

## Original Research Article

# Endoscopic sinus surgery and its effects on pulmonary function test in patients of chronic rhinosinusitis with nasal polyposis

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## ABSTRACT

**Background:** The human upper and lower respiratory tract share a close relationship in respect to existence of diseases. The objectives of this study were to evaluate the outcome of endoscopic sinus surgery with the Lund-Mackay staging system and to find any objective changes between the pre and post-operative pulmonary function test values in patients with chronic rhinosinusitis undergoing endoscopic sinus surgery.

**Methods:** A total of 50 patients of CRSwNP refractory to maximal medical treatment (for 1 month) planned for endoscopic sinus surgery were included in the study. Results were assessed on the basis of pre and post-operative endoscopic and CT scores and PFT (FEV1, FVC and FEV1/FVC) values.

**Results:** Postoperatively, Lund Mackay endoscopic and CT scores improved from the preoperative values, which were statistically significant with p values < 0.05. Comparing FEV1/FVC, FVC and FEV1 values in three situations- preoperative versus postoperative 1 month, preoperative versus postoperative 3<sup>rd</sup> month and post-operative 1<sup>st</sup> month versus postoperative 3<sup>rd</sup> month, the difference between the means were found to be statistically significant (p=0.000), except for FVC between postoperative 3<sup>rd</sup> month and 1<sup>st</sup> month.

**Conclusions:** This study provides objective evidence that patients with CRSwNP may have non clinical lower airway disease detected by PFT and ESS is effective in improvement of both nasal and lower airway disease as evident from the improvements in PFT values.

**Keywords:** CRSwNP, Endoscopic sinus surgery, FEV1, FVC, Pulmonary function test

## INTRODUCTION

The human respiratory tract is divided into an upper and lower respiratory tract which share a close relationship in respect to coexistence of diseases.<sup>1</sup> Chronic rhinosinusitis (CRS) is characterised by mucosal inflammation of the nose and paranasal sinuses lasting for more than 12 weeks or 3 months.<sup>2</sup> The global prevalence of CRS as per EPOS criteria is 10.9%.<sup>3</sup> However incidence of CRS is highly variable from region to region. Although clinical evidence is accumulating that chronic sinusitis exacerbates lower airway disease, a more direct and objective studies are needed to elucidate the importance of CRS in lower airway disease. Direct evidence of an

association could be obtained by examining the effect of treatment of chronic rhinosinusitis on pulmonary function. Functional endoscopic sinus surgery (FESS) is a minimally invasive technique in which sinus air cells and sinus ostia are opened under direct visualization. The goal of this procedure is to restore sinus ventilation and normal function.<sup>4-7</sup>

Pulmonary function tests is a generic term used to indicate a battery of studies or manoeuvres that may be performed using standardized equipment to measure lung function. Of the pulmonary function tests, forced spirometric variables like forced vital capacity (FVC), forced expiratory volume in 1 second (FEV1) and the

ratio of FEV1/FVC is particularly important in assessing the lower airways. Hence, the relationship between ESS (primarily a surgery for upper airway) and PFT (a test for the lower airway) is still an area that can be studied further; thereby making the current study an opportunity to add more data to the said relationship.

## METHODS

A prospective study was done from July 2017 to July 2019 in Sri Rama Chandra Bhanja Medical College and Hospital, Cuttack, Odisha, India with a sample size of 50 patients after obtaining Ethical committee clearance from the Institutional Ethics Committee (IEC).

### Inclusion criteria

Age >18 years to <60 years; All cases of Chronic Rhinosinusitis (with nasal polyposis) diagnosed according to the EPOS 2007 and 2012 criteria, who were refractory to medical treatment and planned for surgery.<sup>8</sup>

### Exclusion criteria

ESS done for tumours; patients not giving consent; patients with acute infections of nose and paranasal sinuses; patients with smoking history; pregnant women; patients with known psychiatric illness; patients with coexisting systemic diseases like diabetes, hypertension and ear, nose, throat cancer; patients with neurodegenerative diseases; patients lost to follow up.

Informed written consent was taken from each patient and a detailed history and clinical examination was done. Lund-Mackay endoscopic score and radiological score pre and post operatively were obtained.<sup>12</sup> Spirometry was done 1 week prior to surgery and at postoperative 1 and 3 month.

In a normal case, as per GOLD criteria, forced vital capacity (FVC) and forced expiratory volume at first second (FEV1) should be  $\geq 80\%$  of the predicted value for a patient's age, height, and weight.<sup>9</sup> Reduction of FEV1/FVC indicates obstructive lower airway defect. Reduction of FVC indicates a restrictive lower airway defect. Reduction of both FVC and FEV1 is seen in mixed defect.

The severity of lower airway obstruction was assessed as per ATS criteria, an FEV1 value  $\geq 70\%$  was regarded as mild obstruction; 60% to 69% as moderate; and 50-59% as moderately severe; 35-49% as severe and  $<35\%$  is very severe.<sup>10</sup>

Endoscopic sinus surgery was performed under general anaesthesia as per Messerklinger technique, (anterior to posterior approach) with patient in reverse Trendelenburg position.<sup>11</sup> Nasal packing removed 48 hours post operatively and discharged on post op day 5. Follow up done at 1<sup>st</sup> and 3<sup>rd</sup> post-operative month. Statistical

analysis done using SPSS 22 and a p value of  $<0.05$  was set to be statistically significant.

## RESULTS

50 patients were included in the study. From Table 1, nasal obstruction was the most common symptom present in all patients followed by headache 44 (88%), nasal discharge 26 (52%) and facial pain/ pressure in 17 (34%) cases.

**Table 1: Frequency table of symptoms in the preoperative and postoperative period.**

Symptoms	Pre op N (%)	Post op 1 <sup>st</sup> month N (%)	Post op 3 <sup>rd</sup> month N (%)
Facial pain/ pressure	17 (34)	4 (8)	1 (2)
Headache	44 (88)	9 (18)	3 (6)
Nasal obstruction	50 (100)	5 (10)	1 (2)
Nasal discharge	26 (52)	7 (14)	0
Smell disturbance	6 (12)	0	0
Need to blow nose	3 (6)	0	0
Cough	11 (22)	2 (4)	1 (2)
Breathlessness	9 (18)	3 (6)	0

The symptoms showed major improvement in the post-operative periods. Smell disturbance improved completely following the surgery and so did breathlessness.

Table 2 shows an improved post-operative Lund Mackay endoscopic and CT scores when compared to the pre-operative scores; with all 50 patients having an Endoscopic score below 3 and a CT score below 10 by the post-operative 3<sup>rd</sup> month period. Mean pre and post-operative CT scores are  $12 \pm 4.97$  and  $0.63 \pm 1.32$  respectively.

**Table 2: Frequency table of pre and post-operative endoscopic and CT scores.**

Score	Pre op N (%)	Post op 1 <sup>st</sup> month; N (%)	Post op 3 <sup>rd</sup> month; N (%)
<b>Endoscopic score</b>			
0-3	15 (30)	50 (100)	50 (100)
4-7	26 (52)	0	0
8-12	9 (18)	0	0
<b>CT score</b>			
0-10	19 (38)	-	50 (100)
11-20	29 (58)	-	0
>20	2 (4)	-	0

Table 3 shows the mean, standard deviation and standard error of the mean of all the different variables used to

obtain objective inference regarding the aim of the study. These included: a) FEV1/FVC- pre op, post op 1<sup>st</sup> month and post op 3<sup>rd</sup> month; b) FVC- pre op, post op 1<sup>st</sup> month and post op 3<sup>rd</sup> month; c) FEV1- pre op, post op 1<sup>st</sup> month and post op 3<sup>rd</sup> month; d) total endoscopic score- pre op, post op 1<sup>st</sup> month and post op 3<sup>rd</sup> month; e) total Ct score- pre op and post op 3<sup>rd</sup> month.

Mean preoperative FEV1/FVC ratio was 67.64 (% of predicted value) indicating an obstructive lower airway disease which improved in the post-operative 1 month and 3<sup>rd</sup> month period to 71.59 and 75.76 respectively. Mean preoperative FVC ratio was 2.46 (% of predicted value) which did not change much in the post-operative 1<sup>st</sup> month and 3<sup>rd</sup> month period (i.e., 2.45 and 2.50 respectively). The restrictive lower airway component seen in the patients preoperatively could be attributed to the possibility of poor efforts or mechanical errors during the performance of pulmonary function test. As for FEV1 (an indicator of severity of lower airway abnormality), the mean preoperative improved from 2.07 to 2.19 (postoperative 1<sup>st</sup> month) to 2.29 (postoperative 3<sup>rd</sup> month).

**Table 3: Mean, SD and standard error of mean of pre and post-operative PFT variables.**

	Mean	N	Std. deviation	Std. error mean
<b>FEV1/FVC (Pre op)</b>	67.64	50	10.7	1.5
<b>FEV1/FVC (1 month)</b>	71.59	50	7.7	1.08
<b>FEV1/FVC (3 month)</b>	75.76	50	7.5	1.06
<b>FVC (pre op)</b>	2.46	50	0.5	0.07
<b>FVC (1 month)</b>	2.45	50	0.5	0.07
<b>FVC (3 month)</b>	2.50	50	0.5	0.07
<b>FEV1 (pre op)</b>	2.07	50	0.4	0.06
<b>FEV1 (1 month)</b>	2.19	50	0.4	0.06
<b>FEV1 (3 month)</b>	2.29	50	0.3	0.05
<b>TES (pre op)</b>	5.38	50	2.79	0.39
<b>TES (1 month)</b>	0.28	50	0.60	0.08
<b>TES (3 month)</b>	0.04	50	0.28	0.04
<b>TCTS (pre op)</b>	12	50	4.97	0.71
<b>TCTS (3 month)</b>	0.63	50	1.32	0.19

FEV1- Forced expiratory volume during first second, FVC- forced vital capacity, TES- total endoscopic score, TCTS- total CT score

**Table 4: Comparing pre and post-operative Lund Mackay scores.**

Pre and post-operative Lund Mackay scores	Paired differences			95% confidence interval of the difference				
	Mean	SD	Std. error mean	Lower	Upper	t	df	Sig. (2-tailed)
TES (pre op vs. post op 1 month)	5.1	2.7	0.3	4.3	5.8	13.2	49	*.000
TES (pre op vs. post op 3 month)	5.3	2.8	0.4	4.5	6.1	13.2	49	*.000
TES (post op 1 month vs. post op 3 month)	0.2	0.5	0.07	0.08	0.3	3.0	49	*.004
TCTS (pre op vs. post op 3 month)	11.3	4.4	0.6	10.1	12.6	18.2	49	*.000

TES- total endoscopic score, TCTS- total CT score; \*statistically significant p values

**Table 5: Comparing pre and post-operative FEV1 and FVC values.**

Pre and post-operative FEV1 and FVC values	Paired differences			95% CI of the difference				
	Mean	SD	Std. error mean	Lower	Upper	T	df	Sig. (2-tailed)
FEV1/FVC (pre op vs. post op 1 month)	-3.9	6.8	0.9	-5.8	-2.0	-4.1	49	*.000
FEV1/FVC (pre op vs. post op 3 month)	-8.1	8.9	1.2	-10.6	-5.5	-6.4	49	*.000
FEV1/FVC (post op 1 month vs. post op 3 month)	-4.1	04.4	0.6	-5.4	-2.9	-6.6	49	*.000
FVC (pre op vs. post op 1 month)	0.01	0.13	0.01	-0.02	0.05	0.6	49	.521
FVC (pre op vs. post op 3 month)	-0.03	0.14	0.02	-0.07	0.01	-1.5	49	.126
FVC (post op 1 month vs. post op 3 month)	-0.04	0.1	0.01	-0.07	-0.01	-3.0	49	*.004
FEV1 (pre op vs. post op 1 month)	-0.11	0.16	0.02	-0.16	-0.07	-5.1	49	*.000
FEV1 (pre op vs. post op 3 month)	-0.21	0.21	0.03	-0.27	-0.1	-7.1	49	*.000
FEV1 (post op 1 month vs. post op 3 month)	-0.09	0.13	0.01	-0.13	-0.05	-5.0	49	*.000

FEV1- forced expiratory volume during first second, FVC- forced vital capacity; \*statistically significant p value.

When a statistical comparison was done between preoperative and postoperative values/scores, it was seen that in all comparisons, there was statistically significant improvement of all the variables and statistically significant better scores in the post-operative periods with a p value of <0.05 (Table 4 and 5). However, only the

comparison between FVC (preoperative versus postoperative 1<sup>st</sup> month) and FVC (preoperative versus postoperative 3<sup>rd</sup> month) were found to be statistically insignificant with a p value of 0.52 and 0.12 respectively (Table 5).

## DISCUSSION

Rhinosinusitis significantly affects quality of life. This disease is one of the main reasons for which antibiotics are prescribed and for loss of productivity in workforce.<sup>13</sup>

Ragab et al found different kinds of lower airway involvement in 60% of adult patients with CRS who failed medical treatment: some are manifest (in the form of asthma), and other are non-manifest (in the form of bronchial hyper reactivity).<sup>14</sup> They also showed that the presence of nasal polyps was a risk factor for the involvement of the lower airways.

In our study, nasal obstruction was the most common symptom encountered in this study in 50 (100%) cases. This was followed by headache 44 (88%), nasal discharge 26 (52%) and facial pain/ pressure in 17 (34%) cases.

The commonalities of the symptoms in this study were found to be in accordance with that of a study done by Abdalla et al.<sup>15</sup> However, in a study by Singh et al, the most common symptom encountered was headache (80%) followed by nasal obstruction (76.66%).<sup>16</sup> Similarly, in a study by Yousef et al, he found that the most common symptom was facial pain and pressure accounting for 80% of the cases followed by headache and postnasal discharge of 60% and 48% respectively.<sup>17</sup>

Though studies have been done to find the impact of ESS on PFT, none of those studies had a comparison between the pre and post-operative endoscopic scores.

In this study maximum number of patients presented when the disease was in a moderate stage- Table 2 (i.e., endoscopic score of 4-7 and CT score of 11-20).

From Table 3, we clearly see the improvement in the postoperative endoscopic scores when compared to the preoperative values with a p values of <0.05, which is statistically significant. Similarly, the case in postoperative CT scan scores too showed a statistically significant improvement with a p value of 0.00.

In a study conducted by Wang et al, 51.3% of the patients had a CT score in the range of 2-4.<sup>18</sup> Similarly, 12 (40%) cases had a score in the range of 5-8 in a study by Singh et al.<sup>1</sup> Also similar findings were noted by Bhattacharya et al.<sup>19</sup>

The mean difference in FEV1/FVC values at 1 month and pre-operative was 3.95. The mean difference in FEV1/FVC values at 3-month post-operative and 1preoperative was 8.12. The mean difference in the FEV1/FVC values at 3 month and 1 month post-operative was 4.16. All these three comparisons were found to be statistically significant with a p-value=0.000. Similar study by Singh et al, similar result were obtained except

that mean difference between post op 1 month and postop 3 month was found to be not statistically significant.<sup>1</sup>

Kariya et al, also reported that the pulmonary functions were affected in patients with CRS regardless of their sensitization status.<sup>20</sup> Tanaka et al, reported that 13% of patients with CRSwNP exhibited obstructive lung dysfunction i.e. FEV1/FVC<70% of the predicted despite the absence of asthma symptoms.<sup>21</sup>

The mean difference between FVC at post-operative 1 month and pre op was -0.01; between postoperative 3 month and pre op was 0.03; and between post-operative 3 month and 1 month was 0.04. The difference in FVC mean was found to be statistically significant only between post-operative 3 month and 1 month with a p-value of 0.04.

Yousef et al, also obtained significant results in his study although the follow up period in his study was just for 1 month.<sup>17</sup>

The mean difference in FEV1/FVC values at 1 month post-operative and pre-operative was 3.9. The mean difference in FEV1/FVC values at 3 month post-operative and 1 month pre-operative was 8.1. The mean difference in the FEV1/FVC values at 3 month and 1 month post-operative was 4.1. All these three comparisons were found to be statistically significant with a p-value=0.000. Thus, ESS helps improving the severity of the non clinical lower airway disease too. These findings are in accordance to the study by Singh et al.<sup>1</sup> In a study done by Ragab et al, it was found that the 6 and 12 month postoperative FEV1 percent (% of predicted) showed a significant increase.<sup>14</sup> In a similar study conducted by Nagamura et al, on the effects of sinus surgery on asthma in aspirin triad patients, an important correlation was found between the pre and post-operative FEV1 scores and asthma severity.<sup>22</sup>

So in this study, from the discussion above on the PFT changes post operatively it can be seen that in patients with CRS, some amount of lower airway disease is evident; which however, remains asymptomatic in most patients in this study. This non symptomatic nature of the lower airway involvement in patients with CRS can be explained by the dysfunction of the small airways (i.e. terminal and respiratory bronchioles- 2-3 mm in diameter), or what is otherwise called as small airway disease.<sup>17</sup>

In cases of CRSwNP, the primary function of the nasal cavity is bypassed- its function for cleaning, warming, and humidifying the inhaled air and with loss of its protective mechanisms.<sup>23</sup> With nasal polyps, the sinus ostia are blocked, resulting in a decrease in the availability of nitric oxide in the upper and lower airways, as reported for patients with chronic sinus disease.<sup>24</sup>



Shturman-Ellstein et al, examined the effect of nasal breathing versus mouth breathing among patients with asthma during exercise or hyperventilation, which resulted in worsened pulmonary function with mouth breathing versus nasal breathing.<sup>25</sup>

There are only a handful of reports based on lung functions to evaluate the impact of sinus surgery for patients with CRS. Singh et al, evaluated the impact of ESS on the PFTs of patients with CRS and found that patients benefited from ESS, with better PFTs.<sup>1</sup> Other studies have shown that patients with CRS and asthma may benefit from ESS.

In a systematic review, Rix et al, reported that ESS and medical interventions with systemic anti-inflammatory drugs improved nasal outcomes, although their efficacy in relation to the lower airways remains unclear.<sup>26</sup>

The exact mechanism of improvement of PFTs that occurred among patients with CRS after ESS is unclear. It is likely that part of the improvement after ESS is from removing trigger areas in the nose and sinuses that can cause release of leukotrienes, prostaglandins, and other inflammatory mediators that may affect the lower airways.<sup>27</sup>

In our study, there was also a significant improvement in the FEV1/FVC value at both 1 month and 3 month postoperatively, reflecting the effect of ESS on relieving the non symptomatic lower airway obstruction. These results also may be attributed to the postoperative usage of intranasal corticosteroid sprays that may lead to significant reductions in upper and lower airway responses to intense triggers.<sup>28</sup>

## CONCLUSION

This study provides objective evidence that patients with CRSwNP may have non clinical lower airway disease detected by PFT and ESS is effective in improvement of both nasal and lower airway disease as evident from the improvements in PFT values.

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## REFERENCES

- Karuthedath S, Singh I, Chadha S. Impact of functional endoscopic sinus surgery on the pulmonary function of patients with chronic rhinosinusitis: a prospective study. *Indian J Otolaryngol Head Neck Surg*. 2014;66(4):441-8.
- Zachary M Soler. Results of medical and surgical treatment of chronic rhinosinusitis with and without nasal polyposis. In: Flint P, Haughey B, Lund V, Niparko J, Robbins K, Thomas JR, et al, eds. *Cummings Otolaryngology Head and Neck surgery* 6th edition. Saunders, Elsevier; 2015: 703.
- Hastan D, Fokkens WJ, Bachert C, Newson RB, Bislimovska J, Bockelbrink A, et al. Chronic rhinosinusitis in Europe- an underestimated disease. A GA(2) LEN study. *Allergy*. 2011;66(9):1216-23.
- Stammberger H. Functional endoscopic sinus surgery: the Messerklinger technique. Philadelphia: Decker; 1991: 283.
- Wigand ME. Endoscopic surgery of the paranasal sinuses and anterior skull base. New York: Thieme Medical Publishers; 1990: 1-2.
- Kennedy DW, Zinreich SJ, Rosenbaum AE, Johns ME. Functional endoscopic sinus surgery. Theory and diagnostic evaluation. *Arch Otolaryngol*. 1985;111:576-82.
- Kennedy DW. Functional endoscopic sinus surgery. Technique. *Arch Otolaryngol*. 1985;111:643-9.
- Fokkens WJ, Lund VJ, Mullol J, Bachert C, Alobid I, Baroody F, et al. European Position Paper on Rhinosinusitis and Nasal Polyps 2012. *Rhinology*. 2012;2012(23):1-298.
- Hansen JE, Sun XG, Wasserman K. Spirometric criteria for airway obstruction: use percentage of FEV1/FVC ratio below the fifth percentile, not <70%. *Chest*. 2007;131(2):349-55.
- Barreiro TJ, Perillo I. An approach to interpreting spirometry. *Am Fam Phys*. 2004;69(5):1107-14.
- Stammberger H. Endoscopic endonasal surgery- New concepts in the treatment of recurring sinusitis. Part II. Surgical technique. *Otolaryngol Head Neck Surg*. 1985;94:143-7.
- Lund VJ, Kennedy DW. Quantification for staging sinusitis. *Ann Otol Rhinol Laryngol*. 1995;104(10):17-21.
- Benninger MS, Ferguson B, Hadley J. Adult chronic rhinosinusitis: definitions, diagnosis, epidemiology, and pathophysiology. *Otolaryngol Head Neck Surg*. 2003;129:1-32.
- Ragab A, Clement P, Vincken W. Objective assessment of lower airway involvement in chronic rhinosinusitis. *Am J Rhinol*. 2004;18:16-21.
- Abdalla S, Alreefy H, Hopkins C. Prevalence of sinonasal outcome test (SNOT-22) symptoms in patients undergoing surgery for chronic rhinosinusitis in the England and Wales National prospective audit. *Clin Otolaryngol*. 2012;37(4):276-82.
- Sing I, Shrestha A, Gautam D. Chronic rhinosinusitis and nasal polyposis in Nepal. *Clin Rhinol*. 2010;3(2):87-91.
- Yousef M, Awad OGAN, Taha M. Pulmonary function of patients with chronic rhinosinusitis and the impact of endoscopic sinus surgery. *OTO Open*. 2017;1(4):1-31
- Wang PC, Chu CC, Liang SC, Tai CJ. Outcome predictors for endoscopic sinus surgery. *Otolaryngol Head Neck Surg*. 2002;126:154-9.

19. Bhattacharyya N, Fried MP. The accuracy of computed tomography in the diagnosis of chronic rhinosinusitis. *Laryngoscope*. 2003;113:125-9
20. Kariya S, Okano M, Higaki T. Chronic rhinosinusitis patients have decreased lung function. *Int Forum Allerg Rhinol*. 2014;44:828-33.
21. Tanaka S, Hirota T, Kamiyo A. Lung functions of Japanese patients with chronic rhinosinusitis who underwent endoscopic sinus surgery. *Allergol Int*. 2014;63:27-35.
22. Nakamura H, Kawasaki M, Higuchi Y, Takahashi S. Effects of sinus surgery on asthma in aspirin triad patients. *Acta Otolaryngol*. 1999;119(5):592-8.
23. Togias A. Mechanisms of nose-lung interaction. *Allergy*. 1999;57:94-105.
24. Maniscalco M, Sofia M, Pelaia G. Nitric oxide in upper airways inflammatory diseases. *Inflamm Res*. 2007;56:58-69.
25. Shturman-Ellstein R, Zeballos R, Buckley JM, Souhrada JF. The beneficial effect of nasal breathing on exercise induced bronchoconstriction. *Am Rev Respir Dis*. 1978;118:65-73.
26. Rix I, Hagkansson K, Larsen CG, Frend M, von Buchwald C. Management of chronic rhinosinusitis with nasal polyps and coexisting asthma: a systematic review. *Am J Rhinol Allerg*. 2015;29:193-201.
27. Jung T, Juhn S, Hwang D, Stewart R. Prostaglandins, leukotrienes, and other arachidonic acid metabolites in nasal polyps and nasal mucosa. *Laryngoscope*. 1987;97:184-9.
28. Wood R, Eggleston P. The effect of intranasal steroids on nasal and pulmonary responses to cat exposure. *Am J Respir Crit Care Med*. 1995;151:315-20.

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