

The Effect Of Functional Endoscopic Sinus Surgery On Lung Function In Patients With Chronic Sinusitis And Nasal Polyps Without Asthma

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Abstract

Objectives: The aim of this study was to look into how functional endoscopic sinus surgery (FESS) for CRSwNP without asthma affects lung function. The investigators aimed to determine any correlation between Lund-Kennedy scores, Lund-Mackay scores and pulmonary function.

Methods: All participants underwent nasal endoscopic examination and CT scanning paranasally. Lund-Kennedy endoscopy and Lund-Mackay CT scores were calculated and compared with postoperative findings. Statistical analysis was performed to compare preoperative and postoperative spirometry findings to assess efficacy of surgery on pulmonary function.

Results: There were no statistically significant differences between the Lund-Mackay scores for primary FESS and revision. Nevertheless, Lund-Kennedy scores did show evidence of greater statistical significance when comparing revision FESS and primary FESS ($p=0.04$) With respect to both primary and revision FESS patients there was no statistical significance between the preoperative values of FEV1, FEV1/FVC, FVC, and FEF25-75 and the same parameters measured one month postoperatively ($p>0.05$).

Conclusion: Our results reveal that FVC improves following FESS in cases of CRSwNP that are not also asthmatic. No relationship was demonstrable between how severe the disease is and how the lung functions. Further research that looks at FESS in asymptomatic cases of airway obstruction over more prolonged follow-up needs to be undertaken.

Introduction

Chronic rhinosinusitis (CRS) is an umbrella term for several disorders characterised by two symptoms or more lasting longer than 12 weeks. Sufferers may have pain or pressure over the face, a pus-filled discharge from the nose, blocked nose and hyposmia. The presence of a chronic inflammatory process can be demonstrated either radiologically or endoscopically ^[1]. CRS occurs frequently in the

general population. According to the National Ambulatory Medical Care Survey, amongst Americans, between 14 and 16% of the population have experienced CRS. The cost in terms of lost productivity and additional healthcare expenditure runs into the billions of dollars ^[2-4]. A recent division of CRS into two types uses the presence or absence of nasal polyps as a distinguishing feature ^[5].

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If nasal polyps are present within the nasal cavity, they indicate that the upper airway is inflamed. The inflammation may be secondary to a variety of causes, such as persistent bacterial or mycological infection, cystic fibrosis, dysfunctional cilia [6] or Peutz-Jegher Syndrome [7]. The polyposis itself results from chronic inflammation of eosinophilic aetiology within the mucosae of the nose and adjacent structures. It may be found in isolation, with an unknown cause, or be a feature of chronic rhinosinusitis with nasal polyposis (CRSwNP) [7]. In this article, the definition used for CRSwNP is that of the European Position Paper on Rhinosinusitis and Nasal Polyps [7]. The prevalence of nasal polyposis approaches 4% [5, 8, 9] and treatment is problematic due to the disease's severity [10]. There is a proven association with asthma, especially asthma in association with NSAID/aspirin intolerance, the so-called Samter Triad [11]. Sufferers from both asthma and COPD (chronic obstructive pulmonary disease) commonly also have CRS and rhinitis [12, 13]. Williamson and colleagues [14] discovered that cases of CRSwNP have a reduction in their airways that does not lead to symptoms, whilst Ciprandi and colleagues [15] found 53.7% of cases with chronic hayfever had measures of reduced lung function. As yet, how operative therapy for CRS influences inflammatory processes in the lower airways remains under-researched [16]. For this reason, the current study was undertaken to look into how functional endoscopic sinus surgery (FESS) for CRSwNP without asthma affects lung function.

Material And Methods

The research has a prospective methodology. Ethical approval was obtained from the Bagcilar Teaching And Research Hospital Non-Invasive Clinical Research Ethical Committee, on 21.03.2017 with the registration number 2017/566. Participants were recruited who had CRSwNP of treatment-resistant type. Exclusion criteria were: smoker, known asthmatic or using bronchodilatory therapy or similar.

All participants underwent nasal endoscopic examination and CT scanning paranasally. Lund-Kennedy endoscopy and Lund-Mackay CT scores were calculated. Preoperative spirometry was performed to assess baseline pulmonary function.

In total, 30 cases of CRSwNP had FESS performed by otorhinolaryngologists at a single centre. Histopathological examination showed chronic inflammatory-type nasal polyps in all cases. All participants received one month's

steroid treatment for one month post-operatively. The steroid was given as intranasal mometasone furoate. Follow-up examinations were carried out at one week and one month post-operatively and spirometry was also done one month after FESS.

The investigators aimed to determine any correlation between Lund-Kennedy scores, Lund-Mackay scores and pulmonary function. Likewise, the study aimed to clarify how FESS influences pulmonary function in cases of CRSwNP without asthma.

Statistical analyses were carried out by means of the NCSS (Number Cruncher Statistical System) 2007 Statistical Software (Utah, USA) application. Descriptive statistics (means and corresponding SD) were obtained and the groups compared in binary fashion using independent t tests and the Pearson Correlation tests. A value of $p < 0.05$ was taken to indicate statistical significance.

Results

The male:female distribution amongst participants was 8:22 and the mean age was 44.37 years. The mean Lund-Kennedy endoscopy score was 7.77 and the mean Lund-Mackay CT score was 19.17. The mean Lund-Kennedy endoscopy score in the primary FESS cases was 7.38 whilst in the revision FESS patients it was 8.67. The mean Lund-Mackay CT score in primary FESS patients was 19.14 and in revision FESS patients was 19.22. Table-1 lists these values and also the preoperative and postoperative spirometry values. These last include the percentage of predicted forced expiratory volume in 1 second (%FEV1), forced vital capacity (%FVC), forced expiratory volume in 1 second/forced vital capacity ratio (%FEV1/FVC) and mean forced expiratory flow between 25 and 75 per cent of the forced vital capacity (%FEF25-75). 9 out of 30 patients had previously undergone one or more FESS. The values for revision FESS patients can be found in Table 2.

There were statistically significant differences between the postoperative 1st month FVC and the preoperative FVC values ($p = 0.019$). FEV1, FEV1/FVC and FEF25-75 values were not different at the level of statistical significance between preoperative and postoperative 1st month measurements ($p = 0.167$, $p = 0.568$, $p = 0.09$). The study showed that FESS surgery for the treatment of CRSwNP increased the patient's FVC (Table 3).

As it was anticipated that disease severity would affect the patient's lung function, the correlation between disease severity and pulmonary function was analysed. There were

Table 1: Preoperative and postoperative spirometric measurements and endoscopic scores.

	N	Minimum	Maximum	Mean±SS
Age	30	18	68	44.37±12.21
Lund-Kennedy endoscopy score	30	5	11	7.77±1.59
Lund-Mackay CT score	30	10	24	19.17±4.11
Pre-op % FVC	30	58	125	87.2±17.02
Post-op 1st month % FVC	30	61	129	91.33±13.84
Pre-op % FEV1	30	37	130	85.37±20.87
Post-op 1st month % FEV1	30	42	129	88.2±15.94
Pre-op % FEV1/FVC	30	63	114	96.33±10.96
Post-op 1st month % FEV1/FVC	30	68	119	95.7±10.48
Pre-op % FEF 25-75	30	19	147	79.2±30.48
Post-op 1st month % FEF 25-75	30	21	177	84.53±33.15

Table 2: Preoperative and postoperative spirometric measurements, endoscopic scores, CT scores of primary and revision cases.

P/R		N	Minimum	Maximum	Mean±SS
Primer n:21 (%70)	Age	21	18	68	44.86±13.51
	Lund-Kennedy endoscopy score	21	5	11	7.38±1.66
	Lund-Mackay CT score	21	10	24	19.14±4.46
	Pre-op % FVC	21	58	125	90.52±17.82
	Post-op 1st month % FVC	21	61	129	93.86±15.18
	Pre-op % FEV1	21	37	130	87.57±23.22
	Post-op 1st month % FEV1	21	42	129	88.81±18.28
	Pre-op % FEV1/FVC	21	63	114	94.19±11.54
	Post-op 1st month % FEV1/FVC	21	68	110	93.14±10.19
	Pre-op % FEF 25-75	21	19	147	77.62±32.95
Post-op 1st month % FEF 25-75	21	21	150	79.24±30.96	
Revision n:9 (%30)	Age	9	31	56	43.22±9.03
	Lund-Kennedy endoscopy score	9	7	10	8.67±1
	Lund-Mackay CT score	9	14	22	19.22±3.38
	Pre-op % FVC	9	60	103	79.44±12.63
	Post-op 1st month % FVC	9	72	96	85.44±7.92
	Pre-op % FEV1	9	61	109	80.22±13.72
	Post-op 1st month % FEV1	9	75	99	86.78±9.07
	Pre-op % FEV1/FVC	9	86	112	101.33±7.89
Post-op 1st month % FEV1/FVC	9	90	119	101.67±9.01	
Pre-op % FEF 25-75	9	51	121	82.89±25.15	
Post-op 1st month % FEF 25-75	9	51	177	96.89±36.63	

Table 3: Preoperative and postoperative lung functions.

	Pre-op	Post-op 1st month	p
% FVC	87.2±17.02	91.33±13.84	0.019
% FEV1	85.37±20.87	88.2±15.94	0.167
% FEV1/FVC	96.33±10.96	95.7±10.48	0.568
% FEF 25-75	79.2±30.48	84.53±33.15	0.09

Paired t-test

no statistically significant correlations between Lund-Kennedy scores and Lund-Mackay scores, nor with preoperative FEV1, FEV1/FVC, FVC or FEF25-75 (p>0.05) (Table 4).

Table 4: Preoperative and postoperative spirometric measurements, endoscopic scores, and CT scores.

		Lund-Kennedy endoscopy score	Lund-Mackay CT score
Pre-op % FVC	r	-0.156	0.102
	p	0.410	0.592
Pre-op % FEV1	r	-0.327	-0.04
	p	0.078	0.833
Pre-op % FEV1/FVC	r	-0.282	-0.03
	p	0.131	0.877
Pre-Op % FEF 25-75	r	-0.269	-0.074
	p	0.151	0.699

Pearson Correlation test

Cases involving both primary and revision FESS were then compared. There were no statistically significant differences between the Lund-Mackay scores for primary FESS and revision FESS (p: 0.962). Nevertheless, Lund-Kennedy scores did show evidence of greater statistical significance when comparing revision FESS and primary FESS (p=0.04) (Table 5). With respect to both primary and revision FESS patients there was no statistical significance between the preoperative values of FEV1, FEV1/FVC, FVC, and FEF25-75 and the same parameters measured one month postoperatively (p>0.05) (Table 6).

Discussion

Chronic rhinosinusitis is an umbrella term for several disorders characterised by two symptoms or more lasting longer than 12 weeks. Sufferers may have pain or pressure

Table 5: Endoscopic scores and CT scores of primary and revision cases.

	Primary FESS	Revision FESS	p
Lund-Kennedy endoscopy score	7.38±1.66	8.67±1	0.04
Lund-Mackay CT score	19.14±4.46	19.22±3.38	0.962

Independent t-test

over the face, a pus-filled discharge from the nose, blocked nose and hyposmia. The presence of a chronic inflammatory process can be demonstrated either radiologically or endoscopically [1]. A recent division of CRS into two types uses the presence or absence of nasal polyps as a distinguishing feature [5].

It has already been demonstrated by other researchers investigating nasal polyposis that applying steroids locally, or using mometasone furoate as an intranasal spray, can lead to both statistically and clinically significant reductions in polyp magnitude and airway obstruction, and helps counter hyposmia [17, 18]. Nonetheless, FESS remains a treatment of choice where nasal polyps have failed to respond to pharmacological measures, despite optimisation.

Sufferers from both asthma and COPD (chronic obstructive pulmonary disease) commonly also have CRS and rhinitis [12, 13]. Allergic rhinitis is proven to be a risk factor in becoming asthmatic. This connection may be explicable by the ‘united airway disease’ hypothesis [5, 19]. A recent finding is that, even where symptomatic/overt pulmonary disease is absent, sufferers from nasal polyposis had reduced pulmonary function [20]. CRS was found to be associated with reductions in pulmonary function typical of obstructive disease, whether asthma was known to be present or not [21]. Cases of rhinitis where the sputum revealed eosinophilia were associated with reduced pulmonary function, even where the airways were not hyperresponsive [22]. Despite these findings, how nasal polyps relate to lung function remains incompletely elucidated, as does how the histopathological findings in different parts of the respiratory tract tie up.

From the literature, it appears that Kariya *et al* [20] were the first to report the latent obstruction in low diameter airways associated with CRS. Their suggestion was that obstructive pulmonary alterations were present in CRS cases, even where they caused no symptoms and had not led to a diagnosis of obstructive airway disease. Ciprandi *et al*. [15] concluded that 53.7% of chronic allergic rhinitis cases had associated decreases in measures of lung function.

Table 6: Lung functions of primary and revision cases.

		Primary FESS	Revision FESS	p*
% FVC	Pre-op	90.52±17.82	79.44±12.63	0.103
	Post-op 1st month	93.86±15.18	85.44±7.92	0.129
	p‡	0.083	0.143	
% FEV1	Pre-op	87.57±23.22	80.22±13.72	0.386
	Post-op 1st month	88.81±18.28	86.78±9.07	0.755
	p‡	0.625	0.066	
% FEV1/FVC	Pre-op	94.19±11.54	101.33±7.89	0.103
	Post-op 1st month	93.14±10.19	101.67±9.01	0.039
	p‡	0.311	0.912	
% FEF 2575	Pre-op	77.62±32.95	82.89±25.15	0.672
	Post-op 1st month	79.24±30.96	96.89±36.63	0.186
	p‡	0.499	0.123	

*Independent t-test ‡ Paired t-test

Williamson *et al.* [14] found the airways were impaired sub-clinically and FEV1 and FEF25-75 were both diminished, in CRSwNP. Tanaka *et al.* revealed that an FEV1/FVC below 75% was present in 20% of cases of CRSwNP, but in such cases, asthma had not been diagnosed. Lee and colleagues [24] reached similar conclusions. Their finding was that if features of chronic sinusitis and nasal polyps were visible on CT, the airway would present obstacles to flow at a subclinical level, even if no underlying pulmonary pathology was present. Zhang *et al.* [2] investigated cases where FEF25-75 and FEV1 were diminished, and found that reduced pulmonary function had a correlation with chronic sinusitis and nasal polyps as shown by CT, in the absence of disease affecting the lower respiratory tract. They were able to show, too, that FEV1 and FEF25-75 were lowest in cases of CRSwNP, compared to CRS without nasal polyposis and cases lacking CRS altogether.

The authors’ belief is that CRSwNP is indeed associated with more frequent reductions in measures of lung function, and for this reason, they aimed to investigate how the severity of disease relates to changes in lung function. The study findings do not, however, support a definite correlation between the scores for Lund-Mackay (CT), Lund-Kennedy (endoscopy) and the measures for lung function recorded preoperatively. The severity of the in-

flammatory process or the magnitude of polyps alone do not predict pulmonary functional values.

Recently, the following suggestions have been made as to how disease in different portions of the airway is related: (a) inflammatory substances released in the nose or liberated antigens cause stimulation lower down in the respiratory tract (b) that there are reflexes connecting the nose and bronchi and pharynx and bronchi (c) histologically, the upper and lower airways share many similarities and the mucosae respond similarly (d) localised disease is amplified systemically [25, 26]. Vizzaccaro *et al.* [27] reported on the existence of a nasobronchial reflex connecting the upper and lower portions of the airway. Stimulation of the nasal mucosal surface or the paranasal sinuses led to a reflex contraction of involuntary muscle within the bronchi, which could account for the increased resistance to airflow and the diminution in pulmonary function. Likewise, if the area of the pharynx draining the nose and sinuses is stimulated posteriorly, the bronchi were observed to contract, with resultant fall in flow of air through the airway. Airway hyperreactivity was observed in both CRS with and without accompanying asthma when there was a flare-up [28].

It is debateable how far FESS for CRSwNP can ameliorate asthma. Uri *et al.*, reporting on a case series with nasal polyposis and accompanying asthma (n = 13), stated that FESS offered no benefit to asthmatics whose nasal polyps

were very severe. Ragab et al. [29], examining a subgroup of their study who had both nasal polyposis and asthma, remarked that asthma improved both subjectively and objectively, although this was not borne out statistically. Ike-da and colleagues do, however, clearly state that FESS can enhance lung function in those cases where asthma and chronic sinusitis co-exist [13]. In a similar fashion, Vleming's series of 30 cases with both nasal polyps and asthma had improvement in their measures of lung function 64% of the time [30].

Whilst research into the benefit of FESS for asthma does exist, similar research involving subclinical airway flow reduction does not. For this reason, we used FESS on cases with CRSwNP, but without clinically diagnosed asthma. One finding was the statistically significant increase in FVC at 1 month post FESS, indicative of a connection between upper and lower portions of the airway. But alongside this, FESS seems not to have altered FEV1, FEV1/FVC or FEF-25-75. However, the spirometry was not repeated at either 6 months or 1 year post-operatively and the possibility exists that these values might have altered at those points. Lamblin and colleagues [31] noted that cases

of nasal polyposis that was treatment-resistant to steroid therapy and had undergone nasal surgery, had an ongoing reduction in FEV1 and features showing obstructed airways 4 years after intranasal ethmoidectomy. Our own study resembles Lamblin's [31], and it showed FESS to be effective. It would be pertinent, therefore, if our study extended the follow-up period to 1 year, specifically looking at whether FEV1 declines.

Conclusion

Our results reveal that FVC improves following FESS in cases of CRSwNP that are not also asthmatic. No relationship was demonstrable between how severe the disease is and how the lung functions. The limitations of the study meant there needs to be caution in interpreting the results. It is quite possible that spirometric measures of lung function (FEV1, FEV1 / FVC, FEF25-75), if they had been measured at 6 months and 1 year post-FESS, would have shown a decline. Further research that looks at FESS in asymptomatic cases of airway obstruction over more prolonged follow-up needs to be undertaken.

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