

Evaluation of Pulmonary Function in Patients Undergoing Functional Endoscopic Sinus Surgery

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Citation: Mark Jittu Vincent*, Vadisha S Bhat, Vaishnavi Shetty, Rajeshwary Aroor, Marina Saldanha, Goutham MK, et al. Evaluation of Pulmonary Function in Patients Undergoing Functional Endoscopic Sinus Surgery. *Annal of Otol Head and Neck Surg.* 2024;3(1):1-11.

Received Date: 28 January, 2024; **Accepted Date:** 07 February, 2024; **Published Date:** 08 February, 2024

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ABSTRACT

Objective: To assess pulmonary function before and after FESS. **Methods:** We conducted a cross-sectional analytical study consisting of 40 patients with Chronic Rhinosinusitis with or without nasal polyposis. Pulmonary function test (PFT) was performed using a spirometer (RMS Helios 401) preoperatively and after 1 month of FESS. The preoperative and postoperative PFT results were analysed.

Results: There was a male preponderance in the study group (67.5%). Most of the subjects were in the age group of 41-60. Nasal obstruction was the predominant complaint of the study subjects (57.5%). There was a significant improvement in FVC, FEV1 percentage of predicted value and FEF 25%-75% percentage of predicted value postoperatively. The improvement in pulmonary function of patients who underwent FESS for CRS and FESS for CRSwNP did not show any statistically significant difference.

Conclusion: CRS is a disease commonly seen in men in the fourth and fifth decades of life. Nasal obstruction is the most common presenting in these patients. FESS improves pulmonary function in patients with CRS or CRSwNP.

Keywords: FESS; Pulmonary function test; Chronic Rhinosinusitis; Nasal polyposis

INTRODUCTION

Chronic rhinosinusitis (CRS) is an inflammatory disease of the mucosa of the nasal cavity and paranasal sinuses with symptoms lasting longer than 12 weeks [1-3]. The respiratory tract is in continuous exposure to gases and airborne particles and is secured by immune responses and the mucociliary clearance system [4]. FESS is a minimally invasive and accomplished surgical treatment for the management of paranasal sinus pathologies such as polyp and sinusitis [5,6]. More explicitly, it has been demonstrated that an antigen set in a territory of the respiratory tract results in the induction of inflammatory mediators in other distal areas, leading to the conclusion that onset of inflammation can occur throughout the respiratory system by some regulatory processes which appear to be set off from any site of the respiratory tract [4,6]. The relationship between Nose and Lung ailments is notable. However, there are very few number of studies concerning the effects of FESS on pulmonary function

in patients with CRS and CRSwNP. We conducted this study to evaluate the change in pulmonary function of patients with CRS or CRSwNP following FESS.

METHODS

This cross-sectional analytical study was conducted in a teaching hospital over a period of one and half years after obtaining the clearance from the institutional ethics committee. Chronic Rhinosinusitis/ Sino nasal polyposis patients of age more than 5 years who undergo FESS, willing to participate in the study, and able to perform spirometry were included in the study. Patients not willing to participate in the study, patients with pre-existing COPD or pulmonary disease and patients undergoing septoplasty for deviated nasal septum along with FESS were excluded.

The details of the study participants like gender, age, presenting complaint, clinical findings were noted. Pulmonary function test (PFT) was performed using a spirometer (RMS Helios 401). All measurements were made in the sitting position. Forced expiratory volume in one second (FEV1), forced vital capacity (FVC), and maximal mid expiratory flow (FEF25–75%) were measured. The largest values of FVC, FEV1, and FEF25–75 from the first three technically satisfactory forced expirations were selected. All data were expressed in absolute values and the percentage of predicted normal values. The preoperative and postoperative PFT results were analysed

STATISTICAL ANALYSIS

SPSS software was used for data analysis. The collected information was summarised by using

1. Frequency and Percentage-Qualitative Data
2. Mean and Standard Deviation -Quantitative Data

To compare the outcomes of the Pulmonary Function test Paired t-test was used.

RESULTS

The mean age of study subjects was 42.55. Most number of subjects were found in the age group of 41-60. The youngest was a 7-year-old boy, and the oldest was a 68-year-old male. Nasal obstruction was the most common presenting symptom in the subjects (57.5%) included in the study. Patients were broadly divided into two categories, based on presence of nasal polyps as CRSwNP (30) and CRS (10).

Among 40 patients evaluated, one had abnormal FVC percentage of predicted value preoperatively. In rest of the patients, preoperative percentage of predicted values of FVC, FEV1, FEV1/FVC and FEF25-75% were within normal range.

Similar to the percentage of predicted value, the same patient had preoperative abnormal FVC absolute value. In rest of the patient's preoperative absolute values of FVC, FEV1, FEV1/FVC and FEF25-75% were within normal range.

The patient who had preoperative abnormal FVC percentage of predicted value had normal post-operative value. In all other patients the post-operative percentage of predicted values of FVC, FEV1, FEV1/FVC and FEF25-75% were within normal range.

The percentage of predicted value of the patient who had preoperative abnormal FVC absolute value, was normal during post-operative Pulmonary function testing. In rest of the patients, post-operative absolute values of FVC, FEV1, FEV1/FVC and FEF25-75% were within normal range.

There is no statistical significance in the FVC absolute values and FEV1/FVC ratio preop and post-operative values, however there is statistically significant difference in FVC percentage of predicted pre and postoperative values.

There was a difference in the mean FEV1 percentage of predicted value and absolute FEV1 values pre and postoperatively, however the change in FEV1 percentage of predicted value was found to be statistically significant.

There was a difference in the mean FEF25-75% percentage of predicted value and absolute FEF25-75% values pre and postoperatively, however the change in FEF25-75% percentage of predicted value was found to be statistically significant.

Analysis of preoperative and post-operative parameters of pulmonary function tests in patients with Nasal Polyposis (n=30) and Chronic Rhinosinusitis (n=10) showed that results were comparable to that of the study group.

Comparison of the Pulmonary Function Test values and statistical indices of patients who underwent FESS for Chronic Rhinosinusitis with Nasal Polyposis and Chronic Rhinosinusitis did not show any statistically significant difference among the two groups.

Table 1: FVC, FEV1, FEV1/FVC AND FEF_{25-75%} - Preoperative percentage of predicted values.

Percentage of Predicted Values	N	Mean	Standard Deviation	Standard Error Mean
FVC %P	40	86.33	12.033	1.903
FEV1 %P	40	93.03	10.197	1.612
FEV1/FVC %P	40	108.8	12.502	1.977
FEF _{25-75%} %P	40	91.55	16.662	2.635

Among 40 patients evaluated, one had abnormal FVC percentage of predicted value preoperatively. In rest of the patients, preoperative percentage of predicted values of FVC, FEV1, FEV1/FVC and FEF_{25-75%} were within normal range.

Table 2: FVC, FEV1, FEV1/FVC AND FEF_{25-75%} - Preoperative absolute values.

Absolute Values	N	Mean	Standard Deviation	Standard Error Mean
FVC	40	3.53	0.64	0.101
FEV1	40	3.2	0.564	0.089
FEV1/FVC	40	0.87	0.25	0.071
FEF _{25-75%}	40	0.98	0.158	0.025

Similar to the percentage of predicted value, the same patient had preoperative abnormal FVC absolute value. In rest of the patient's preoperative absolute values of FVC, FEV1, FEV1/FVC and FEF_{25-75%} were within normal range.

Table 3: FVC, FEV1, FEV1/FVC AND FEF_{25-75%} - Post operative percentage of predicted values.

Percentage of Predicted Values	N	Mean	Standard Deviation	Standard Error Mean
FVC %P	40	88.68	10.442	1.651
FEV1 %P	40	96.08	9.577	1.514
FEV1/FVC %P	40	108.7	10.843	1.714
FEF _{25-75%} %P	40	92.9	15.189	2.402

The patient who had preoperative abnormal FVC percentage of predicted value had normal post-operative value. In all other patients the post-operative percentage of predicted values of FVC, FEV1, FEV1/FVC and FEF_{25-75%} were within normal range.

Table 4: FVC, FEV1, FEV1/FVC AND FEF_{25-75%} - Postoperative absolute values.

Absolute Values	N	Mean	Standard Deviation	Standard Error Mean
FVC	40	3.65	0.662	0.105
FEV1	40	3.23	0.62	0.098
FEV1/FVC	40	0.88	0.22	0.068
FEF _{25-75%}	40	0.96	0.09	0.024

The percentage of predicted value of the patient who had preoperative abnormal FVC absolute value, was normal during post-operative Pulmonary function testing. In rest of the patients, post-operative absolute values of FVC, FEV1, FEV1/FVC and FEF_{25-75%} were within normal range.

Table 5: Paired t-Test - FVC %P and FVC.

	Paired Differences				t	p-value
	Mean	95% Confidence Interval of the Difference				
		Lower	Upper			
FVC %P preop - FVC %P postop	-2.35	-3.268	-1.432	-5.18	0.001	
FVC preop - FVC postop	-0.13	-0.254	0.004	-1.96	0.058	

There is no statistical significance in the FVC absolute values, however there is statistically significant difference in FVC percentage of predicted pre and postoperative values.

Table 6: Paired t-Test FEV1 %P and FEV1.

	Paired Differences				t	p-value
	Mean	95% Confidence Interval of the Difference				
		Lower	Upper			
FEV1 %P preop - FEV1 %P postop	-3.05	-4.066	-2.03	-6.1	0.001	
FEV1 preop - FEV1 postop	-0.025	-0.178	0.128	-0.3	0.743	

There was a difference in the mean FEV1 percentage of predicted value and absolute FEV1 values pre and postoperatively, however the change in FEV1 percentage of predicted value was found to be statistically significant.

Table 7: Paired t-Test FEV1/FVC

	Paired Differences			t	p-value
	Mean	95% Confidence Interval of the Difference			
		Lower	Upper		
FEV1/FVC preop - FEV1/FVC postop	0.1	-1.429	1.629	0.13	0.895

There was no statistically significant difference in FEV1/FVC ratio preop and post-operative values.

Table 8: Paired t-Test FEF_{25-75%} %P and FEF_{25-75%}.

	Paired Differences			t	p-value
	Mean	95% Confidence Interval of the Difference			
		Lower	Upper		
FEF 25-75 %P preop - FEF 25-75 %P postop	-1.35	-2.122	-0.578	-3.538	0.001
FEF 25-75 preop - FEF 25-75 postop	0.025	-0.076	0.026	-1	0.323

There was a difference in the mean FEF_{25-75%} percentage of predicted value and absolute FEF_{25-75%} values pre and postoperatively, however the change in FEF_{25-75%} percentage of predicted value was found to be statistically significant.

Table 9: Preoperative and postoperative analysis of pft in patients with chronic rhinosinusitis with nasal polyposis(n=30).

	Paired Differences			t	p-value
	Mean	95% Confidence Interval of the Difference			
		Lower	Upper		
FVC %P preop - FVC %P postop	-2.25	-3.568	-1.732	-5.3	0.001
FVC preop - FVC postop	0.115	-0.654	0.002	1.935	0.06
FEV1 %P preop - FEV1 %P postop	-3.15	-4.116	-1.904	-6.02	0.001
FEV1 preop - FEV1 postop	0.035	-0.188	0.148	-0.36	0.749
FEV1/FVC %P preop - FEV1/FVC %P postop	0.13	-1.329	1.529	0.12	0.925
FEF _{25-75%} %P preop - FEF _{25-75%} %P postop	-1.4	-2.122	-0.578	-3.508	0.001
FEF _{25-75%} preop - FEF _{25-75%} postop	-0.04	-0.086	0.016	-1	0.336

Analysis of preoperative and post-operative parameters of pulmonary function tests in patients with Nasal Polyposis showed that results were comparable to that of the study group.

Table 10: Preoperative and postoperative analysis of pft in patients with chronic rhinosinusitis (n=10)

	Paired Differences			t	p-value
	Mean	95% Confidence Interval of the Difference			
		Lower	Upper		
FVC %P preop - FVC %P postop	-2.45	-3.428	-1.632	-5.06	0.001
FVC preop - FVC postop	0.135	-0.054	0.006	1.995	0.056

FEV1 %P preop - FEV1 %P postop	-2.95	-4.026	-2.094	-6.12	0.001
FEV1 preop - FEV1 postop	0.015	-0.158	0.118	-0.3	0.737
FEV1/FVC %P preop - FEV1/FVC %P postop	0.07	-1.229	1.739	0.144	0.865
FEF _{25-75%} %P preop - FEF _{25-75%} %P postop	-1.3	-2.362	-0.458	3.568	0.001
FEF _{25-75%} preop - FEF _{25-75%} postop	-0.01	-0.066	0.036	-1	0.31

The comparison of preoperative and post-operative parameters of pulmonary function tests in patients with Chronic Rhinosinusitis showed that results were similar to that of the study group.

Table 11: comparison of the results of chronic rhinosinusitis and chronic rhinosinusitis with nasal polyposis.

Difference	2.35
Standard error	3.958
95% Confidence interval	-5.6629 to 10.3629
t- statistics	0.594
Significance level (p-value)	0.5562

Comparison of the Pulmonary Function Test values and statistical indices of patients who underwent FESS for Chronic Rhinosinusitis without Polyposis (Table 9) and Chronic Rhinosinusitis with Nasal Polyposis (Table 10) did not show any significant difference among the two groups.

DISCUSSION

We conducted a study to evaluate the functional relationship between the nose and the lower airway by performing a Pulmonary Function Test (PFT) before FESS and one month following the surgery using spirometry to assess the changes.

In our study, the majority of the patients undergoing FESS were men, consisting of 67.5% of the total study group, suggesting a male predominance of the condition. Karuthedath S *et al.* [7] and Stevens W *et al.* [8] also had found that males were more likely to be affected, but no specific factors like genetic, hormonal, or environmental factors responsible for this were found.

Most of the patients included in our study were in the 41-60 age group which was similar to studies done by Karuthedath S *et al.* [7] and Tomiki K [9].

The chief complaint of the majority of the patients in this study was Nasal obstruction which was in accordance with the study done by Newton J [10]. Other frequent presenting symptoms may be watery rhinorrhea, anosmia, and post nasal drip which also were evident in some subjects included in this study.

The patients included in this study underwent FESS which is the established and effective treatment for medically resistant Chronic Rhinosinusitis and Chronic Rhinosinusitis with Nasal Polyposis (CRSwNP) and many studies support this fact including the studies by Sharma R *et al.* [11] and Gulati S *et al.* [12].

In our study there were 10 patients with Chronic Rhinosinusitis (CRS) and 30 patients had Chronic Rhinosinusitis with Nasal Polyposis (CRSwNP). The clinical presentation of these cases ascertained the need for surgery that is FESS.

In a study done by Yasan H [13], surgical outcomes were analyzed clinically. Zhang L *et al.* [14] studied the pulmonary function in 240 patients undergoing FESS. FEV1 was found to be significantly lower in CRSwNP

group compared to other group ($p < 0.01$) and had significant increase when compared to the other groups post-operatively. In our study we performed PFT to analyze the outcome following FESS.

In our study, there was a significant improvement in FVC, FEV1 percentage of predicted value and FEF25-75% percentage of predicted value. In a study done by Karuthedath S *et al.* [7] amongst 30 adult patients with CRSwNP who belonged to the age group of 18-55 years, there was a significant improvement in the mean FEV1 values post-surgically ($p < 0.05$). They concluded that improvement in PFT values signifies a decrease in bronchial hyperresponsiveness as compared to preoperative.

In a similar study by Youssef A *et al.* [15] in medically resistant CRS patients, they found that in the patients undergoing FESS for chronic sinusitis had significant improvement in values of Mean FVC, FVC%, FEV1, and FEV1% suggesting a more efficient pulmonary gas exchange.

Stevens W *et al.* [16] conducted a prospective study in 48 patients with nasal polyposis by performing a PFT. Their study showed that subjects with nasal polyps who underwent FESS exhibited a significant increase in pulmonary function post-operatively.

FESS relieved the subjects of complaints like nasal obstruction, headache and anosmia. However, the improvement in the PFT values signifies a decrease in the bronchial hyperresponsiveness as compared to the pre-operative condition. In the study done by Karuthedath S *et al.* [7] while comparing the postoperative improvement in the FEV1/FVC value after one month with that of the value after 3 and 6 months showed, more marked improvement in the PFT values after 3 and 6 months. This may be due to immediate post-operative inflammation and crusting [7,17]. In a prospective observational study done by Rao D *et al.* [18] amongst 30 males and 20 females with Ethmoidal Polyposis, which is a frequent form of chronic rhinosinusitis with nasal polyposis, there was a significant improvement in symptoms and quality of life without having any adverse effects on the lower airways.

Pulmonary Function Test is an objective test that aids in the diagnosis of diseases of the airway and lower respiratory system. It is also an effective tool in the evaluation of the pulmonary function of patients with CRS or CRSwNP. Breathing quality significantly increases following FESS leading to lesser respiratory effort and more efficient gaseous exchange [18,19].

In our study, there is significant improvement in FVC, FEV1 percentage of predicted value and FEF25-75% percentage of predicted value while comparing the preoperative and postoperative values. This overall improvement can be due to reduced bronchial hyperresponsiveness [7,20]. In a study by Gudiseva A *et al.* [21] there was no significant change in PFT but the patients had a better symptom profile following the surgery. Significant improvement in PFT of children with allergic rhinitis was seen in the study conducted by George S and Nair R [17].

FVC differs very little from VC in the normal subject, but it is proportionately more reduced when there is airway obstruction with air trapping. FEV1 and FEF25-75% are derived from FVC. FEV1 is an indicator of generalized airway obstruction. FEF25-75% indicates the patency of small airways. The ratio of FEV1/FVC is approximately 0.75 to 0.80. This is a more sensitive indicator of airway obstruction than FVC or FEV1 alone [19]. So the improvement of these values in our study signifies the reduction in the degree of airway obstruction as nasal obstruction was the predominant presenting complaint among most of our subjects.

In a study by Zhang L *et al.* [14] preoperative FEV1 was found to be significantly lower in CRSwNP group compared to the other groups without polyposis ($p < 0.01$) and had significant increase when compared to other group post-operatively. However, in our study we couldn't establish a similar relationship. The limitations of our study are a small sample size and a single follow-up after surgery.

CONCLUSION

CRS is a disease usually seen in men in the fourth and fifth decade of life. Nasal obstruction is the most widely recognized presenting complaint in these patients. FESS is an effective and minimally invasive surgical treatment for CRS. Pulmonary function of patients with CRS and/or CRSwNP improve following FESS.

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