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# Study of The Effect of Functional Endoscopic Sinus Surgery on Spirometry in Patients with Chronic Rhinosinusitis and Chronic Obstructive Lung Disease

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## Abstract:

The goal of this study is to assess the effect of functional endoscopic sinus surgery (FESS) on spirometry results in patients with chronic rhinosinusitis (CRS) and chronic obstructive lung disease. In Otorhinolaryngology and chest departments in Beni-Suef University hospital from August 2016 to February 2019, 60 patients were included in this study: 47 were asthmatic and 13 were chronic obstructive pulmonary disease (COPD) and all had chronic rhinosinusitis with nasal polypi, preoperative spirometry and computerized tomography (CT) were done. Lund-MacKay CT score system was used. After FESS by comparing results of preoperative spirometry in Forced Expiratory Volume at 1st second percentage (FEV1%) and Forced Expiratory Volume at 1st second/ Forced Vital Capacity percentage (FEV1/FVC%) and Lund-MacKay CT score, there was a statistical significance in improvement of FEV1% and FEV1/FVC% on 1st and 3rd months postoperative in both asthmatic and COPD patients and there was a statistical significance in decrease of Lund-MacKay CT score on 3rd month postoperatively.

**Keywords:** FESS, Spirometry, Rhinosinusitis, Asthma, COPD.

## 1. Introduction:

Chronic rhinosinusitis (CRS) is an inflammatory process of the mucous membrane of the nose and paranasal sinuses with the accumulation of eosinophils, mast cells, goblet cells and fibroblasts [1].

Obstruction of sinus ostium by edema and inflammatory mucous, delayed recovery of mucociliary function mainly lead to a transformation from an acute to a chronic inflammatory process [2]. Symptoms of chronic rhinosinusitis (CRS) include mucopurulent anterior or posterior nasal

discharge, localized facial pain, tenderness at the region of sinus affected, fetid odor and other symptoms with no response to 12 weeks of adequate therapy [3]. The incidence of chronic rhinosinusitis increases in lower respiratory diseases' patients mainly with asthma, chronic obstructive pulmonary disease (COPD) and bronchiectasis [4].

The presence of asthma in chronic rhinosinusitis patients is estimated to be 20% and increases to 50% in patients that have chronic rhinosinusitis with nasal polyposis [5]. Asthma is characterized by symptoms as cough, wheeze, shortness of breath and chest tightness with association of limitation of expiratory airflow, symptoms and airflow limitation are extremely variable between patients and within the same patient at different points in time [6]. COPD is a chronic disease of progressive airflow limitation combined with symptoms such as cough, sputum production and dyspnea [7]. The unified airway concept represents the entire respiratory system as a functional unit consists of the nose, paranasal sinuses, larynx, trachea, and distal lung [8].

The role of nasal blockage in pathogenesis of lower airway disease includes loss of nasal function as cleaning, warming and humidifying the inhaled air, loss of its protective mechanism and that produces obstruction of the sinus ostia with a reduction in the nitric oxide (NO) level in the upper and lower airways in patients with chronic sinus disease [9]. Patients with chronic rhinosinusitis with nasal polyps (CRSwNP) and asthma have higher CT scores and severe nasal obstruction and decrease of smell with lower airway outcomes, while patients with chronic rhinosinusitis without nasal polyps (CRSsNP) and asthma complain of more severe headaches and postnasal discharge [10]. Pulmonary function tests are useful methods that help in the diagnosis and monitoring of patients with asthma, and spirometry is the most commonly used measure of pulmonary function [11]. Forced expiratory volume in the first second (FEV1) is the amount expelled during the first second of the FVC maneuver. The ratio of FEV1 and FVC (FEV1/FVC) is used as an indicator of obstruction [12]. Spirometry is used in diagnosis of airflow obstruction in patients with asthma or chronic obstructive pulmonary disease (COPD) [13].

Diagnosis of asthma or COPD without assessment of lung function is impossible as both asthma and COPD have in their definitions a combination of lung function and clinical criteria [14]. Endoscopic sinus surgery aims to reduce inflamed and diseased tissue, open natural ostium of sinuses and for better application of topical treatment after absence of objective improvement on endoscopy, opacification seen on CT scans and failure of symptoms to improve [15].

Surgical management of CRS should be the choice if there is associated lower airway

disease for better control of lower airway disease [16].

The aim of the study was to evaluate the effect of functional endoscopic sinus surgery on spirometry in patients with chronic rhinosinusitis and chronic obstructive lung disease.

## 2. Patients and Methods:

This was a prospective study performed in otorhinolaryngology department of Beni-Suef university hospital, chest evaluation and spirometry were carried out to the patients in the chest department from August 2016 to February 2019 involving 60 patients and preoperative consents were obtained from patients.

**2.1 - Inclusion criteria:**

1. Adult patients >18years with chronic rhinosinusitis with nasal polypi for more than 3 months with failure of medical treatment diagnosed according European Position Paper on Rhinosinusitis and Nasal Polyps (EPOS2012) [17].

2. Associated with obstructive airway disease with wheezy dyspnea, cough and expectoration and obstructive Spirometry with FEV1/FVC% <70%.

**- Exclusion criteria:**

1. Patients with chronic rhinosinusitis improved on medical treatment.

2. Patients with prior surgery for chronic rhinosinusitis.

3. Pregnant women.

4. Patients with bleeding tendency.

5. Patients with chronic diseases who are not fit for surgery.

**2.2 All patients were subjected to:**

**A. preoperative assessment;**

1. History taking regarding severity of symptoms of chronic rhinosinusitis and its duration.

2. Examination of patients and diagnosis of CRS according to **(EPOS2012)** with the presence of

Two or more symptoms of:

- Nasal blockage/obstruction/congestion
- Nasal discharge (anterior/posterior nasal drip)
- Facial pain/pressure
- Reduction or loss of smell

And either

• Endoscopic signs of:

1- Nasal polyps (and/or)

2- Mucopurulent discharge primarily from middle meatus (and/or)

3- Edema/ mucosal obstruction primarily in middle meatus

and/or

• CT changes:

- Mucosal changes within the ostiomeatal complex and/or sinuses.

- Chronic rhinosinusitis with nasal polyps (CRSwNP) which is chronic rhinosinusitis with bilateral, endoscopically visualized polyps in middle meatus.

3. CT scan was assessed according to **Lund-MacKay** scoring system [18]. It is a widely

used method for radiologic staging of chronic rhinosinusitis

When reading a CT scan of the paranasal sinuses and ostiomeatal complex, each sinus is given a score of: 0 (no abnormality), 1 (partial opacification) and 2 (complete opacification)

The ostiomeatal complex is assigned a score of either 0 (not obstructed) or 2 (obstructed).

Grouping of sinuses into:

- frontal sinus
- anterior ethmoidal cells
- posterior ethmoidal cells
- maxillary sinus
- sphenoid sinus
- ostiomeatal complex

Each side is graded separately. A combined score of up to 24 is possible. A score of < 6 is insignificant.

4. Preoperative chest assessment:

- Full history related to chest diseases as dyspnea, wheezes, chronic cough and drug intake, chest examination and Spirometry were done to all patients at the Chest department.

- Spirometry was done using (JEAGER type Masterscreen- PFT) at chest department.

- The Spirometry values were considered to indicate significant airway obstruction when FEV1/ FVC% < 70%.

5. Preoperative full labs were done to all patients and ECG for patients above 40 years.

Functional Endoscopic Sinus Surgery:

- Was done under general hypotensive anesthesia

- Using 0, 30 degrees 4mm rigid nasal endoscope

- According to number and severity of sinuses affection, the process of sinuses cleaning and opening of sinuses ostium was carried out using Messerklinger's technique [19].

- Incising the anterior attachment of the uncinate process by sickle knife then uncinectomy.

- The ethmoidal bulla was opened and removed piecemeal.

- The anterior ethmoidal air cells were cleared.

- Opening the maxillary antrum for associated maxillary sinusitis, exploring the frontal recess in need.

- The posterior ethmoids and the sphenoid were also identified and cleared.

- At the end of surgery Merocel nasal pack was put in the nasal cavity.

**B. At the follow up visits;**

1. Immediately after operation patients received medical treatment in the form of I.V antibiotics and analgesics.

2. Nasal pack was removed 48 hours postoperative.

3. Medications were described to the patients in the form of antibiotics, steroid nasal spray and alkaline nasal douche.

4. 1$^{st}$ post-operative visit was 1 week after hospital departure then 2 weeks later and after that every 1 month.

5. Spirometry was done after 1 and 3 months.
6. CT assessment was done after 3 months.

**2.3 Statistical Analysis**

• Analysis of data was done using SPSS (statistical program for social science) as follows;

- Description of quantitative variables as mean, SD, minimum and maximum.
- Description of qualitative variables was in the form of number (NO) and percentage (%).
- Comparison between quantitative variables was carried out by independent t-test which was used to test the difference between the means of two groups of a scale variable.
- Comparison between categorical data was done using the Chi square test, to test the statistical difference between the two groups.
- The significance of the results was assessed in the form of P-value that was differentiated into:

• P value > 0.05 non-significant
• P < 0.05 significant
• P < 0.001 highly significant

**2.4. Ethical Considerations and Review:** study protocol was approved by Faculty of Medicine, Beni-Suef University, Research Ethics Committee.

## 3. Results:

60 patients with ages ranged from 24 to 63 years with mean age of 37.7, 43 females and 17 males. Two obstructive lung diseases were included in the study with 47 asthmatic patients and 13 COPD patients (table1). Comparing of spirometry results was done preoperatively and after 1 and 3 months postoperatively and Lund-Mackay CT score was done after 3 months postoperatively.

The results have shown significant decrease of Lund-Mackay CT score after 3 months postoperatively in asthmatic group from 20.9±2.9 to 2.5±1.3 and in COPD group from 21.7±2.7 to 2.5±1.5 (table 2).

Significant improvement of FEV1% value was present in asthmatic group from 74.1±10.8 preoperatively to 79.7±8.3 at 1 month postoperative and to 90.1±10.5 at 3 months postoperatively (table 3).

Also there was a significant improvement of FEV1% value in COPD group from 40±4.8 preoperatively to 43.5±4.6 at 1 month postoperative and to 48.4±4.3 at 3 months postoperatively (table 4).

Significant improvement was present in FEV1/FVC% postoperative values in asthmatic group in 1 and 3 months postoperatively from 61.3±5.8 to 67.5±3.8 then to 70.6±3.9 (table 5).

Significant improvement was present in FEV1/FVC% postoperative values in COPD group in 1 and 3 months postoperatively from 44.6±8.1 to 47.46±6.7 then to 49.84±6.8 (table 6).

**Table (1): Baseline patient characteristics:**

| **Characters** | **Values** |
|---|---|
| **Age** | |
| Mean± SD | 37.7 ± 10.9 |
| Range(Min-Max) | (24- 63) |
| Median | 36 |
| **Sex No. (%)** | |
| Males | 17(28.3%) |
| Females | 43(71.7%) |
| **Pathology (%)** | |
| Asthma | 47(78.3%) |
| COPD | 13(21.7%) |

**Table (2): Lund-MacKay CT score assessment preoperative and 3 months postoperative**

| **CT Score** | **Pre-operative** | **3 months post-operative** | **P-value** |
|---|---|---|---|
| **Asthmatic group** | | | |
| Mean± SD | 20.9 ± 2.9 | 2.5 ± 1.3 | **<0.001**** |
| **COPD group** | | | |
| Mean± SD | 21.7 ± 2.7 | 2.5 ± 1.5 | **<0.001**** |

**Table (3): Follow up of FEV1% in asthmatic group:**

| FEV1% | Mean ± Std. Deviation | P-value |
|---|---|---|
| Preoperative | 74.1±10.8 | **<0.001**** |
| 1st month post-operative | 79.7±8.3 | |
| Preoperative | 74.1±10.8 | **<0.001**** |
| 3rd month post-operative | 90.1±10.5 | |
| 1st month post-operative | 79.7±8.3 | **<0.001**** |
| 3rd month post-operative | 90.1±10.5 | |

**Table (4): Follow up of FEV1% in COPD group:**

| FEV1% | Mean ±Std. Deviation | P-value |
|---|---|---|
| Preoperative | 40±4.8 | **<0.001**** |
| 1st month post-operative | 43.5±4.6 | |
| Preoperative | 40±4.8 | **<0.001**** |
| 3rd month post-operative | 48.4±4.3 | |
| 1st month post-operative | 43.5±4.6 | **<0.001**** |
| 3rd month post-operative | 48.4±4.3 | |

**Table (5): Follow up of FEV1/FVC% in asthmatic group:**

| FEV1/FVC% | Mean± Std. Deviation | P-value |
|---|---|---|
| Preoperative | 61.3±5.8 | **<0.001**** |
| 1st month post-operative | 67.5±3.8 | |
| Preoperative | 61.3±5.8 | **<0.001**** |
| 3rd month post-operative | 70.6±3.9 | |
| 1st month post-operative | 67.5±3.8 | **<0.001**** |
| 3rd month post-operative | 70.6±3.9 | |

**Table (6): Follow up of FEV1/FVC% in COPD group:**

| FEV1/FVC% | Mean± Std. Deviation | P-value |
|---|---|---|
| Preoperative | 44.6±8.1 | **<0.001**** |
| 1st month post-operative | 47.46±6.7 | |
| Preoperative | 44.6±8.1 | **<0.001**** |
| 3rd month post-operative | 49.84±6.8 | |
| 1st month post-operative | 47.46±6.7 | **0.021*** |
| 3rd month post-operative | 49.84±6.8 | |

## 4. Discussion:

Among 2.7% to 6.6% of the population are thought to have chronic rhinosinusitis, the incidence increases in patients with chronic inflammatory lower respiratory disease mainly in association with bronchial asthma and COPD [20].

A powerful association between asthma and chronic rhinosinusitis as they share the same histology, with tissue eosinophil

infiltration, increased glandular tissue and edema [11]. Chronic sinusitis is present in about 40–75 % of patients with asthma [21].

The main mechanisms of this association are not clear but the two common suggested hypotheses are sinonasal bronchial reflex and dripping of nasal discharge to the lung and the duration of the coexistence of asthma and sinusitis had a negative effect on the treatment outcome of both diseases and that supports the theory of unified airway [22]. The studies [23], [24] reported that the pulmonary function test did not change or improve postoperatively and the study [25] found that there was no statistically significant change in postoperative pulmonary function test results regarding asthmatic patients. The study [26] found that asthma was not improved significantly following FESS, but there was a significant drug reduction and improvement in nasal symptoms in patients with massive nasal polyposis. And also the studies [22], [27] and [28] and meta-analysis [29] reported no statistically significant change in FEV1 value postoperatively.

By contrast in study [30] there was a significant improvement in mean FEV1 in patients after FESS operation. And the study [31] found a significant improvement in pulmonary function test of patients with asthma associated with chronic sinusitis following ESS.

Lund-Mackay scores were statistically lower postoperatively and the sinonasal symptoms were also statistically better and the FEV1% value improved from 83% to 90% and this improvement was statistically significant in [32]. In the study [33] 12-month FEV1 (% predicted) after ESS showed significant increase, with a change of 3.95 ± 7.87% compared with the baseline. And the study [34] reported that FEV1 (% predicted) improved from 64 to 86% and the study [35] evaluated the FEV1 (% predicted) of 86 patients which improved after endoscopic sinus surgery (ESS).

The study [36] concluded that FESS has a positive effect on the pulmonary function of asthmatic patients with chronic sinusitis and performing surgery early in the course of the disease gives a better outcome and could be useful to the patient.

There was also a significant improvement in the FEV1/FVC value at 1 month postoperatively in study [9] with an effect of ESS on relieving the lower airway obstruction and the main mechanism of improvement in Pulmonary Functions is unclear. It is likely to occur due to removal of trigger areas in the nose and sinuses that can induce the release of leukotrienes, prostaglandins and inflammatory mediators which affect the lower airways, also the study [21] reported a significant improvement in the FEV1/FVC ratio post-operatively in the third month.

In our study FEV1/FVC% values preoperatively were 61.3 for asthmatic and 44.6 for COPD and 1 month postoperatively were 67.5 and 47.46 sequentially. And 3 months postoperative values was 70.6 asthmatic and 49.84 for COPD and the improvement was statistically significant in both.

Also the studies [32], [37] reported a significant improvement in postoperative FEV1 value and a reduction in drug usage in asthmatic patients and in the study [38] it was found that the 6- and 12-month postoperative FEV1 percent (% of predicted) showed significant increase.

In our study FEV1% value has shown significant increase on 1st and 3rd months postoperatively for both asthmatic and COPD groups

For asthmatic group it improved from 74.1 to 79.7 then to 90.1

For COPD group it improved from 40 to 43.5 then to 48.4

The data regarding postoperative CT scoring was taken at three months after endoscopic sinus surgery in the study [39] and that because of the edema phase takes nearly one month and after three months the healing process becomes complete.

And it showed the positive effect of sinus surgery on patients with bronchial asthma as well as patients with COPD and this symptomatic improvement was independent of pulmonary disease, it also reported that the median Lund-MacKay Score was 13.5 points with no difference between asthma patients and COPD patients (p = 0.277), Patients with score of five points were determined to be nonpathological. In the study [40] patients with chronic sinusitis were found to have a score ranging from 10 to 13.4 points

In our study Lund-Mackay CT score was taken 3 months postoperative. It was preoperatively with mean of 20.9 for asthmatic patients and mean of 2.5 postoperatively and for COPD patients 21.7 mean Pre and 2.5 mean post operatively respectively.

## 5. Conclusion and Recommendations:

Association of upper and lower airway diseases is very common, bronchial asthma and COPD are associated with chronic rhinosinusitis and functional endoscopic sinus surgery has a positive effect on spirometry results in asthmatic and COPD patients associated with chronic rhinosinusitis mainly with nasal polyps The study recommends FESS for CRS associated with asthma or COPD and more attention to COPD coexistence with CRS.

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