Inferior Turbinectomy, Is It a Nasal Crime!?

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Objectives / Hypothesis: Inferior turbinectomy may cause empty nose syndrome (ENS) which results in sino-nasal problems. There is lack of data that explain the relationship between turbinate volume and patient symptoms. The aim of this study was to measure the effects of interior turbinate volume on symptom severity.

Study Design: Retrospective study from 20 patients with ENS.

Methods: All patients have CT scan and complete SNOT-25 questionnaire. The control group formed of 8 patients with skull base lesions without any nasal problems. The inferior turbinate volumes (ITVs) and SNOT-25 was also assessed.

Results: the ENS patients presented with a small inferior turbinate volume than the control group ($P < 0.001$). SNOT-25 score showed high dryness score which was correlated with a small total ITV ($P = 0.029$), facial pain was correlated with smaller anterior ITV ($P = 0.010$). Patients with small ITV demonstrated higher score of sense of suffocation ($P = 0.039$).

Conclusion: Inferior turbinectomy may lead to ENS which resulted in nasal dysfunction as evident by SNOT-25 items.

Keywords: Inferior turbinectomy, Empty nose syndrome, SNOT-25.

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Introduction

Empty nose syndrome (ENS) is an iatrogenic disorder caused by turbinate reduction procedures, which results in considerable nasal dysfunction and is associated with severely impaired quality of life. [1] Empty nose syndrome was first described in 1994. [2]

ENS is a poorly recognized but undoubtedly devasting clinical entity. In their 2001 article on atrophic rhinitis Moore and Kern stated in reference to those suffering from this disease that "the absence of normal nasal structures is universal in these patients, and the symptoms of atrophic rhinitis coupled with a cavernous nasal airway lacking identifiable turbinate tissue has been termed the empty nose syndrome". [3]

Turbinate reduction surgery can induce ENS; these procedures include not only total turbinate excision but also more conservative procedures such as submucosal cautry, submucosal resection, laser therapy, radiofrequency therapy and cryosurgery. [4] Similar sentiments against radical turbinate surgery were echoed by Huizing and De-Groot, who stated that "a wide nasal cavity syndrome due to reduction of the inferior turbinate is still frequently seen". [5]

ENS appears to most commonly arise a postsurgical phenomenon secondary to loss of inferior turbinate tissue or volume. This diagnosis is most often associated with the presence of paradoxical nasal obstruction despite an obtaining potent nasal airway. [6] A wide constellation of prominent symptoms are also espoused by ENS patients, including dyspnea, nasal and pharyngeal dryness, facial or nasal pain, crusting, hyposmia and depression.[7] The onset of these symptoms can occur months to years postoperatively. [8]

The loss of the turbinate mucosal surface, along with the associated mucosal glands and sensory nerve fibres (which are essential for normal air conditioning), mucociliary clearance and perception of nasal airflow, has been suggested as the underlying pathogenesis of this debilitated disorder. [9] Airflow changes have been described following inferior turbinate resection in a computational model of nasal airflow dynamics, where loss of turbinate tissue bulk disrupts the structure of the inferior meatus, leading to turbulent less efficient airflow. [10]

For many years, ENS was thought to be a form of secondary atrophic rhinitis. [11] The existence of ENS has been hotly depated, and it remains to be answered why some patients develop ENS following turbinate surgery. The inability to diagnose ENS objectively has fulled further speculation that it could be either a form of nasal neuropothy or rhinitis hystricus. [12] After years of careful assessment and follow up of ENS patients, Houser proposed that ENS should be redefined as a symptom complex that includes a paradoxical sense of obstruction in spite of partial or complete tur binate resection. [4,13] The most commonly used outcome survey for ENS is probably the Sino-Nasal Outcome Test 25 "SNOT-25"(14) which is has been used in several earlier studies using the Spearman Correlation formula [15] "Table I".

Table I The Sino-Nasal Outcome Test-25 for the Assessment of Empty Nose Syndrome regarding symptoms Scoring Range (0-5) O = No 1 2 3 4 5 severe

1	Need to blow nose
2	Sneezing
3	Runny nose
4	Cough
5	Postnasal drip PND
6	Thick nasal discharge
7	Ear fullness
8	Dizziness
9	Ear pain
10	Facial pain
11	Difficulty falling asleep
12	Waking up at night
13	Lack of good night's sleep
14	Waking up tired
15	Fatigue
16	Reduced productivity
17	Reduced concentration
18	Frustration / restlessness / irritability
19	Sadness
20	Embarrassment
	ENT SPECIFIC SYMPTOMS
21	Dryness
22	Difficulty with nasal breathing
23	Suffocation
24	Nose is too open
25	Nasal crusting

Material and Methods

Study Population

This retrospective study included 20 patients who were diagnosed with ENS at October 6 University Hospital, between March 2013 and April 2016. Written informed consent was obtained from all included patients.

The diagnosis of ENS was based on the following criteria:

1. History of previous turbinate reduction surgery
2. Partial or total turbinectomy with abnormally widen nasal cavities
3. Endoscopic examination for all patients
4. Subjective symptoms including paradoxical nasal obstruction, nasal crustations and discharge, excessive airflow, facial or nasal pain on inspiration and depression.
5. All patients have computed tomography (CT) axial and coronal cuts without contrast
6. A positive "cotton test". The cotton test involves placement of dry cotton in the region of the deficient (or absent) inferior turbinate tissue in the un-anesthetized inferior meatus to simulate the bulk and tubular contour of a negative turbinate in the lateral nasal wall. The patient's symptoms are then re-evaluated and an almost instantaneous, striking reduction in detrimental nasal symptoms, with a subjective improvement in the patient's sense of nasal airflow, supports the diagnosis of ENS. The control group consisted of 8 patients without history of sinusitis or previous sinonasal surgery, and were recuited from the pre-operative skull base surgery clinic.

Radiological Study

CT scan of the paranasal sinuses axial and coronal thin cuts 2-mm intervals with no gap were performed for all 20 patients using a multidectector CT scanner. The control group underwent CT scanning of the skull base, which was also obtained at 2-mm intervals on coronal images in order to fully present the whole sinonasal structure.

The inferior turbinate volume (ITV) on the coronal CT images was quantitatively calculated by summing areas that were manually traced on every imaging slice and multiplied by the slice thickness using the "Picture Archiving and Communication System (figure I). To define the different contributions of the reduced turbinate volumes on the anterior and posterior halves, which were divided by a line corresponding to the level of the natural maxillary sinus ostium. To maintain consistent data, all measurements were checked by the same examiner using a fixed setting at window 250 and level 50.

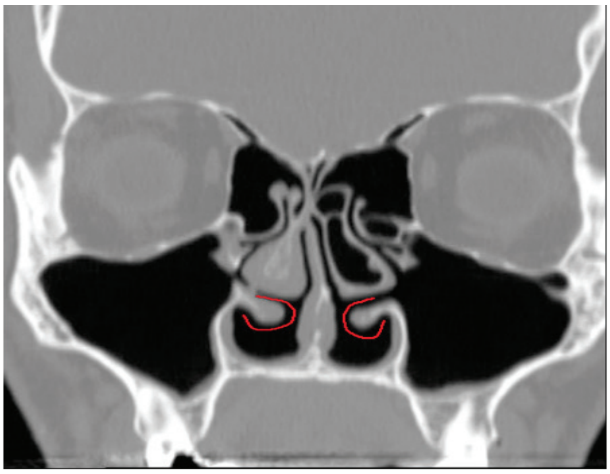

Fig 1 Measurements of ITV in a 32 years old male patient with empty nose syndrome of both nasal cavity. The ITV on the coronal CT image was quantitatively calculated by summing areas that were manually traced on every imaging slice and multiplied by the slice thickness

Outcome Measurements

We compared anterior, posterior and total ITV between the ENS group and control group. For each patient, the symptoms score was assessed using SNOT-25 via questionnaire. SNOT-25 consists of 25 items that quantify the symptoms associated with ENS, and each item is rated on a score from O (no symptoms) to 5 (severe symptoms).[17] The correlation between SNOT-25 and anterior, posterior and total ITV was analyzed in this study. The influence of remnant anterior, posterior and total ITV on each individual SNOT-25 item was also assessed.

Statistical Analysis

Continuous variables expressed as the mean ± standard deviations. Categorical variables are expressed as numbers and percentages. All statistical analyses were performed using SPSS version 21.0 (IBM Armonk, NY) and P < 0.05 was considered statistically significant. The independent sample t-test was used to compare ITV between ENS and control groups. To identify the correlation between subjective symptoms and ITV, we used the Spearman correlation test. The r value can range from +1 to -1. An r value of +1 indicates the perfect association between ranks, an r value of O indicates no association between ranks, and an r value of -1 indicates a perfect negative relation between ranks. The closer r is to O, the weaker the association between ranks. [15]

Resault

The 20 patients with ENS consisted of 14 men (70%) and 6 women (30%) and the mean age 32 years (range 22-42). The control group consisted of 8 patients "six men and two women" and the mean age 50 years (range 35-70 years). Comparisons of ITV between the ENS and control groups are shown in table II. The mean total ITV was 1.68±0.88 mL in ENS group and 7.62±1.36 mL in control group. The mean anterior ITV was 0.59±0.38 mL in ENS group and 3.78±0.90 in control group. The mean posterior ITV of ENS group was 1.09±0.54 mL, and the mean posterior ITV of the control group was 3.84±0.58 mL. The ENS group demonstrated a significantly smaller total ITV, anterior ITV, and posterior ITV than the control group (P < 0.001, respectively). Correlations between subjective symptoms (i.e. SNOT-25) and ITV in the 20 ENT patients are presented in Table III.

Among the various SNOT-25 items, a high dryness score was significantly correlated with a smaller total ITV (r=-0.316; p = 0.031) (Table III). In contrast, a larger total ITV presented a statistically significant correlation with a high fatigue score (r = 0.321; p = 0.029) (Table III). High intensity facial pain was significantly related with a smaller anterior ITV (r=-0.416; p=0.010) (Table III). Difficult nasal breathing (r=0.286; p=0.042) was significantly worsened by larger anterior ITV. Patients who had a smaller posterior ITV presented higher score for PND (r=-0.314; p=0.030) thick nasal discharge (r=-.298; p=0.032), and dryness (r=-0.299, p=0.043) (TableIII). By contrast, a larger posterior ITV was significantly with high score for a nose that was opened too much (r = 0.346; p = 0.024) and fatigue (r=0.364; p=0.011) (Table III). On the other hand, sense of suffocation was significantly correlated with large total ITV (r=0.302; p=0.039) (Table III).

Table II Comparison of Inferior Turbinate Volume Between Empty Nose Syndrome and Control Group

Inferior Turbinate Volume					
	Empty Nose Syndrome (N = 20)		Control (N = 8)		
	Mean	SD	Mean	SD	P Value
Anterior	0.59	0.38	3.78	0.90	<0.001
Posterior	1.09	0.54	3.84	0.58	<0.001
Total	1.68	0.88	7.62	1.36	<0.001

The independent t test, P < 0.05
Anterior = anterior portion of the inferior turbinate; posterior = posterior portion of the inferior turbinate; total = total inferior turbinate

Table III Correlation Between Subjective Symptoms (SNOT-25) and Inferior Turbinate Volume in Patients with Empty Nose Syndrome (N = 20)

	Anterior		Posterior		Total	
	R	P	R	P	R	P
Need to blow nose	0.218	0.064	-0.142	0.175	0.046	0.326
Sneezing	0.046	0.512	-0.218	0.162	0.012	0.322
Runny nose	0.162	0.560	-0.082	0.198	-0.024	0.396
Cough	0.032	0.436	0.216	0.482	0.024	0.388
PND	-0.144	0.416	-0.314	0.030*	-0.121	0.264
Thick nasal discharge	-0.112	0.362	-0.298	0.032*	-0.216	0.128
Dryness	-0.264	0.061	-0.299	0.043*	-0.316	0.031*
Difficulty with nasal breathing	0.286	0.042*	0.084	0.321	0.187	0.092
Waking up at night	0.142	0.338	0.187	0.124	0.242	0.168
Nasal crusting	0.136	0.296	0.214	0.236	0.146	0.196
Ear fullness	-0.216	0.136	0.264	0.145	-0.246	0.124
Dizziness	-0.174	0.216	-0.136	0.208	-0.224	0.236
Ear pain	-0.216	0.158	-0.104	0.288	-0.114	0.274
Nose is too open	-0.062	0.448	0.346	0.024*	0.314	0.142
Facial pain / pressure	-0.416	0.010*	-0.048	0.314	-0.182	0.163
Difficulty falling asleep	0.214	0.316	0.118	0.260	0.216	0.117
Lack of good night's sleep	0.156	0.196	0.142	0.201	0.216	0.117
Waking up tired	0.132	0.248	0.181	0.123	0.245	0.076
Fatigue	0.214	0.159	0.364	0.011*	0.321	0.029*
Reduced productivity	0.263	0.052	0.246	0.079	0.245	0.063
Reduced concentration	0.214	0.061	0.137	0.216	0.258	0.064
Suffocation	0.266	0.095	0.282	0.081	0.302	0.039*
Frustration / restlessness Irritability	-0.396	0.364	-0.216	0.213	-0.219	0.251
Sadness	0.093	0.473	0.117	0.257	0.060	0.362
Embarrassment	0.020	0.456	-0.072	0.344	-0.119	0.251

PND = post nasal discharge; r = Spearmens correlation coefficient; SNOT-25 = Sino Nasal Outcome Test-25.

Discussion

ENS is a recognized complication, with onset at an interval of months or years after inferior and/or middle turbinate surgery.(2) The most common symptoms is so-called "paradoxical" nasal obstruction reported by the patient despite objectively permeable cavities on clinical examination with no obstacle found on imaging or rhinomanometry and acoustic rhinometry. [2,4]

Incidence, is unknown but Chhabra and Houser estimate a rate of 20% following inferior turbinate resection, which induces simple dryness in many other patients. [2,16]

This study measured the degree of remnant turbinate volume in ENS patients using CT scan. There was a significant difference in ITV between the ENS and control group (P<0.001) (Table II). We found that remnant ITV influences the symptoms of ENS. The most commonly used outcome survey for ENS is probably the Sino-nasal outcome test 25 "SNOT-25",(12) which has been used in several earlier studies (Table I). [4,6,12,13]

Nose-specific symptoms–including nasal dryness, facial pain, PND, and thick nasal discharge – were significantly worsened by a smaller ITV (P<0.005) (Table III). The smaller total ITV presented a significant correlation with increased nasal dryness. This is may be due to loss of the mucosal tissue of the inferior turbinate, which alters the temperature and humidity of the nasal cavity due to affection of mucosal glands. (8) After turbinectomy, a relatively large volume of the inspired air goes through a wide path without suitable time for air conditioning. Naftali et al. estimated the middle and inferior turbinates are responsible for up to 70% of total nasal air conditioning and that loss of the turbinates surface area reduces the efficacy of nasal air conditioning by 30%.[17] Another study found that patient with ENS tend to have warmer and dryer nasal mucosa. [18]

The intensity of facial pain was significantly correlated with smaller anterior ITV in ENS patients (P=0.010). The pain may be related to derangements in the sensory innervation of the anterior nasal cavity. The sensory receptors in the nose are responsible for the sensation of airflow and these receptors are temperature – sensitive. If there is no proper regeneration of the nerves and receptors, the nose might present hypersensitive responses to inspired air. [19,20] This response is aggravated by uncontrolled and turbulent airflow caused by small anterior ITV after turbinectomy.

PND and thick nasal discharge are increased with smaller posterior ITV (P = 0.030 and 0.032, respectively). Nasal mucociliary clearance is very important to nasal drainage. [21] An altered histologic structure, as the loss of cilia after turbinectomy, disrupts normal mucociliary flow from the paranasal sinuses which is carried along the uncinate process and inferior turbinate to the posterior nasopherynx. Thus, PND and thick nasal discharge are associated with defective mucociliary clearance in ENS patients due to inferior turbinectomy.

Regarding the scores of the extra-sinonasal symptoms, some of them suffered from sense of suffocation and this finding was significantly higher in patients with small ITVs (P=0.039) (Table III).

These findings are in agreement with the findings of previous studies. Jiang et al. reported that ENS patients seen to be in a state of dyspnea and felt suffocated due to decreased airflow resistance. [12] Hong and Jang reported that unexpectedly the scores of the extra-sinonasal symptoms were significantly higher in patients who had larger ITVs. [13]

Moreover, the abnormal breathing sensations lead to reduced concentration; chronic fatigue and mood troubles as fruntation, anger and depression. [12]

Extra-sinonasal symptoms might show greater individual variations, depending on personality and psychological condition of the patient.

The strength point of this study is the presentation of objective data guided by CT regarding inferior turbinate volume and its relationship with subjective symptoms in ENS patients. Other studies have only concentrated on subjective symptoms of these patients. [2,3,4,12,18,22,23]

The weak points in this study include small number of patients and lack of some investigations such as rhinomanometry.

Conclusion

ENS is a complex condition which can significantly impact patient's quality of life. The problem with ENS is the loss of inferior turbinate tissue. This study demonstrates that a small ITV is correlated with specific SNOT-25 as nasal dryness, PND, thick nasal discharge and facial pain in ENS patients.

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