly nasal obstruction may also affect the formation of an international consensus on the treatment of NSD.¹⁶ The causes of nasal obstruction must be carefully analysed before a diagnosis of structural nasal obstruction can be made (Fig. 1).¹⁷ Overall, the nasal structure needs to be evaluated on both sides in four aspects: (1) the external nasal morphology⁹; (2) the nasal valve, nasal septum and nasal turbinate (including the superior, middle and inferior turbinate)^{14,18,19}; (3) the anterior ethmoid complex (including the agger nasi cells and ethmoidal bulla) and

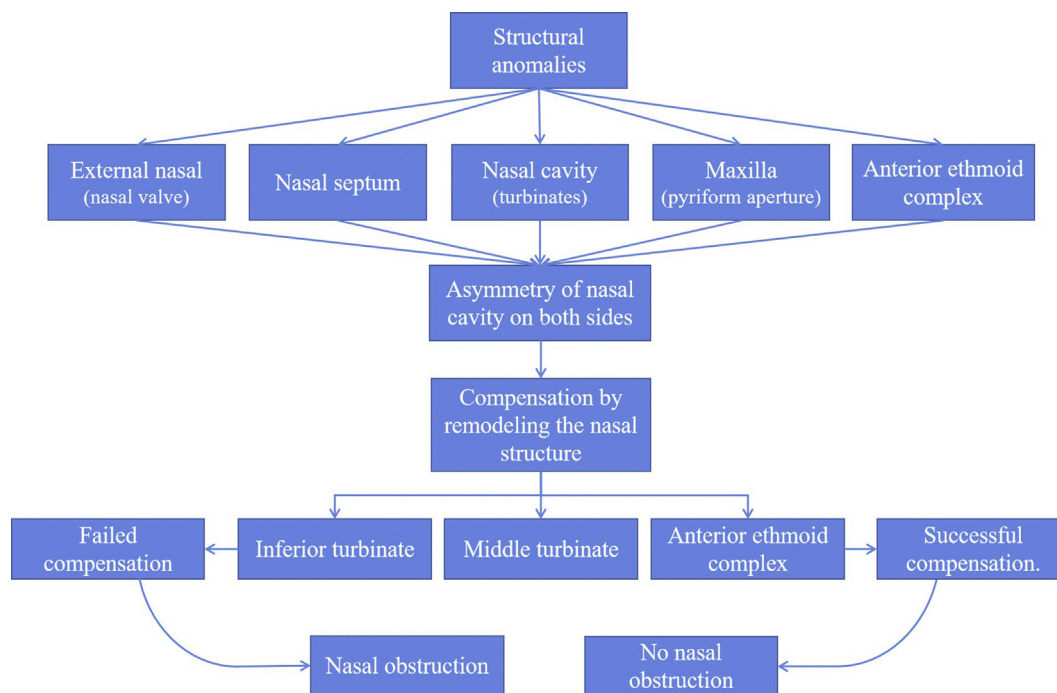


Fig. 1 Aetiological derivation of structural nasal obstruction. Structural abnormalities of the external nasal morphology, nasal septum, nasal cavity, maxilla and anterior ethmoid complex, which cause remodelling (compensation) of the nasal structure (including the inferior turbinate, middle turbinate and anterior ethmoid complex). Failed compensation leads to structural nasal obstruction. Nasal septum deviation is only one of a number of structural anomalies in structural nasal obstruction.

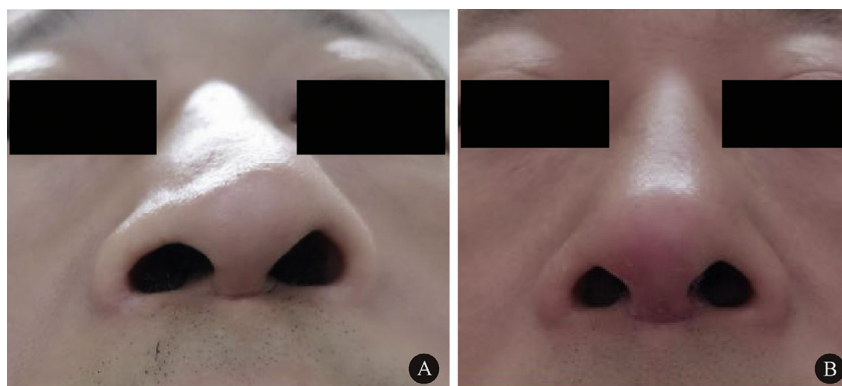


Fig. 2 A patient with external nostril stenosis caused by cartilage bracket malformation (Fig. 2A) and the shape of the external nose after external rhinoplasty (Fig. 2B).

uncinate process¹⁰; and (4) the maxilla (including pyriform aperture) and pneumatization of the maxillary sinus.^{11,12}

Septoplasty is only one of the surgical components for the treatment of structural nasal obstruction

Although septoplasties have been performed for thousands of years (first recorded in the Ebers Papyrus, 3500 BC, Egypt).¹⁴ The septoplasty for chronic nasal obstruction is still an important part of endoscopic sinus surgery.^{1,20} Because most patients with nasal obstruction without tumour and inflammation are accompanied with deviation

of the nasal septum, septoplasty alone can also achieve a high degree of postoperative satisfaction.⁴ However, some patients still suffer from persistent obstruction after their primary septoplasty.²¹ Williams et al¹² showed that persistent nasal obstruction may be seen in patients with a narrow, high arched hard palate despite prior nasal surgical intervention. Currently, there is still a knowledge gap in this field of surgery.¹⁴ The literature also suggests that septoplasty is only one of the surgical components for the treatment of structural nasal obstruction; the surgery should also correct the other structural factors hindering nasal ventilation as much as possible and restore the structural symmetry of the bilateral nasal cavity beyond what can be achieved with septoplasty.^{1,2} Therefore,

septoplasty alone is not suitable for the treatment of most structural nasal obstructions.¹² At least, in most cases, septoplasty should be combined with inferior turbinate surgery or other procedures.¹² Han et al¹ proposed nasal cavity ventilation expansion techniques for the nasal obstruction in obstructive sleep apnoea (OSA) patients. The operation involves septoplasty, medial displacement of the middle turbinate, ethmoidectomy, lateral displacement of the inferior turbinate, uncinata process resection and so on. In recent years, the curative effect of the nasal cavity ventilation expansion technique has also been well verified, and most patients have achieved good improvement in nasal ventilation function.²² In addition, functional rhinoplasty and nasal valve surgery are also widely used in the management of structural nasal obstructions because this condition can be commonly caused by structural abnormalities of the nasal valve as well.^{19,23,24} Therefore, there is a need for a more accurate name that could better generalize the surgical procedures used to treat structural nasal obstruction while reflecting the purpose of the operation. The surgical implications of NVES can include all structures affecting the physical volume or width of the nasal cavity¹: intranasal structures (turbinate and nasal septum) and structures surrounding the nasal cavity (nasus externus, nasal valve, nasal pyriform aperture, anterior ethmoid complex and maxillary sinus, etc., Fig. 3).¹² Hence, we suggest that NVES should be used instead of septoplasty in the treatment of structural nasal obstruction.

In patients with chronic nasal obstruction, because the nasal structure varies greatly among different individuals,^{25,26} it is necessary to individually evaluate the abnormal nasal structure according to different patients. When a patient has many structural abnormalities at the same time, how can the structure of surgical intervention be chosen? At present, the surgical procedures used are still based on the clinical experience of the doctor. Therefore,

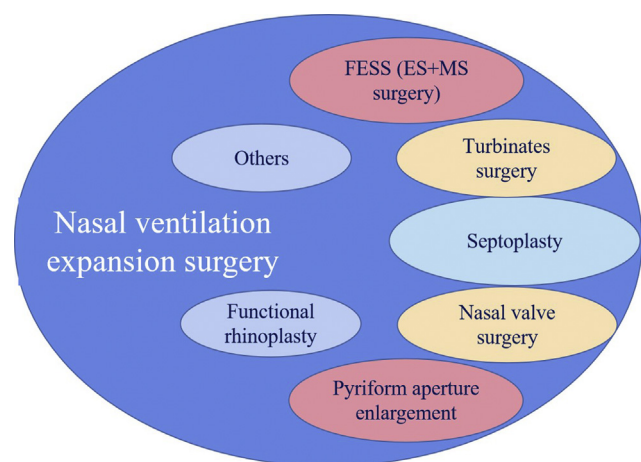


Fig. 3 The range of nasal ventilation expansion surgeries (NVESs) and the relationship of NVES with septoplasty. NVES covers most of the surgical aspects of structural nasal obstruction, and septoplasty is only one part of NVES. FESS: functional endoscopic sinus surgery; MS: maxillary sinus; ES: ethmoidal sinus.

the understanding of the pathological changes of the remaining nasal cavity morphology apart from NSD in patients with nasal obstruction is helpful for us to develop a surgical plan and determine the surgical components before the operation.

Structural remodelling of the nasal cavity after septum deviation may be the cause of structural nasal obstruction

It is undeniable that deviation of the nasal septum is the most important cause of structural nasal obstruction. However, in many cases, the occurrence of NSD is not consistent with the time of nasal obstruction. Most patients with nasal obstruction have progressive aggravation. This suggests that as a result of deviation of the nasal septum, the nasal cavity has experienced a long adaptive process (compensation), and NSD may be the driving factor for the remodelling of other nasal structures. We think that other structures of the nasal cavity have the ability to adjust or compensate adaptively as a result of NSD.²⁷ This adaptive structural adjustment of the nasal cavity and paranasal sinuses is called plasticity in the present review. The plasticity of the nasal structure is the key to its compensation for certain structural changes in the nasal cavity. Remodelling of the nasal cavity and paranasal sinus refers to the structural changes that occur as a result of their plasticity. The purpose of the natural remodelling of the nasal cavity and paranasal sinus is to improve the nasal ventilation function, and if the structural remodelling of the nasal cavity finally allows respiratory function, this compensation does not result in disease and is considered successful (Fig. 1). This may be why the incidence of NSD is as high as 80% in people without nasal obstruction.²⁸ If this compensation ultimately leads to a deterioration of the nasal ventilation function, however, failed compensation occurs and leads to structural nasal obstruction, which is a reasonable explanation for the time difference between the occurrence of NSD and the occurrence of nasal obstruction in patients.

Furthermore, the plasticity of the nasal cavity and paranasal sinuses may be related to their developmental stage. Deviation of the nasal septum can occur at different stages of development, and the remodelling changes of other structures of the nasal cavity may also differ. On the whole, the remodelling of the nasal cavity and paranasal sinus can be divided into bone structure remodelling and mucous membrane remodelling.^{27,29,30} We speculate that the remodelling of the osseous structure mainly occurs during the development of the nasal cavity and paranasal sinuses, while mucous remodelling can occur at any time in life (Fig. 4). Due to airflow changes, compensatory hypertrophy of the nasal mucosa on the concave side is often found. Furthermore, there may be greater lymphocytic infiltration and squamous metaplasia in the lateral wall mucosa on the concave side than on the convex side, which may be evidence of mucosal remodelling.^{7,30} Based on the inference of the structural remodelling of the nasal cavity and paranasal sinus, the septoplasty alone cannot completely restore the symmetry of the nasal cavity between the two sides, and the remodelling structure should

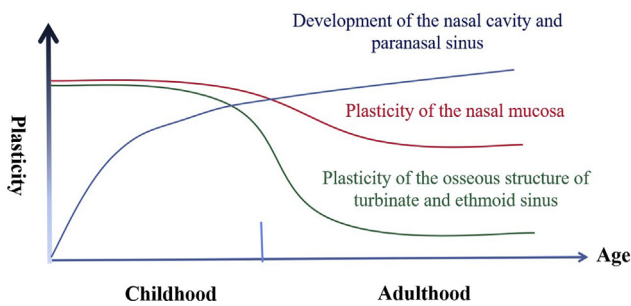


Fig. 4 Estimations of the plasticity of the nasal cavity and paranasal sinus with age. During the development of the paranasal sinus, the osseous structure and mucosa have strong plasticity. If nasal septum deviation occurs during this period and results in asymmetry of the bilateral nasal cavity, compensatory remodelling of the osseous and mucosal structures will occur due to their strong plasticity. However, in adulthood, the plasticity of the osseous structure decreases significantly, and compensatory changes are mainly mucosal.

be carefully identified and treated at the same time during septoplasty.

Finally, we would like to stress once again that structural nasal obstruction should be an independent disease that may be related to the structural remodelling of the nasal cavity and paranasal sinuses. All structures involved in nasal remodelling or resulting in structural asymmetry should form the focus of the NVES. However, according to the degree of structural abnormality, the components of the surgery should be individualized. Septoplasty alone is not suitable for the treatment of most structural nasal obstructions because it cannot completely reflect the connotation and purpose of surgery.

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Declaration of Competing Interest

The authors have no relevant competing interests to declare in relation to this manuscript.

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