Assessment of The Effect of Partial Inferior Turbinectomy on Pulmonary Function Tests

Original Article

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ABSTRACT

Objective: This work aimed to assess the effect of partial inferior turbinectomy on pulmonary function tests.

Patients and Methods: This prospective case series study was conducted on twenty-five patients with hypertrophied inferior turbinate. All of the study patients were subjected to comprehensive history taking with particular emphasis on the severity of the nasal obstruction using nasal obstruction symptom evaluation (NOSE) scale and response to medical treatment especially local decongestants, complete ENT examination with an endoscopic examination of the nose and paranasal sinuses to confirm the presence of bilateral hypertrophied inferior turbinates. Other parameters were measured, including O2 saturation (%), dyspnea score, and fatigue score. The pulmonary functions were measured using spirometry. Patients of the study were subjected to bilateral partial inferior turbinectomy under general anesthesia with the removal of the posterior end of the inferior turbinates. All preoperative measures were repeated three months postoperatively after stoppage of medical treatment for comparison with preoperative measures.

Results: Comparison between pre and post-operative measurements revealed a significant increase in post-operative FVC, FEV1, FEV1 / FVC, PEF, and FIF 50% measurement after partial inferior turbinectomy patients ($p < 0.05$ for all). However, there was a non-significant difference in FEF 50% measurements after partial inferior turbinectomy ($p = 0.066$).

Conclusion: Partial inferior turbinectomy surgery is a successful procedure for treating nasal blockage caused by a bilateral hypertrophied inferior turbinate that has not responded to the medicinal treatment, with improved pulmonary function tests and daily activity following the procedure.

Key Words: Hypertrophied turbinates, inferior turbinectomy, pulmonary function tests, spirometry.

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INTRODUCTION

Upper airway obstruction or extrathoracic obstruction includes any obstruction in the nasal cavity which is the first part of the upper airway. Chronic nasal obstruction causes mouth breathing, which reduces the nose's ability to humidify and warm the inspired air. This can cause bronchial constriction by changing the criteria of pulmonary surfactants including their diffusion and viscosity. A chronic nasal blockage also increases upper airway resistance, reducing airflow to the lungs and increasing breathing effort[1].

Since the nasal airway accounts for approximately half of total airway resistance, any nasal obstruction might increase total airway resistance. Even though nasal and pulmonary diseases are treated separately, the upper and lower airways may be thought of as one anatomical and functional unit. Nasal aerodynamics play a key role in tissue oxygenation during exercise. Increased nasal resistance affects tissue oxygenation and hence exercise tolerance[2].

Nasal obstruction is one of the most prevalent reasons for frequent Otorhinolaryngology outpatient visits. Either mucosal or anatomical factors can cause nasal obstruction. Inferior turbinate hypertrophy is one of the most prevalent anatomical nasal abnormalities. Hypertrophied inferior turbinates associated with deviated nasal septum are found in around 60–90% of persons with nasal blockage. The causes for hypertrophy of inferior turbinates include inhaled allergens, irritants, recurrent infection, and deviated nasal septum[3]. Medical treatment, including topical corticosteroids, antihistaminic drugs, and decongestants, can alleviate the manifestations of nasal obstruction in the early stage. Once failed, surgical correction is required,

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with partial inferior turbinectomy being a surgical option. Early surgical correction is required for an excellent postoperative outcome[4]. The work aimed to assess the effect of partial inferior turbinectomy on pulmonary function tests, whether there was an improvement or not.

PATIENTS AND METHODS:

A prospective case series study was conducted on twenty-five patients with bilateral hypertrophied inferior turbinates indicated for surgical intervention. Patients were enrolled in the study from the outpatient clinics of Otorhinolaryngology departments of [removed for blinding] spanning the period from June 2019 to December 2021. Approval of the institutional review board was obtained and informed written consent was taken from every patient before enrollment in the study.

In the study, patients should have bilateral persistent nasal obstruction not responding to medical treatment due to bilateral hypertrophied inferior turbinates. **Exclusion criteria for the study were** age less than 18 and more than 65 years old, uncontrolled hypertension or DM, history of previous nasal operation, nasal polyposis, excessive septal deviation necessitating surgical correction, or bilateral enlarged inferior turbinates with normal pulmonary function tests.

One hundred patients with bilateral hypertrophied inferior turbinates indicated for surgical correction were subjected to the specified inclusion and exclusion criteria resulting in 25 patients eligible for the study with normal pulmonary function tests being the main reason for exclusion from the study. The patients of the study were subjected to comprehensive history taking with particular emphasis on the severity of the nasal obstruction using an Arabic version of NOSE scale validated by **Amer *et al*.**[5] (Figure 1) and response to medical treatment, especially local decongestants, complete ENT examination with an endoscopic examination of the nose and paranasal sinuses to confirm the presence of bilateral hypertrophied inferior turbinates. Computed tomography of the nose and paranasal sinuses was performed for every patient to confirm the clinical findings. Other parameters were measured, including O2 saturation (%), dyspnea score (Figure 2), and fatigue score (Figure 3).

The pulmonary functions were measured with spirometry including the following measures: Forced Vital Capacity (FVC) (L), Forced Expiratory Volume in one second (FEV1) (L), the ratio of FEV1/FVC (%, Peak Expiratory Flow (PEF) (L/M), Forced Expiratory Flow at 50% (FEF 50%) (L/M) and Forced Inspiratory Flow at 50% (FIF 50%) (L/M)[5] (Table 1). The last two measures are specific for cases of upper airway obstruction

Patients of the study were subjected to bilateral partial inferior turbinectomy under general anesthesia with the removal of the posterior end of the inferior turbinates. All preoperative measures were repeated three months postoperatively after the stoppage of medical treatment for comparison with preoperative measurements.

Outcomes:

The primary outcome of the study was the assessment of the effect of partial inferior turbinectomy on pulmonary function tests, NOSE scale, oxygen saturation, dyspnea score, and fatigue score whether there was an improvement or not. The secondary outcomes of the study included a correlation between preoperative NOSE scale and pulmonary function tests and a correlation between postoperative NOSE scale and pulmonary function tests.

Statistical Analysis:

MedCalc version 18.11.3 (MedCalc, Ostend, Belgium) was used for data entry, processing, and statistical analysis. *Descriptive statistics included* mean, standard deviation (± SD), and range for parametric numerical data, while median and inter-quartile range (IQR) for non-parametric numerical data, and frequency and percentage for non-numerical data. The data of the study turned up to be non normally distributed using Kolmogorov–Smirnov test. *Analytical statistics included Wilcoxon sign rank* test to compare two (paired) study group means. Spearman's correlation analysis represented by the correlation coefficient "rs" assessed the strength of association between two quantitative variables. *P-values* of less than 0.05 (5%) were considered statistically significant, while *p values* of less than 0.001 were regarded as statistically highly significant.

* **تملأ بمعرفة المريض** : من فضلك أجب علي الاستبيان التالي لمعرفة تأثير انسداد التنفس علي حياتك اليومية. ما مدى تأثرك بهذه الأعراض فى الشهر الماضى؟
من فضلك اختر الاجابة الأدق

	لا يوجد مشكلة	**مشكلة بسيطة**	**مشكلة متوسطة**	**مشكلة سيئة إلى حد ما**	**مشكلة شديدة**
احتقان أو تصلب بالأنف	0	1	2	3	4
انسداد بالأنف	0	1	2	3	4
صعوبة التنفس عن طريق الأنف	0	1	2	3	4
اضطرابات في النوم	0	1	2	3	4
عدم القدرة علي التنفس جيدا من الأنف أثناء بذل مجهود اضافى	0	1	2	3	4

Fig. 1: Arabic version of NOSE scale

Item description	Grade	*n* (%)
I only get breathless with strenuous exercise	0	16 (7.2)
I get shortness of breath when hurrying on the level or walking up a slight hill	1	46 (20.8)
I walk slower than people of the same age on the level because of breathlessness or have to stop for breath when walking at my own pace on the level	2	41 (18.6)
I stop for breath after walking about 100 meters or after a few minutes on the level	3	72 (32.6)
I am too breathless to leave the house or I am breathless when dressing	4	46 (20.8)

Mean score 2.38±1.22

Fig. 2: Dyspnea score

During the past week, I have found that:	Score						
1. My motivation is lower when I am fatigued.	1	2	3	4	5	6	7
2. Exercise brings on my fatigue.	1	2	3	4	5	6	7
3. I am easily fatigued.	1	2	3	4	5	6	7
4. Fatigue interferes with my physical functioning.	1	2	3	4	5	6	7
5. Fatigue causes frequent problems for me.	1	2	3	4	5	6	7
6. My fatigue prevents sustained physical functioning.	1	2	3	4	5	6	7
7. Fatigue interferes with carrying out certain duties and responsibilities.	1	2	3	4	5	6	7
8. Fatigue is among my three most disabling symptoms.	1	2	3	4	5	6	7
9. Fatigue interferes with my work, family, or social life.	1	2	3	4	5	6	7

Fig. 3: Fatigue score

Table 1: The pulmonary function tests used in the study: Definitions and normal values.

Pulmonary function test	Definition	Normal values
Forced Vital Capacity (FVC) (L)	Forced vital capacity; the total volume of air that can be exhaled during a maximal forced expiration effort.	80% to 120% of predicted value by spirometer
Forced Expiratory Volume in one second (FEV1) (L),	Forced expiratory volume in one second; the volume of air exhaled in the first second under force after a maximal inhalation.	More than 80% of predicted value by spirometer
FEV1 / FVC % ratio	The percentage of the FVC expired in one second.	70% to 80% of predicted value by spirometer
Peak Expiratory Flow (PEF) (L/M),	person's maximum speed of expiration	400 and 700 L/M
Forced Expiratory Flow at 50% (FEF 50%) (L/M)	the rate of airflow exhaled recorded at 50% of forced vital capacity	80-100% of predicted value by spirometer
Forced Inspiratory Flow at 50% (FIF 50%) (L/M)	the rate of airflow inhaled recorded at 50% of forced vital capacity	80-100% of predicted value by spirometer

RESULTS:

Regarding primary clinical data, the mean age of all patients was (22 ± 3.57) years, and the average BMI was (25.5 ± 6). Regarding the gender of the patients, the majority (64%) of patients were males, while (36%) were females (Table 2).

A comparison between pre-and post-operative measurements revealed a highly significant decrease in postoperative dyspnea score, fatigue score, and NOSE scale, after partial inferior turbinectomy ($p < 0.0001$ for all). However, there was a significant increase in O2 saturation measurements after partial inferior turbinectomy patients ($p = 0.002$) (Table 3).

Comparison between pre and post-operative measurements revealed a highly significant increase in post-operative FVC, FEV1, PEF, and FIF 50% measurement after partial inferior turbinectomy patients ($p < 0.00001$ for all) and a significant increase in FEV1/ FVC ratio ($p = 0.029$). However, there was a non-significant improvement in FEF 50% measurements after partial inferior turbinectomy ($p = 0.066$) (Table 4).

Spearman's correlation analysis showed a significant negative correlation between pre-operative FVC and FEV1, and preoperative NOSE scale ($p = 0.037$ and 0.039, respectively) (Table 5). However, all post-operative spirometry measurements had a nonsignificant correlation with the post-operative NOSE scale ($p > 0.05$ for all) (Table 6). Regarding postoperative complications, 6 patients (24%) had postoperative bleeding, 15 patients (60%) had nasal crustations, and one patient had nasal synechia (Table 7).

Table 2: Basic clinical data among study patients:

Variables		Frequency (%)
Age (years)		22 ± 3.57*
BMI		25.5 ± 6
Gender	Female	9 (36%)
	Male	16 (64%)

* Mean ± SD. BMI: body mass index.

Table 3: Comparison between preoperative and postoperative clinical measurements:

Variable	Pre-operative measurement Mean ± SD	Post-operative measurement Mean ± SD	Wilcoxon Sign Rank test	*p value*
O2 saturation (%)	96.72 ± 0.68	97.36 ± 0.76	z =-3.0594	*0.002* *
Dyspnea score	2.5 ± 0.5	0.64 ± 0.48	z=-4.3724	*< 0.00001* **
Fatigue score	3.36 ± 0.48	0.48 ± 0.5	z=-4.3724	*< 0.00001* **
NOSE scale	12.36 ± 0.1.38	2.16 ± 1.46	z=-4.3724	*< 0.00001* **

NOSE: Nasal Obstruction and Septoplasty Effectiveness
** Highly significant
* Significant

Table 4: Comparison between preoperative and postoperative spirometry measurements:

Variable	Pre-operative measurement Mean ± SD	Post-operative measurement Mean ± SD	Wilcoxon Sign Rank test	*p value*
FVC (L)	4.13 ± 0.28	4.84 ± 0.12	z=-4.1143	*< 0.00001***
FEV1 (L)	3.44 ± 0.36	4.27 ± 0.3	z=-4.2513	*< 0.00001***
FEV1 / FVC (%)	83.4 ± 8.3	88.4 ± 6	z=-2.1929.	*= 0.02852.**
PEF (L/M)	7.12 ± 0.49	8.58 ± 0.59	z=-4.3724.	*< 0.00001***
FEF 50% (L/M)	3.94 ± 0.1	4.06 ± 0.32	z =-1.8422.	*0.06576.*
FIF 50% (L/M)	3.42 ± 0.15	4.8 ± 0.13	z=-4.3724.	*< 0.00001***

FVC: Forced vital capacity, FEV: Forced Expiratory Volume, PEF: Peak Expiratory Flow, FIF: Forced Inspiratory Flow, FEF: Forced Expiratory Flow
** Highly significant
* Significant

Table 5: Correlation between pre-operative spirometry measurements and pre-operative NOSE scale.

Associated Factor	Pre-operative NOSE scale	
	rs	*P*
Pre-operative FVC (L)	rs = -0.41992	*0.03663**
Pre-operative FEV1 (L)	rs = -0.4156	*0.03882**
Pre-operative FEV1 / FVC (%)	rs = -0.14031	*0.50353*
Pre-operative PEF (L/M)	rs = -0.27921	*0.17648*
Pre-operative FEF 50% (L/M)	rs = -0.18361	*0.37965*
Pre-operative FIF 50% (L/M)	rs = 0.17674	*0.39803*

rs: Spearman's rho (correlation coefficient), FVC: Forced vital capacity, FEV: Forced Expiratory Volume, PEF: Peak Expiratory Flow, FIF: Forced Inspiratory Flow, FEF: Forced Expiratory Flow
* Significant

Table 6: Correlation between post-operative spirometry measurements and post-operative NOSE scale:

Associated Factor	Post-operative NOSE scale	
	rs	*P*
Post-operative FVC (L)	rs = 0.15091	*0.47148*
Post-operative FEV1 (L)	rs = -0.11191	*0.59432.*
Post-operative FEV1 / FVC (%)	rs = -0.34956	*0.08674*
Post-operative PEF (L/M)	rs = -0.11057	*0.59876*
Post-operative FEF 50% (L/M)	rs = -0.12884	*0.53935*
Post-operative FIF 50% (L/M)	rs = 0.19477	*0.35083*

rs: Spearman's rho (correlation coefficient), FVC: Forced vital capacity, FEV: Forced Expiratory Volume, PEF: Peak Expiratory Flow, FIF: Forced Inspiratory Flow,
FEF: Forced Expiratory Flow

Table 7: Postoperative complication of the study patients

Complication	No.	Percentage
Bleeding	6	24%
Crustations	15	60%
Synechia	1	4%

DISCUSSION

In the present study, we evaluated the effect of partial inferior turbinectomy on pulmonary function tests in 25 patients with chronic bilateral nasal obstruction due to hypertrophied inferior turbinates. Pulmonary function tests were assessed preoperatively and three months post-operative. Other measures were evaluated with their implications on daily activity, including oxygen saturation, dyspnea score, and fatigue score.

In the present study, a comparison between pre and post-operative measurements revealed a highly significant increase in post-operative FVC, FEV1, PEF, and FIF 50% measurement after partial inferior turbinectomy patients ($p < 0.00001$ for all) and a significant increase in FEV1/FVC ratio ($p= 0.029$) after partial inferior turbinectomy ($p = 0.066$). This matches the findings of other studies, including a study by **Elzayat and Moussa**[7] who studied the effect of partial inferior turbinectomy on pulmonary function tests in 30 patients after the operation and found that the postoperative FVC, FEV1, FEV1/FVC ratio significantly improved in comparison with the pre-operative values. **Mandour *et al*.**[8] evaluated the effect of septoplasty with turbinectomy on polysomnographic findings and pulmonary function measures in 90 patients in a comparative way where the pre-operative; FVC, FEV1, and FEV1/FVC have significantly improved postoperatively. They hypothesized that the improvement was related to widening the nasal cavity, increased respiratory capacity, and increased breathing depth when compared with the preoperative period. **Arifa *et al*.**[1] assessed 88 after upper airway surgeries, including septoplasty and turbinoplasty. Spirometry was performed one day before and one month after surgery. Spirometry showed a statistically significant improvement in all four parameters (FVC, FEV1, FEV1/FVC, and PEFR after surgery in 86 subjects. They observed that age and duration of nasal obstruction had no effect on their findings. Their study concluded that diseases narrowing the nasal airway could affect the lower airway functions. **Unsal *et al***.[9] assessed nasal and pulmonary functions after radiofrequency ablation of persistent inferior turbinate hypertrophy in twenty-seven patients having no septal deviation. They found a statistically significant improvement of FEV1, FVC, and PEF.

In the current study, a comparison between pre and post-operative measurements revealed; non-significant difference in FEF 50% measurements in partial inferior turbinectomy patients ($p > 0.05$). This matches the finding of **Elzayat and Moussa**[7] who found a non-significant improvement of FEF 50% ($p = 0.673$). **Tuzuner *et al***.[10] who found a non-significant improvement of FEF 50% after septoplasty. However, **Mandour *et al***.[8] found a highly significant improvement in FEF 25-75% ($p < 0.001$). This difference in the results can be attributed to the combination between septoplasty and turbinectomy in the study by **Mandour *et al***.[8] compared with turbinectomy alone in our research.

In the present study, comparing pre and post-operative measurements revealed a highly significant decrease in postoperative dyspnea score, fatigue score, and NOSE scale, after partial inferior turbinectomy ($p < 0.0001$ for all). However, there was a significant increase in O2 saturation measurements after partial inferior turbinectomy patients ($p = 0.002$). Our findings match the findings of **Elzayat and Mousa**.[7] who found a significant improvement of dyspnea and fatigue scores postoperatively. **Mansour** *et al*.[11] assessed 80 patients with moderate to severe turbinate hypertrophy, 40 of them underwent submucosal turbinoplasty and the other 40 patients underwent partial inferior turbinectomy. There was a statistically significant decrease in mean nasal obstruction scores ($P < 0.05$) after surgery. **Arifa *et al***.[1] found a statistically significant improvement of oxygen saturation after upper airway surgeries, including septoplasty and turbinoplasty. They explained their finding by the enhancing effect of relieving upper airway obstruction on pulmonary oxygenation[6]. **Mandour *et al***.[9] reported a statistically significant improvement of oxygen saturation after septoplasty with turbinectomy.

In the current study, there was a significant negative correlation between pre-operative FVC and FEV1, and preoperative NOSE scale ($p = 0.037$ and 0.039, respectively). This finding supports the reverse relationship between nasal obstruction as demonstrated by the NOSE scale and pulmonary functions. Other studies have evaluated the effect of other surgeries for chronic nasal obstruction on pulmonary function tests (Table 8). Limitations of our study included resistance of some patients to do pulmonary function tests, non-compliance of patients with instructions, and a relatively small sample size

Table 8: Studies evaluating the effect of different nasal surgeries for chronic nasal obstruction on pulmonary function tests.

Author	Year	Number of patients	Type of surgery	Outcome measures	Results
Bulcun *et al*.[12]	2010	14 patients 20 controls	Septoplasty	Acoustic rhinometry (AR), visual analog scale (VAS), Pulmonary function tests, and bronchoprovocation test (BPT) on the day before surgery and 8 to 12 weeks after surgery.	• Significant improvement of FVC, FEV1, PEFR% • A borderline decrease in the rate of BHR in six patients. • A significant improvement in the symptoms of left and right nasal congestion, headache, postnasal drip, and olfactory function after surgery. • A significant improvement in the values of AR at right minimal cross-sectional area 1, left distance 1, and left distance 2.
Tuzuner *et al*.[10]	2016	30	Septoplasty	NOSE/SNOT22 questionnaires, Spirometry and 6mWT preoperatively.	Significant improvement of PEF, FIF50%, diastolic blood pressure, total tour count, Basal heart rate, dyspnea rate, fatigue score, NOSE, SNOT22
Elzayat and Moussa[7]	2018	30	Partial inferior turbinectomy	• Spirometry tests (FVC, FEV1, FEV1/FVC ratio, PEF, FEF50%, FIF50%). • Six minute walk test.	Significant improvement of FVC, FEV1, FEV1/FVC ratio, PEF, FIF50% Significant improvement of walked distance, diastolic blood pressure, heart rate, dyspnea score, and fatigue score

Panicker and Belaldavar[13]	2018	35	Septoplasty: 31 patients; septorhinoplasty: 4 patients.	Spirometry tests (FVC, FEV1, FEV1/FVC ratio, PEFR%).	Significant improvement of spirometry tests
Mandour *et al*.[8]	2019	90	Septoplasty with Turbinectomy	• Spirometry tests (FVC, FEV1, FEV1/FVC ratio, PEFR, FEF 25-75%,). • Polysomnography (Apnea hypopnea index, Snoring index /hour, Basal SpaO2, Minimal SpaO2.	• Highly significant improvement of all tested Spirometry tests • Highly significant improvement of polysomnography indices.
Unsal *et al*.[9]	2019	27	Radiofrequency ablation of the inferior turbinates	Acoustic rhinometry, a visual analog scale for nasal obstruction, and flow-sensitive spirometry on the day before and 4 months after the operation.	• A significant increase in the mean cross-sectional area and volume of the nose, • A significant increase in FEV1, FVC, PEF • A significant decrease in visual analog scale scores for nasal obstruction.
Elsherif *et al*.[14]	2019	60	45 patients: septoplasties and 15 patients: SMR.	• Spirometry tests (FVC, FEV1, FEV1/FVC ratio) • 6-minute walking test • VAS for nasal obstruction • Lund Kennedy score for nasal crustations	Significant improvement of FVC, FEV1, and FEV1/FVC, VAS score, walked distance, diastolic blood pressure, heart rate, fatigue Score, and dyspnea score.
Saxena *et al*.[15]	2020	56	34 patients: septoplasty. 22 patients: FESS.	Spirometry tests (FVC, FEV1, FEV1/FVC ratio)	Clinically and statistically significant improvement in FEV1 and FVC was irrespective of age, gender, or duration of obstruction

Sobh *et al*.[16]	2021	59	Endoscopic septoplasty	• Arterial blood gases • Spirometry tests (FVC, FEV1, and FEV1/FVC. • NOSE score	• A significant improvement of FVC and FEV1. • Oxygen saturation was significantly lower during nasal packing with significant improvement after removal of the nasal pack. • NOSE score significantly improved

FVC: Forced vital capacity, **FEV:** Forced Expiratory Volume, **PEF:** Peak Expiratory Flow, **FIF:** Forced Inspiratory Flow, **FEF:** Forced Expiratory Flow, **VAS:** Visual Analog Scale, **SMR:** Submucosal Resection, **NOSE:** Nasal Obstruction Symptom Evaluation, **SNOT:** Sinonasal Outcome Test, **BPT:** Bronchoprovocation Test.

CONCLUSION

Partial inferior turbinectomy surgery is a successful procedure for treating nasal blockage caused by a bilateral hypertrophied inferior turbinate that has not responded to the medicinal treatment, with improved pulmonary function tests and daily activity following the procedure.

CONFLICT OF INTEREST

There are no conflicts of interest.

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