Assessment of Pulmonary Function before and after Sinus Surgery in Lung Transplant Recipients

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Abstract

Introduction The association between sinus and lung diseases is well known. However, there are scarce studies regarding the effects of sinus surgery on pulmonary function in lung transplant recipients. The present study describes our experience with sinus surgery in lung transplant recipients with chronic rhinosinusitis.

Objectives To assess the impact of sinus surgery for chronic rhinosinusitis on pulmonary function and on inpatient hospitalization days due to lower respiratory tract infection in lung transplant recipients.

Methods A retrospective study conducted between 2006 and 2012 on a sample of lung transplant recipients undergoing sinus surgery for chronic rhinosinusitis. Pulmonary function, measured by forced vital capacity (FVC) and forced expiratory volume in the first second (FEV1), as well as inpatient hospitalization days due to lower respiratory tract infection, were compared 6 months before and 6 months after sinus surgery.

Results The FEV1 values increased significantly, and the inpatient hospitalization days due to bronchopneumonia decreased significantly 6 months after sinus surgery. The preoperative and postoperative median FEV1 values were **2.35** and **2.68** respectively ($p = \mathbf{0.0056}$). The median number of inpatient hospitalization days due to bronchopneumonia 6 months before and 6 months after surgery were **32.82** and **5.41** respectively ($p = \mathbf{0.0013}$).

Conclusion In this sample of lung transplant recipients with chronic rhinosinusitis, sinus surgery led to an improvement in pulmonary function and a decrease in inpatient hospitalization days due to bronchopneumonia.

Keywords
- lung transplantation
- respiratory function tests
- respiratory tract diseases
- paranasal sinus diseases
- nasal surgical procedures

Introduction

According to the one airway, one disease concept, there is a well-established relationship between the infectious and inflammatory conditions of the paranasal sinuses and lungs.[1,2] There are several possible explanations for this concept. One possibility is that inflammation and its effects would involve the lower and upper airways by contiguity.[3] Other authors attribute it to the fact that recurrent upper airway disease leads to increased pulmonary reactivity.[4] Therefore, the treatment for rhinosinusitis would lead to an improvement in several pulmonary conditions.[1,2]

There is no consensus as to the optimal timing for functional endoscopic sinus surgery in lung transplant recipients

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with chronic rhinosinusitis. In patients with cystic fibrosis, sinus surgery should be performed before lung transplantation if at all possible, so as to prevent post-transplant complications[5] such as recurrent bronchopneumonia or deterioration in lung function secondary to graft rejection. Furthermore, the paranasal sinuses have been proposed to serve as a reservoir for bacteria, which may lead to lung graft recolonization.[6]

Holzmann et al[7] reported a decrease in the incidence rates of tracheobronchitis and bronchopneumonia, and a trend toward a decreasing incidence of bronchiolitis obliterans in lung transplant recipients who had undergone sinus surgery. Patients with underlying pulmonary disease and concomitant rhinosinusitis who undergo sinus surgery exhibit decreased rates of hospital admission for bronchopneumonia, which suggests a potential for cost-saving and subjective improvements in quality of life.[8,9] Holzmann et al[7] also reported successful reductions in lower respiratory tract colonization and recurrent pulmonary infection rates among lung transplant recipients with cystic fibrosis who underwent sinus surgery.

However, many of these patients are in highly unfavorable clinical condition before lung transplantation, precluding any otorhinolaryngological surgery or intervention. In addition, pre-transplant sinus surgery was not associated with a reduction in graft colonization after transplantation.[6] Although several authors have reported improvements in pulmonary function in asthmatic patients who underwent clinical or surgical treatment for chronic rhinosinusitis,[10,11] it is unclear whether this also occurs in lung transplant recipients.

Within this context, and given the scarce literature on this patient population, studies are needed to examine the role of endoscopic sinus surgery in the improvement of pulmonary function, as well as the reduction of lower respiratory tract infections secondary to rhinosinusitis in lung transplant recipients. The objective of this study was to examine the impact of sinus surgery on pulmonary function as measured by forced vital capacity (FVC) and forced expiratory volume in the first second (FEV1) and inpatient hospitalization days due to lower respiratory tract infection in lung transplant recipients.

Method

A retrospective study was conducted at a tertiary university hospital, with the approval of the institutional review board (under protocol number 061720/2012), on lung transplants recipients, regardless of the underlying lung disease indication, who had also undergone endoscopic sinus surgery between 2006 and 2012.

All patients had chronic rhinosinusitis refractory to the conventional nonsurgical treatment, progressive decline in pulmonary function, and recurrent lung infections.

All sinus surgeries were performed by the same surgical team, and consisted of endoscopic endonasal sinusectomy of the affected paranasal sinuses as determined by computed tomography (CT) (►**Table 1**).

All patients underwent pulmonary function tests, which consisted of measuring the FVC and FEV_1 every three months.

Table 1 Lund-Mackay score and surgically approached paranasal sinuses

Patient number	Lund-Mackay score		Surgically approached paranasal sinuses							
	Right	Left	Maxillary		Ethmoid		Sphenoid		Frontal	
			Right	Left	Right	Left	Right	Left	Right	Left
1	10	10	x	x	x	x	x	x		
2	8	8	x	x	x	x	x	x		
3	10	10	x	x	x	x	x	x		
4	12	12	x	x	x	x	x	x	x	x
5	8	8	x	x	x	x	x	x		
6	12	12	x	x	x	x	x	x	x	x
7	12	12	x	x	x	x	x	x		
8	0	6	x	x	x	x				
9	12	12	x	x	x	x	x	x	x	x
10	10	10	x	x	x	x	x	x		
11	8	8	x	x	x	x	x	x		
12	12	12	x	x	x	x	x	x	x	x
13	8	8	x	x	x	x	x	x		
14	12	12	x	x	x	x	x	x	x	x
15	12	12	x	x	x	x				
16	10	10	x	x	x	x	x	x		
17	9	9	x	x	x	x	x	x		

Note: The "x" indicates the paranasal sinuses surgically approached.

Intravenous antibiotics were administered at least 48 hours before the surgery, and were maintained until the results of the intra-operative cultures arrived. A course of oral or intravenous antibiotics that ranged from 14 to 21 days was administered after the sinus surgeries, as well as inhaled tobramycin, colistin or gentamicin twice a day for 4 weeks.

Statistical analyses were performed for the comparison between the median FVC and FEV_1 values obtained at baseline (before sinus surgery) and 6 months after surgery. The median numbers of inpatient hospitalization days due to bronchopneumonia 6 months before and 6 months after surgery were also compared. The non-parametric Wilcoxon signed-rank test was used for both comparisons. The significance level was set at $p = 0.017$ (after Bonferroni adjustment).

Results

All patients underwent sinus surgery between 2006 and 2012, at least 6 months after lung transplantation. Overall, the sample comprised 17 patients: 11 (64.7%) males and 6 (35.3%) females; 10 (58.8%) were diagnosed with cystic fibrosis, 5 (29.4%) with bronchiectasis non-cystic fibrosis, 1 (5.9%) with pulmonary silicosis, and 1 (5.9%) with ciliary dyskinesia. Sinus surgery was performed after lung transplantation, and only 1 patient (patient number 11) required revision surgery 4 years after the first operation, due to recurrent polyposis in the maxillary sinuses and sinus complaints with no improvement despite conservative treatment. No patients experienced any severe surgical or anesthetic complications. ►**Table 2** shows gender, age at sinus surgery, lung disease etiology, dates of lung transplant and sinus surgery, preoperative and postoperative FEV1 and hospitalization rates 6 months before and 6 months after the sinus surgery of each patient.

The comparison of the median pre- and postoperative FEV_1 values showed a significant improvement in this parameter after sinus surgery once the preoperative and postoperative median FEV1 values were respectively **2.35** and **2.68** ($p = 0.0056$). The number of inpatient hospitalization days was also significantly reduced after surgery, since the median number of inpatient hospitalization days due to bronchopneumonia 6 months before and 6 months after surgery were respectively **32.82** and **5.41** ($p = \mathbf{0.0013}$). Furthermore, the median FVC value also increased, although the difference did not reach statistical significance ($p = 0.3011$) (►**Table 3**).

Discussion

In our study, improvements in pulmonary function and reduction in inpatient hospitalization days due to lower respiratory tract infection were observed following sinus surgery in lung transplant patients.

Table 2 Subjects' characteristics, dates of lung transplant and sinus surgery, preoperative and postoperative FEV1, and hospitalization rates 6 months before and 6 months after sinus surgery

Patient number	Sex	Age at sinus surgery (years)	Lung disease	Lung transplant date	Sinus surgery date	Preop FEV1	Postop FEV1	Hospitalization days preop[a]	Hospitalization days postop[a]
1	M	41	Silicosis	09/09/00	07/15/09	**3.04**	**3.45**	9	0
2	M	26	Cystic fibrosis	10/20/04	08/15/05	**3.24**	**3.3**	25	29
3	M	43	Bronchiectasis	04/25/05	09/27/06	**1.36**	**1.78**	30	0
4	M	19	Cystic fibrosis	01/31/06	05/17/07	**2.35**	**2.71**	19	0
5	M	40	Cystic fibrosis	03/22/06	07/22/09	**2.33**	**2.35**	56	0
6	F	37	Bronchiectasis	09/05/06	04/19/07	**1.68**	**1.78**	62	26
7	M	21	Cystic fibrosis	12/23/06	01/17/08	**2.96**	**3.17**	0	0
8	M	26	Bronchiectasis	08/06/07	09/02/10	**4.08**	**4.04**	0	0
9	F	23	Ciliary dyskinesia	03/03/08	11/18/09	**3.2**	**2.68**	65	14
10	F	22	Cystic fibrosis	06/12/08	09/23/10	**1.98**	**2.38**	30	0
11	F	29	Bronchiectasis	06/20/08	11/11/10	**1.56**	**1.75**	27	0
12	M	32	Bronchiectasis	09/19/07	01/22/09	**2.83**	**3.4**	14	21
13	F	22	Cystic fibrosis	10/20/08	11/24/11	**1.66**	**2.64**	23	0
14	M	11	Cystic fibrosis	05/19/09	11/12/09	**0.74**	**1.33**	33	0
15	M	22	Cystic fibrosis	01/06/10	01/19/11	**1.86**	**1.85**	83	0
16	F	33	Cystic fibrosis	03/09/10	08/18/11	**2.75**	**3.11**	37	0
17	M	37	Cystic fibrosis	09/20/10	04/04/12	**3.29**	**3.57**	20	0

Abbreviations: F, Female; M, male; Postop, postoperative; Preop, preoperative; FEV1, forced expiratory volume in the first second.
[a]The preoperative days were defined as all hospitalization days in the six months preceding the date of the operation, and the postoperative days were defined as all hospitalization days during the six months of follow-up (excluding the hospitalization days due to the sinus surgery).

Table 3 Changes in FEV1, FVC and hospitalization rates before and after sinus surgery

	Preoperative value (median, IQR)	Postoperative value (median, IQR)	*p*-value
FEV1 (absolute value)	2.35 (1.36)	2.68 (1.45)	0.0056
FVC (absolute value)	3.11 (1.65)	3.3 (1.38)	0.3011
Hospitalization days*	32.82 (16)	5.41 (0)	0.0013

Abbreviations: FEV1, forced expiratory volume in the first second; FVC, forced vital capacity; IQR, interquartile range.
Note: * The preoperative days were defined as all hospitalization days in the six months preceding the date of the operation, and the postoperative days were defined as all hospitalization days during the six months of follow-up (excluding the hospitalization days due to the sinus surgery).

The vast majority of studies correlating rhinosinusitis and lung transplantation have been conducted exclusively in patients with cystic fibrosis. The present study also included patients with bronchiectasis non-cystic fibrosis and disorders of ciliary motility. Despite their distinct pathophysiology, both conditions have sinus disease as a common feature.

The literature is clear on the need for an aggressive treatment of rhinosinusitis in patients with lower respiratory tract involvement, since bacterial colonization from the paranasal sinuses induces pulmonary function deterioration.[12]

In a study with children with cystic fibrosis, Rosbe et al[8] found no statistically significant differences in FEV_1 and FVC values before and after sinus surgery. However, the study population was heterogeneous; of the 66 patients assessed, only 8 were lung transplant recipients.

Despite the small sample size, the results of our study showed a significant difference in the parameters considered important to assess respiratory function and patterns of infection in the lung graft.

Although recolonization of the paranasal sinuses after surgery is known to be highly prevalent in these patients,[6] sinus surgery is known to facilitate the mechanical clearance of secretions and to reduce the incidence of rhinosinusitis. The reduction in inpatient hospitalization days demonstrated in this study is probably related to upper airway inflammation treatment leading to a positive impact on the lower respiratory tract, which is consistent with the one airway, one disease concept.[1,2]

The significant reduction in the length of the hospitalization observed in our sample corroborates the results of previous studies that suggested a reduction in hospital costs and a subjective improvement in quality of life.[8,9]

Some limitations of this study should be noted. The sample was small, as it was restricted to patients with rare diseases who underwent a surgical procedure with precise indications that is only performed at select few hospitals (lung transplantation). The presence of a control group was infeasible due to the severity of the patients' clinical condition and to the lack of therapeutic alternatives. Finally, there was no long-term follow-up, but in a patient population with exceedingly high morbidity and mortality rates, 6 months represents a substantial gain in survival due to the improvement in FEV_1 values and the reduction in lung infection episodes.

On the other hand, the literature is scarce regarding studies that demonstrate statistically significant improvements in pulmonary function after surgery of the paranasal sinuses in this patient population. Furthermore, the sample of the present study was quite homogeneous, consisting only of lung transplant recipients, and all procedures were performed by the same surgical team, thus providing consistent data with greater internal validity.

Conclusion

Based on the present study, sinus surgery was associated with an apparent improvement in pulmonary function and a decrease in inpatient hospitalization days attributable to bronchopneumonia in lung transplant recipients with chronic rhinosinusitis. However, further studies with longer follow-up periods are required to assess the long-term effects of this surgery in this patient population.

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