Brief Overview about Atrophic Rhinitis and Empty Nose Syndrome

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Abstract

There have been descriptions of atrophic rhinitis in both its primary and secondary forms, with the secondary form typically occurring as a result of surgical trauma, granulomatous inflammation, or irradiation. Nasal biopsy if performed reveals glandular atrophy, endarteritis obliterans, and inflammatory cell infiltration. Paradoxical congestion (sensation of nasal congestion or obstruction despite large nasal cavities), dryness, and crusting are features, much as in ENS. The dryness and crusting represent loss of glandular function and humidification of the inspired air. Atrophic rhinitis can be a crippling disease, and the patient can be disabled by the chronic, unrelenting nature of the symptoms and airflow limitation. Endoscopy reveals partial or total absence of the inferior and/or middle turbinate in many cases. Empty Nose Syndrome (ENS) is typically diagnosed after turbinectomy and can be further subdivided into three distinct subtypes. ENS einferior turbinate, also known as ENS-IT, is an ENS that is found after tissue from the IT has been resected. This is the most common subtype of the condition, and it is estimated that it will develop in 20% of patients who have IT surgery. estimates, on the other hand, put the incidence after IT surgery at 16%. In these patients, it has been hypothesised that the development of the syndrome was brought on by a combination of factors, including tissue resection brought on by surgery and inadequate nerve regeneration. Patients who suffer from refractory sinus headaches, patients who have malignant tumours, and sometimes even patients who are undergoing transsphenoidal pituitary surgery are all candidates for extensive turbinectomy. Nasal hygiene with regular intranasal irrigation remains the standard of conservative therapy by minimizing crusting and restoring nasal hydration. Medical treatment includes nasal lavage, topical ointment, antibiotic therapy, aerosols, and local corticosteroids, although such treatments seem to be less effective in ENS than in atrophic rhinitis. Adding menthol to the local treatments may be beneficial; however, its effect on the nasal patency is because of a sensory illusion rather than altered airflow. The aims of the endonasal surgery are to reduce nasal cavity volume, increase resistance to the airflow, reduce the airflow to increase air humidity, and deviate the airflow from the surgical site toward a healthy or a nonoperated side. The creation of a neoturbinate is the most common surgical solution for ENS. Techniques vary from team to team, but the results have been very encouraging. The principle consists of positioning an implant in a pocket in the septum, floor, or lateral wall of the nose. The location of the implant is based on the patient's history, examination, computed tomography scan findings, and the results of the cotton test in the office. Patients who gain no benefit from the cotton test are deemed poor candidates for implantation.

Keywords: Atrophic rhinitis, empty nose syndrome

ENS must be distinguished from a related disorder known as atrophic rhinitis, also known as ozena. Atrophic rhinitis is a syndrome characterised by persistent rhinosinusitis, thick adherent crusts, offensive odour (fetor), and nasal congestion. **(1).**

There have been descriptions of atrophic rhinitis in both its primary and secondary forms, with the secondary form typically occurring as a result of surgical trauma, granulomatous inflammation, or irradiation. Nasal biopsy if performed reveals glandular atrophy, endarteritis obliterans, and inflammatory cell infiltration. Paradoxical congestion (sensation of nasal congestion or obstruction despite large nasal cavities), dryness, and crusting are features, much as in ENS. The dryness and crusting represent loss of glandular function and humidification of the inspired air. Atrophic rhinitis can be a crippling disease, and the patient can be disabled by the chronic, unrelenting nature of the symptoms and airflow limitation. Endoscopy reveals partial or total absence of the inferior and/or middle turbinate in many cases**. (2)**

Histopathologic analysis of biopsy tissue reveals typical findings, including atrophy of serous and mucinous glands, loss of cilia and goblet cells, and sporadic inflammatory cell infiltration. Bacterial infection is common, setting this disorder apart from ENS, and nasal cultures often yield pathogenic organisms, including Klebsiella ozaenae, Staphylococcus species, Proteus mirabilis, and Escherichia coli. Computed tomography of the paranasal sinuses reveals a variety of abnormalities, including mucosal thickening of the sinuses, nasal cavity enlargement, and bony destruction/loss of the inferior and/or middle turbinate. The management includes nasal saline irrigation, antibiotics, and surgical techniques that restore nasal mucosal function and narrow the airway using a variety of implants. **(3)**

Empty Nose Syndrome

ENS is typically diagnosed after turbinectomy and can be further subdivided into three distinct subtypes. ENS einferior turbinate, also known as ENS-IT, is an ENS that is found after tissue from the IT has been resected. This is the most common subtype of the condition, and it is estimated that it will develop in 20% of patients who have IT surgery. estimates, on the other hand, put the incidence after IT surgery at 16%. In these patients, it has been hypothesised that the development of the syndrome was brought on by a combination of factors, including tissue resection brought on by surgery and inadequate nerve regeneration. **(3)**

In most cases, the patient will present with paradoxical nasal congestion, dryness, and crusting several months or years after surgery. This can make it difficult to differentiate from atrophic rhinitis at times. **(1).**

Although ENS emiddle turbinate (ENS-MT) is much more likely to develop in patients after IT surgery, it is possible for patients to develop this condition after MT excision. It is unknown what percentage of patients experience ENS following MT resection. It is possible for symptoms of nasal congestion to be accompanied by pain in the nose. This sensation is assumed to be attributable to altered nasal airflow through the mucosa that lies above the sphenopalatine ganglion. Patients who have had a resection of both their IT and MT tissue are referred to as having an ENS-both diagnosis. It is likely that you will experience crippling and severe symptoms, as well as a loss of olfactory sensation. Additionally, some people may develop depression as a result of the recalcitrant nature of the symptoms. Patients who have rhinosinusitis with polyposis, when there is disease such as an inverted papilloma, or when access to the ostium of the maxillary sinus is limited are all candidates for a middle turbinectomy. This procedure is performed more frequently. In patients who have persistent airway obstruction or turbinate hypertrophy that has not responded to medical therapy, an inferior turbinectomy may be an appropriate treatment option**. (4)**

Patients who suffer from refractory sinus headaches, patients who have malignant tumours, and sometimes even patients who are undergoing transsphenoidal pituitary surgery are all candidates for extensive turbinectomy.**(1).**

Pathophysiologic Mechanisms

The pathophysiologic mechanisms of ENS are still a mystery, despite the fact that a great number of ideas have been proposed. Figure 1 presents a schematic representation of the normal nasal physiologic process as well as the aberrant responses that are observed in ENS. In conditions such as atrophic rhinitis and ENS, vital functions of the nose, including the humidification and warming of the air that is inspired, the activity of the mucociliary system, and the elimination of particulate matter, are severely compromised. It is generally accepted that turbinectomy results in the loss of sensorineural receptors, including some that are necessary for the perception of pain and temperature. Alteration and turbulence in the airflow may also be caused by the loss of turbinate tissue and the enlargement of the nasal cavities. On the other hand, mucosal dryness and crusting are caused by a lack of humidification and the destruction of glandular tissue. **(5)**

It is generally accepted that resistance in the nasal airways is necessary to maintain open bronchioles, which in turn helps to improve ventilation and gas exchange. These effects also have the effect of lowering the pressure inside the thoracic cavity, which leads to an improvement in venous return, pulmonary blood flow, and cardiac output. As was mentioned earlier, changes to these physiological aspects may result in dyspnea, paradoxical congestion, and a sensation of being suffocated. It is possible that radical resection of the turbinates will reduce the surface area that is stimulated by mucosal cooling. A loss of valve function and the development of the disease could be the consequence of partial resection of the anterior portion of the turbinate. **(6)**

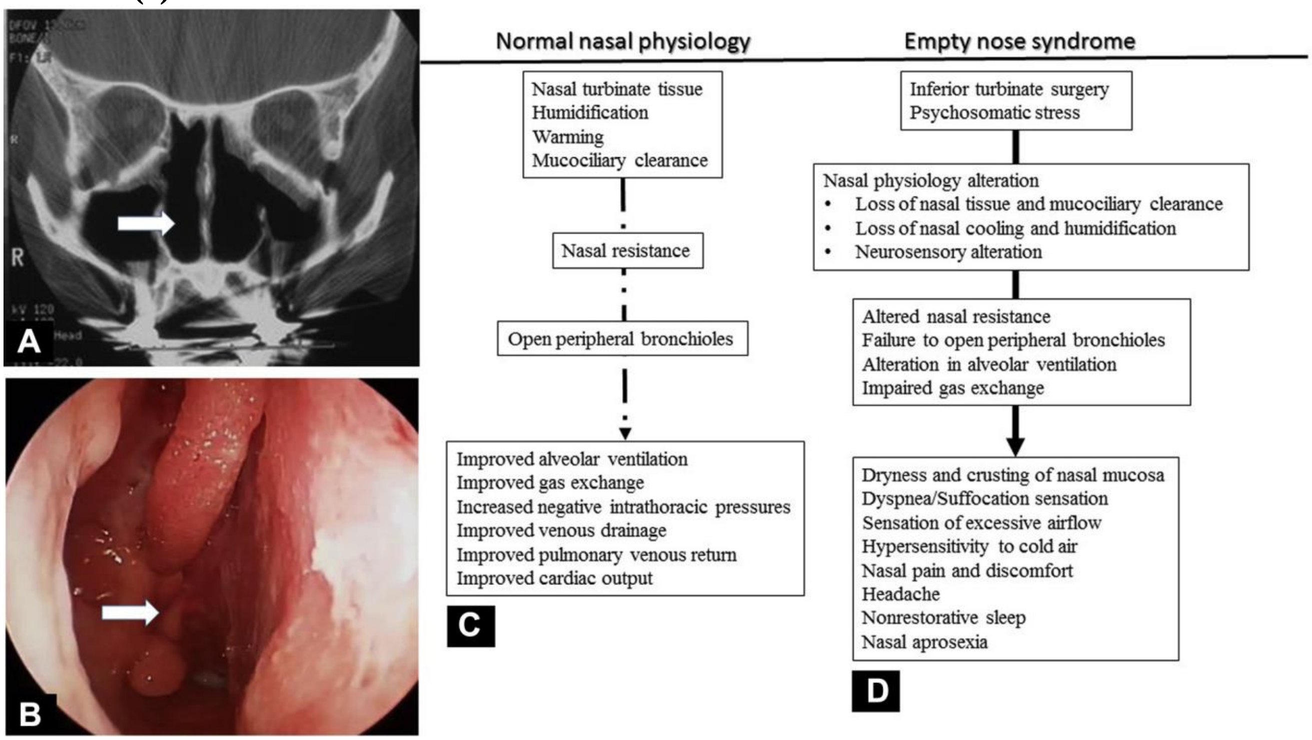

Fig (1) Radiologic (computed tomogram) (A) and nasal endoscopic (B findings in empty nose syndrome. Open nasal cavities with turbinate loss are observed in these patients. Patients often are concerned about a “paradoxical” nasal congestion, obstruction, and sense of suffocation. Normal nasal physiologic features (C) and presumed alterations in empty nose syndrome (D) that lead to the clinical symptoms associated with the disease. White arrows on panels A and B indicate radiological and endoscopic demonstration of tissue loss and open nasal cavity.) **(2)**

It was demonstrated that nasal airway resistance decreased while airflow increased by using simulated three-dimensional models and virtual surgery. They also discovered that total inferior turbinate surgery led to greater increases in nasal airflow, but it also impaired nasal air-conditioning capacity much more so than with middle turbinate resection. This could possibly explain the differences in the incidence of ENS after inferior vs. middle turbinate surgery. **(3)**

It is possible that neuropsychiatric mechanisms are also at play, despite the fact that the symptoms are secondary to changes in normal nasal physiologic functions that occur after the loss of turbinate tissue. As a direct consequence of this, these patients have a significantly increased risk of developing other functional syndromes, such as fibromyalgia, migraines, and irritable bowel syndrome.**(3)**

Feature	Allergic rhinitis	Atrophic rhinitis	Empty nose syndrome
Definition	IgE-mediated inflammatory disease	Inflammatory atrophic disorder with loss of turbinate and mucosal tissue	Paradoxical nasal obstruction after turbinate surgery; iatrogenic disease
Crusting	No	Thick, adherent	++
Nasal dryness	No	++	+++
Foul odor	No	+++	No
Anosmia	No	+++; Loss of olfactory, pain, temperature receptors?	Hyposmia or anosmia
Dyspnea or suffocation	No unless underlying asthma	No	+++
Nasal obstruction Or congestion	+++	+++ Paradoxical (enlarged nasal cavity)	++ Paradoxical (enlarged nasal cavity)
Depression	No	No	++
Etiology	Atopy; genetic	Primary or secondary to trauma, radiation, surgery or granulomatous disease	Iatrogenic secondary to turbinate surgery
Histopathology	Inflammatory cell infiltration; inflammation; edema; Goblet cell hyperplasia	Mucus gland atrophy; loss of cilia and goblet cells; inflammatory cell infiltration	Loss of turbinate and mucosal tissue; no inflammation
Infection	No	*Klebsiella ozenae*, *Proteus mirabilis*, *Staphylococcus aureus* and *Escherichia coli*	No
Management	Nasal steroids, antihistamines, leukotriene antagonists, allergy immunotherapy	Nasal hygiene, irrigation?; antibiotics; treat primary disease; surgical therapy: implantation	Nasal hygiene; irrigation; surgical implantation

++, moderate; +++, severe.

Table (1) Distinguishing Aspects of Allergic Rhinitis, Atrophic Rhinitis, and the Empty Nose Syndrome.**(2)**

Diagnosis of empty nose syndrome

Symptoms

Patients with ENS typically complain of excessive nasal crusting, "paradoxical" nasal obstruction, and malodor emanating from the nasal cavity. Other associated symptoms include facial pain, headache, mucosal dryness, dyspnea, epistaxis, anosmia, sleep disturbance, and occasional mucopurulent rhinorrhea. The feeling of "not getting air" is not alleviated with mouth breathing and often has a negative impact on psychological well-being, which manifests as anxiety, depression, anger, frustration, irritability, and fatigue. A unique symptom in ENS is aprosexia nasalis, where the patient becomes extremely preoccupied with attempting to maintain a sensation of breathing such that they experience chronically decreased concentration.**(4)**

Part of the challenge of understanding the pathophysiology and making the diagnosis of ENS is that there is poor correlation between objective nasal airflow and subjective reports of nasal patency. The subjective symptoms of ENS are thus analogous to that in conditions such as fibromyalgia and subjective tinnitus, where the objective findings do not corroborate the subjective complaints. Yet, it is important for the clinician to recognize that these complaints are very real to the patient and that resolution of these subjective symptoms becomes the primary outcome measure.**(7)**

In Houser's classification of subtypes of ENS, he notes that different subtypes tend to present with certain symptoms with variable frequency. Specifically, crusting is most prominent in ENS-IT, facial pain with inspiration in ENS-MT, and depression and anosmia/hyposmia in ENT-both (most severe). **(8)**

Signs

There are no reliable objective physical exam findings for the diagnosis of ENS. In fact, Houser anecdotally describes two patients who underwent bilateral inferior turbinectomy but who only complained of unilateral ENS despite having nearly identical physical exam and radiographic findings bilaterally. On endoscopic exam, the inferior and/or middle turbinates may be surgically absent or reduced in size, resulting in widely patent nasal cavities The mucosa is characterized as pale and dry. Crusting may be present, as can mucopurulent drainage from secondary infection of the atrophic mucosa. **(8)**

Diagnosis

ENS is a diagnosis of exclusion and should be made from assimilating a complete patient history with endoscopic exam findings. Imaging studies may identify previous turbinate surgery but otherwise is not critical in making the diagnosis. Houser proposed a simple diagnostic test involving placing a piece of saline-moistened cotton within the patient's nasal cavity for 20 to 30 min. Subjectively improved nasal obstructive symptoms lend support to the diagnosis of ENS and may predict good surgical candidacy. Houser observed that patients with ENS-type have an especially favorable response rate to the cotton test when compared to other subtypes, indicating that they may be more likely to benefit from surgery. **(6)**

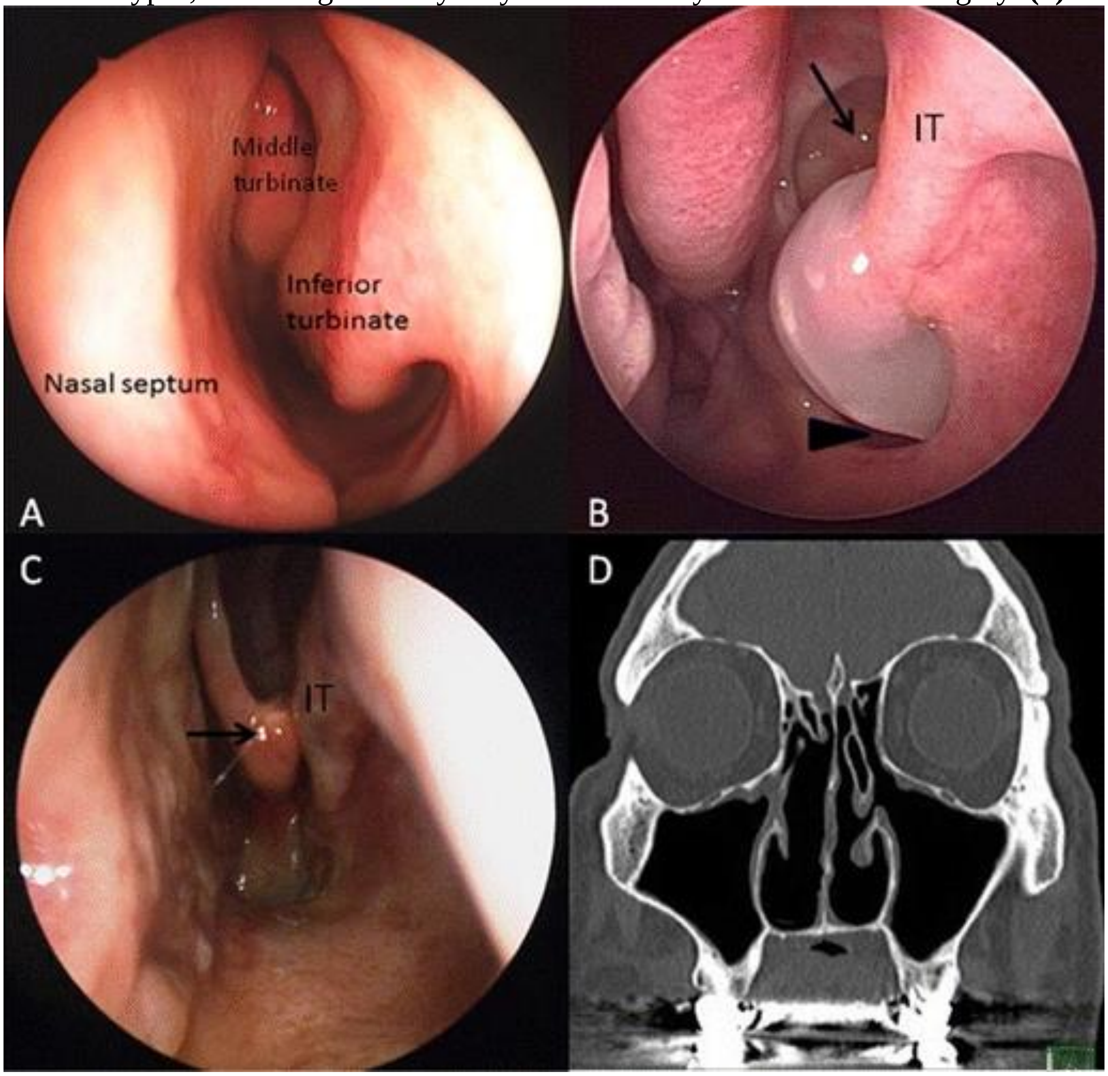

Figure (2) a Normal endoscopic left-sided nasal anatomy demonstrating intact inferior and middle turbinates and nasal septum. **b** Near-complete left inferior turbinate resection (IT) with recirculation of mucus between the natural ostium of the maxillary sinus (*arrow*) and a surgical antrostomy (*arrowhead*) in a patient with empty nose syndrome. **c** Near-complete left inferior turbinate resection (IT) as well as remnant middle turbinate (*arrow*) in a second patient with empty nose syndrome. **d** Coronal view computed tomography image of the paranasal sinuses demonstrating near-complete resection of the bilateral inferior turbinates and the right middle turbinate, with an intact left middle turbinate (concha bullosa), in a third patient with empty nose syndrome. **(8)**

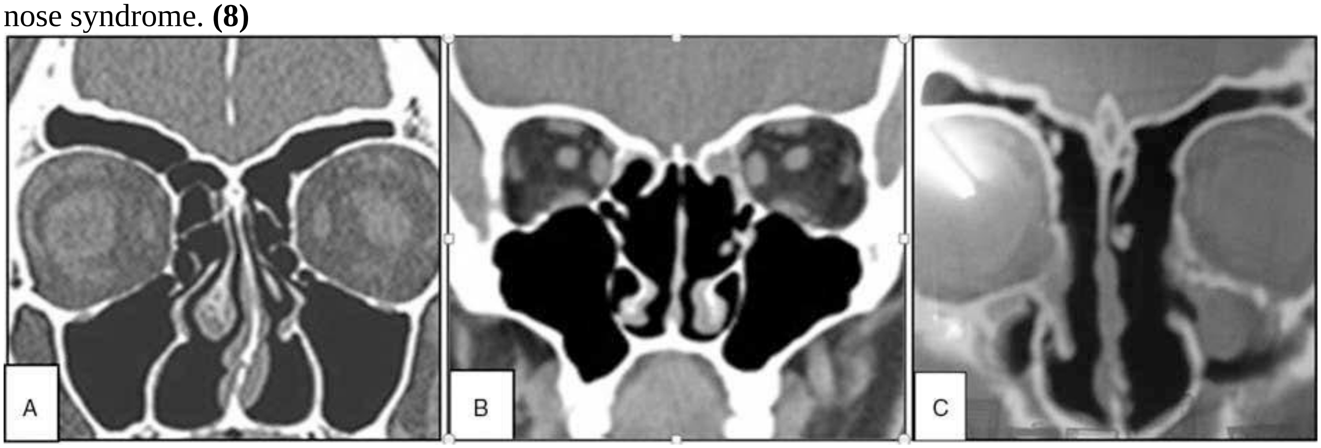

Fig (3) Computed tomography (CT) scan of the paranasal sinuses showing: (a) bilateral total inferior turbinectomy (ENS-IT), (b) bilateral near total middle turbinectomy (ENS-MT), (c) bilateral total inferior and middle turbinectomies (ENS-both).**(5)**

Diagnostic test

Cotton test: using an isotonic sodium chloride solution, cotton is moistened and placed within the nasal cavity in a region in which an implant may be feasible, without local anesthesia or decongestant, for better patient selection. The cotton is kept in place for 20–30 min and the patient is asked to breathe comfortably and report any changes in the symptoms. Patients who report a subjective improvement from the cotton test and whose symptoms and physical examination findings seem consistent with ENS are offered submucosal implantation. The cotton test is an office-based procedure that is not only used as a diagnostic tool but also for preoperative evaluations to select the feasible location and the amount of the implant required to reduce the nasal cavity volume. **(2)**

Rhinomanometry

Rhinomanometry is not useful for the diagnosis of ENS, but generally confirms the absence of any anatomical obstruction. Rhinomanometry may not correlate with the subjective patient nasal patency as it focuses on the nasal obstruction attributable to anatomical factors. Many studies have documented the sensation of obstruction without any demonstrated anatomical causes, for example, topical application of local anesthetics in the nostril produces an artificial sensation of nasal obstruction with no change in objectively measured patency, whereas topical application of menthol produces the sensation of decongestion without actually altering nasal morphology.**(8)**

Other investigations:

(1) Bronchopulmonary functional exploration is useful in case of lower respiratory tract symptoms.

(2) Bacteriology is also recommended in case of crusts and suppuration; it enables adapted antibiotic therapy.**(9).**

Treatment

Prevention of empty nose syndrome

Because the nasal mucosa is the functional entity involved in the air conditioning, minimally invasive surgery on the turbinate that preserves the nasal mucosa and cool thermoreceptors is the key to achieve optimal results and reduce the risk of developing ENS. Surgical techniques for the management of the inferior turbinate hypertrophy vary widely and have evolved considerably in the past four decades as new technologies have emerged. They include turbinate outfracture, partial turbinectomy with resection of the anteromedial 1/3 of the inferior turbinate, and extramucosal destruction of the inferior turbinates by diathermy or laser [most commonly with a carbon dioxide (CO_2) or an Nd : YAG laser]. Along with the laser, cryosurgery can be used, which enables intracellular formation of ice crystals with cell membrane destruction. Although lasers and cryosurgery gained favor in the 1990s and the early 2000s, they are less frequently used nowadays. **(10)**
Currently, many of the surgical techniques for inferior turbinate reduction fall into the category of submucous resection and turbinoplasty, which involve remodeling of the inferior turbinate with removal of submucosal tissue with or without bone removal. Anterior turbinoplasty where the mucoperiosteal flap is detached from the turbinate bone, followed by resection of the turbinate head including bone, together with the lateral mucosal plate are performed; then, the remaining medial mucoperiosteal flap is placed laterally across the defect and secured with a tamponade. Submucosal diathermy and radiofrequency are also used to shrink the submucosal tissue, but they produce high tissue temperatures and can cause significant injury to the surrounding tissue and thermal damage of the overlying mucosa. Radiofrequency ablation using a Coblator is a more recent technique that causes less thermal damage to the surrounding tissues and can be performed using a method similar to that of electrocautery. Submucosal tissue removal by a microdebrider or a bipolar equipped microdebrider can also be used for submucosal tissue removal. The ultrasonic bone aspirator is the newest technique used in inferior turbinate surgery. **(1).**

The key feature of this instrument is tissue selectivity as it vibrates rather than spinning like a drill burr or a microdebrider blade, which results in effective bone removal while causing relatively less damage to the surrounding soft tissue. Multiple techniques (especially outfracture) may be combined to maximize effectiveness. Kennedy argued against routine resection of the middle turbinate and he described its protective and physiologic functions. Therefore, it is better to preserve the middle turbinate during the nasal surgeries, except when there is severe inflammation of its mucosa with or without neosteogenesis or in the case of symptomatic concha bullosa; in such cases, it can be partially resected. **(6)**

Medical treatment

Nasal hygiene with regular intranasal irrigation remains the standard of conservative therapy by minimizing crusting and restoring nasal hydration. Medical treatment includes nasal lavage, topical ointment, antibiotic therapy, aerosols, and local corticosteroids, although such treatments seem to be less effective in ENS than in atrophic rhinitis. Adding menthol to the local treatments may be beneficial; however, its effect on the nasal patency is because of a sensory illusion rather than altered airflow.**(7,11)**

Surgical treatment

The aims of the endonasal surgery are to reduce nasal cavity volume, increase resistance to the airflow, reduce the airflow to increase air humidity, and deviate the airflow from the surgical site toward a healthy or a nonoperated side. The creation of a neoturbinate is the most common surgical solution for ENS. Techniques vary from team to team, but the results have been very encouraging. The principle consists of positioning an implant in a pocket in the septum, floor, or lateral wall of the nose. The location of the implant is based on the patient's history, examination, computed tomography scan findings, and the results of the cotton test in the office. Patients who gain no benefit from the cotton test are deemed poor candidates for implantation. **(2)**

The location of the implant should recreate the natural airflow patterns within the nose. To simulate the inferior turbinate, the implant is placed at the septum, floor, or the lateral nasal wall. As the head of the natural inferior turbinate enters the nasal valve region, the graft should be sufficiently anterior to replace the former inferior turbinate head. A septal implant located anteriorly might function similarly. The lateral wall implant is tethered by the nasolacrimal duct and does not extend sufficiently to the anterior area, and thus may not provide adequate relief. **(7)**

The treatment of ENS-MT has the least number of options because of the surrounding anatomy. It is better to avoid lateral implants because of the presence of thin mucosa within the middle meatus and the possibility of obstructing the drainage pathways of the paranasal sinuses. However, the septum may be used for grafting, which simulates a 'Bolgerized' MT. In a patient who has ENS-both, the septum will be the target for grafting, with a large implant spanning the region of the middle and inferior turbinates.**(12,13)**

Patients with ENS-IT without any IT remnant (or a minimal remnant) may present a difficult reconstructive problem. It was suggested that limited success with lateral wall augmentation of three patients benefited from the procedure) and the nasolacrimal duct might be obstructed. **(14).**

The material used to reduce the nasal cavity volume should have cartilage-like elasticity, immunologic inertness, and combine minimal risk of extrusion, rejection, and infection with sufficient restoration of nasal cavity volume. Various materials are available including autologous (bone, cartilage, and fat) and exogenic materials (hydroxyapatite, goretex, teflon, plastipore). Although all of the synthetic implants may be effective, the use of autologous materials, such as cartilage, is considered ideal as it is cheap and available with a high level of biocompatibility. General evidence indicates long-term positive outcomes associated with the use of cartilage implants in rhinological surgeries. Septal cartilage is the most common material used in rhinological grafts; however, it is usually not enough in some patients, especially those who have undergone previous septal surgery. Conchal and costal cartilages can also be used in the procedure **(15).**

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