

Lung Transplantation in Patients with Pulmonary Emphysema

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Lung transplantation is a viable option for patients with chronic obstructive pulmonary disease (COPD), and emphysema is the most common indication to undergo lung transplantation. A total of seven lung and one heart-lung transplantations were performed between July 1996 and June 2004 at the Yongdong Severance Hospital, and herein, three emphysema patients who underwent single lung transplantations are reviewed. There were 2 males and 1 female, with a mean age of 50 years (35, 57 and 58 years). They all underwent an operation, without cardiopulmonary bypass, and there was no operative mortality. The mean survival was 12 months (4 months, 15 months and 17 months) and all succumbed to death due to activation of pulmonary tuberculosis, post-transplantation lymphoproliferative disease and cytomegalovirus (CMV) gastritis associated with asphyxia. Infection was the most common postoperative complication, resulting in longer hospital stays, higher medical expenses and shorter survival rates, necessitating aggressive prophylactic management. The accumulation of experience, modifications to operative procedures and perioperative care may lead to improved early and long-term survival in patients with emphysema undergoing single or bilateral lung transplantations.

Key Words: Emphysema, single lung transplantation, CMV infection, pulmonary tuberculosis, post-transplantation lymphoproliferative disease, lung volume reduction surgery

INTRODUCTION

Chronic obstructive pulmonary disease (COPD) refers to the progressive development of an air-flow obstruction causing symptoms of a chronic

cough, exertional dyspnea, sputum expectoration and wheezing.¹ Emphysema, defined as the destruction of alveolar walls and permanent enlargement of the airspaces distal to the terminal bronchioles,² carries a high mortality rate resulting from the loss of lung elastic recoil that causes collapse of small airways, especially during forced expiration. An inexorable progression of the disease, with increasing breathlessness, renders the patient for definitive therapy other than medications.

Lung transplantation has become the standard therapy for patients with advanced emphysema,³ and is the most common indication of the need for lung transplantation worldwide,⁴ with three-year survivals of 60 to 70%.^{5,6} Single lung and bilateral lung transplantations have been performed in⁷⁻¹⁰ emphysema patients, and bilateral recipients have had slightly superior actuarial survival at 1, 2, 3 and 4 years.^{10,11} Other surgical options in emphysema is lung volume reduction surgery (LVRS), and appropriate patient selection and procedures are the key to long term survival.

It is a challenge to determine the critical point in the time course of slowly deteriorating patients to make the correct decision to undergo either LVRS or lung transplantation. The numbers of lung transplantations performed at our hospital are small, and accumulation of experience regarding the timing of operation, selection of candidates, choice of an appropriate procedure and the ideal postoperative management and follow-up may result in better long term survivals in the future. With the goal of improving the long term survivals following surgery, our cases were reviewed, along with the world literature on lung

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transplantation in emphysema patients.

MATERIALS AND METHODS

A total of eight patients received lung and heart-lung transplantations (emphysema, n=3; idiopathic pulmonary fibrosis, n=1; secondary pulmonary hypertension, n=2; bronchiectasis, n=1; lymphangiomyomatosis, n=1) at the Yong dong Severance Hospital, Yonsei University, between July 1996 and June 2004, and the medical records of three emphysema patients were retrospectively reviewed. The diagnosis of emphysema was made on the basis of the clinical symptoms, pulmonary function test and with the radiological imaging studies, such as chest CT scan.

Recipient criteria

Our standard criteria for recipient selection were based on Washington University protocols.¹²

Candidates for transplantation are first listed in the Korean Network of Organ Sharing (KONOS) when symptoms limiting daily activities develop. Thorough examinations prior to lung transplantation include the following; physiologic and imaging studies, functions of the renal, hepatic, endocrine, hematologic, cardiovascular and gastrointestinal systems, and the presence of infectious diseases (Table 1). There should also be no other systemic illness that would complicate or be complicated by lung transplantation and immunosuppression, and the patient and family should be economically and emotionally ready to give good family support. Contraindications for lung transplantation (Table 2) are an active extra pulmonary systemic infection, severe malnutrition, cirrhosis, renal failure or a systemic disease that would limit survival, and such patients should be excluded from surgery. Patients on prolonged ventilatory dependence and those with previous cardiothoracic surgery or pleurodesis are no longer contraindication to surgery.

Table 1. Diagnostic Evaluation for Lung Transplantation

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- Physiologic studies- PFT, 6-minute walk test
 - Imaging studies- plain chest x-ray, HRCT, perfusion lung scan
 - Cardiovascular system- EKG, echocardiogram, coronary angiogram
 - Renal, hepatic, and hematologic function-
 - Serum creatinine level, 24 hour creatinine clearance, bilirubin, CBC, platelet, coagulation studies, ABO/Rh, HLA typing, panal reactive antibody
 - Gastrointestinal system- GERD, GI bleeding, colonoscopy
 - Endocrine function- thyroid, pancreatic and adrenal function
 - Infectious disease- HIV, HAV, HBV, HCV, HTLV, CMV, EBV,
 - VZV, HSV, TBC
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Table 2. Contraindications for Lung Transplantation Include the Following

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- Acutely ill or unstable clinical status
 - Uncontrolled or untreatable pulmonary or extrapulmonary infection
 - Uncured neoplasm
 - Significant dysfunction of other vital organs, especially liver, kidney, and central nervous system
 - Significant coronary disease or left ventricular dysfunction
 - Active cigarette smoking
 - Drug or alcohol dependency
 - Unresolved psychosocial problems or noncompliance with medical management
 - HIV infection
 - Hepatitis B antigenemia
 - Hepatitis C infection with histopathologic evidence of liver disease
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Operative method

The standard donor criteria (Table 3) and donor procurement technique were similar to many published reports.¹³ All donors received intravenous, broad-spectrum antibiotics within a few hours before retrieval, and a bolus dose of prostaglandin E1 (25 µg/kg) administered directly into the pulmonary artery immediately before flushing the pulmonoplegia. The lungs were flushed with 4°C modified Euro-Collins solution (70 mL/kg) with a pressure of 30 cm H₂O, and the lung bloc removed in a semi-inflated state, with the trachea clamped, followed by immersion in a cold flush solution for transportation.

The operative technique for recipient implantation was similar to that described in many previous papers.^{14,15} Under a posterolateral thoracotomy, a recipient pneumonectomy are performed, while dissection around the recipient bronchus is kept to a minimum to avoid damage to the blood supply. The distal main bronchus of the donor was cut short, since it is better vascularized than either the carina or the proximal main bronchus. Bronchial anastomosis is performed in an end to end fashion with interrupted Vicryl 4-0 for the cartilaginous portion and over and over continuous suture in the membranous portion. The pulmonary vein of the donor and the left atrium of the recipient were sutured using Prolene 3-0 in a continuous fashion, and the pulmonary artery was sutured in a continuous fashion using Prolene 5-0. After completion of the procedure, the air in the vascular system was removed by starting pulmonary circulation after an intravenous injection of 500 mg of methylprednisolone. After venting of the air in the circulating blood, the clamps were

removed and ventilation of the lung started. Cardiopulmonary bypass should always be ready just in case the hemodynamics becomes unstable. Upon completion of the operation, fibrobronchoscopy was performed to inspect for airway anastomosis and to remove any secretions or blood clots.

Postoperative care

Mechanical ventilation was set with minimal PEEP, with the ventilator discontinued as soon as the weaning parameters permit. Perioperatively, cyclosporine and azathioprine are given, along with broad spectrum antibiotics. Subsequent antibiotic selection was based on the results of donor and recipient bronchial cultures. Prophylaxis against *Pneumocystis carinii* consists of trimethoprim-sulfamethoxazole, given twice daily, until discharge and thereafter for life. The standard immunosuppressive protocol consisted of cyclosporine, corticosteroids and azathioprine. Cyclosporine and azathioprine, twice and once a day, respectively, are given and the cyclosporine level checked and the dosage adjusted based on its level and the renal function. The azathioprine was withheld with a white cell count less than 4000/mm³. The prophylactic treatment for a cytomegalovirus infection was by intravenous ganciclovir for 12 weeks, which was thereafter changed to oral administration for life. Changes were made from cyclosporine to tacrolimus, and from azathioprine to mycophenolate mofetil depending on the clinical course. Routine surveillance by flexible bronchoscopy and transbronchial biopsies was performed at 2, 4 and 6 weeks, as well as for the presence of clinical manifestations suspicious for acute rejection.

A diagnosis of acute rejection required pathologic confirmation of grade A3 or higher from the transbronchial biopsy specimen, according to the grading system of the International Society for Heart and Lung Transplantation (ISHLT).¹⁶ Once acute rejection was diagnosed, bolus doses of intravenous methylprednisolone were administered for three consecutive days, followed by high dosage oral steroids, which were tapered over a few weeks.

Table 3. Standard Donor Criteria

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- Age < 55 years
 - ABO compatibility
 - Clear chest x-ray
 - PaO₂ > 300 mmHg on FiO₂ 1.0, PEEP 5 cm H₂O
 - ≤ 20 pack/year smoking history
 - Absence of chest trauma
 - No previous thoracic surgery on side of harvest
 - No aspiration or sepsis
 - Absence of purulent secretions at bronchoscopy
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RESULTS

The average age of the recipients was 50 years (35, 57 and 58 years), and there were 2 males and one female. All were single lung transplant recipients: two were right and one left. None necessitated cardiopulmonary bypass. The patients survived for a mean of 12 months (4, 15, and 17 months), but succumbed to death due to pulmonary tuberculosis, post-transplantation lymphoproliferative disease and CMV gastritis associated with asphyxia. The details of post-transplantation functional results were checked by the forced vital capacity (FVC), forced expiratory volume in 1 second (FEV1), 6-minute walk test (6MW), arterial oxygen (PaO₂) and carbon dioxide tension (PaCO₂) from the preoperative time of evaluation to post-transplantation.

Case 1

A 35-year-old female, with blood type A+, was diagnosed with pulmonary emphysema in 1994, and the symptoms had been aggravated thereafter, necessitating frequent admission due to dyspnea and pneumonia. In 1999, a pulmonary function test revealed a FEV1 of 0.63 L (20.7%) and FVC of 1.22 L (34.8%), and a blood gas study revealed CO₂ retention (89.6 mmHg). The donor was a 14 year old boy, with blood type O+, diagnosed as brain dead due to a subdural hematoma. At the time of the operation, the recipient was positive for hepatitis B viral antigen, Epstein Barr virus (EBV) IgM and Cytomegalovirus (CMV) IgG. The decision was made to perform single lung transplantation taking into consideration the rapid deterioration of the patient, even though the blood type was mismatched. She underwent left single lung transplantation, without complications, and was discharged on the 18th postoperative day.

The pulmonary function improved to a FEV1 of 1.35L (46%) and FVC of 1.83L (49%) by the 2nd postoperative months. At the 12 month follow-up, she had symptoms of upper respiratory tract infection, with a small nodule found in the transplanted lung. A tuberculosis skin test was negative. Serologic tests indicated that she was CMV IgM and IgG antibody positive. A transbronchial

lung biopsy (TBLB) was performed, but without success in pathologic confirmation; therefore, anti-tuberculosis drugs were empirically tried for 3 months. However, the mass showed no change in size, so a gun biopsy was performed and immunohistochemical study revealed a high grade large B-cell type malignant lymphoma. The dosage of immunosuppressant was reduced and chemotherapy with cytoxan and vincristine were undertaken. After 2 cycles of chemotherapy, she was re-admitted due to the sudden development of dyspnea, and showed rapid deterioration and progression to respiratory failure.

Case 2

A 57 year old male with pulmonary emphysema underwent right single lung transplantation. The donor was a 25 year old male with a subdural hematoma and compatible ABO type, and the viral markers were negative, with the exception of the CMV IgG. The donor lung was infected with MRSA, although it was clean bronchoscopically. The patient was discharged on the 15th postoperative day without complications and the pulmonary function test performed during the first 2 postoperative months showed marked improvements in the FEV1/FVC from 0.64L (22%)/1.68 L (42%) to 1.81 L (63%)/2.34 L (62%). The patient was healthy until he developed dyspnea at the 17 month follow-up, and a chest X-ray revealed consolidation in the lower lobe of the transplanted lung, but TBLB showed no sign of rejection. The result of a sputum culture for AFB (acid-fast bacilli) was strong positive, so anti-tuberculosis medication was started. However, chest x-rays showed aggravation of haziness on the entire lung and the patient succumbed to death due to sepsis.

Case 3

A 58 year old male with centrilobular pulmonary emphysema underwent right lung transplantation. He had been oxygen dependent for six years, and a pulmonary function test revealed a FEV1 /FVC of 0.45 L (16%)/1.33L (35%). He had a past history of pulmonary tuberculosis, which was cured with medication. The donor was a 29 year old male with a subdural hematoma. Their

ABO types were compatible and the viral markers were negative, with the exception of CMV IgG. After the transplantation, his pulmonary functions improved, with a FEV1/FVC of 1.16 L (44%)/1.48 L (41%), but he remained hospitalized due to nausea and vomiting that necessitated a fiberoptic gastro-duodenoscopy, and he was diagnosed with CMV gastritis. He was discharged on the 40th postoperative day. Due to poor oral intake and nausea, he lost 4 kg and his general conditions deteriorated, with development of pneumonia. He was readmitted for nutritional support, and was generally improving until he suddenly expired after food asphyxiation.

DISCUSSION

Chronic obstructive pulmonary disease (COPD) is a nonspecific term, which the American Thoracic Society (ATS) has defined as "a disease state characterized by the presence of airflow limitation due to chronic bronchitis or emphysema; the airflow obstruction is generally progressive, may be accompanied by airway hyperactivity, and may be partially reversible."² The European Respiratory Society defined COPD as "reduced maximum expiratory flow and slow forced emptying of the lungs, which is slowly progressive and mostly irreversible to currently available medical treatment".¹⁷

The incidence of COPD is escalating worldwide,¹⁸ with hospital cost and mortality rate being unacceptably high.¹⁹ The prevalence and mortality of the disease are expected to rise in association with increases in smoking, especially by females and adolescents. The clinical presentation of COPD is heterogeneous, and the most common

reported symptoms being wheezing and shortness of breath, with FEV1 values less than 50% of those predicted. Medical treatment²⁰ or the improvement in muscle strength²¹ has a limited role in the cure, which necessitates surgical treatment.

Ever since the first human lung transplantation was performed in 1963 by Hardy, about 40 attempts were made without success, until Cooper performed the first successful lung transplantation in 1983, in a patient with idiopathic pulmonary fibrosis.²² Emphysema is now the most common indication for lung transplantation, and is reported to account for 40 to 55% of the total number of lung transplantations.^{4,23} If a candidate has no evidence of organ dysfunction that might adversely affect the postoperative course, and if the patient and family are emotionally and economically ready, the decision for lung transplantation is made. The physical status of candidates should be in the "window" for transplantation (Table 4), which means that the patient's condition must have deteriorated, despite proper medical therapy, with an expected survival of less than 2 years, and should be in the NYHA classes II or III. Other indicators defining "the window" are; increased frequency of infectious exacerbations, number and duration of hospitalizations, increasing requirement for supplemental oxygen, increased frequency of syncope, and hemoptysis. Identifying the critical turning point signaling an accelerated decline is a key factor, and once the decision for transplantation is made, the importance of the overall physical status focusing on preserving muscle mass, muscle tone, nutrition and physical activity must be emphasized. The age criteria to receive lung transplantation are less than 55 years for heart-lung transplantation, less than 60 years for bilateral lung transplantation (BLT) and less than 65 years for single lung transplantation (SLT).²⁴

Emphysema patients are more likely to survive during the waiting period.^{25,26} The decision of selecting a candidate from a waiting list solely depends on the waiting time of each patient rather than giving credit for severity of the disease.²⁷ The number of institutes performing lung transplantation in Korea is limited, resulting in fewer difficulties in accessing the donor lung within our lung transplant program in comparison to most

Table 4. Criteria of Transplantation "Window"

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- Patient's condition deteriorate despite proper medical therapy
 - Expected survival less than 2 years
 - NYHA class II or class III
 - Increased frequency of infectious exacerbations
 - Increased number and duration of hospitalizations
 - Increasing supplemental oxygen requirements
 - Syncope
 - Hemoptysis
-

Western countries. However, the limiting factor of the lung transplantation program in Korea is more related to the small number of candidates waiting for transplantation.

Standard donor criteria have been established and undergone a process of widening based on clinical experience. (Table 3) A general prerequisite for a donor lung is a clear chest radiograph, although lungs with diffuse interstitial marking or local infiltrations may often be used due to the shortage of donor lungs. All donors should undergo bronchoscopy in order to define the endobronchial anatomy, to detect gross contamination or foreign bodies of the endobronchial tree, and have had specimens sent for gram stain and sputum culture. Gram stain results showing fungus or heavy contamination of gram negative bacteria precludes a lung for transplantation. Serologic tests for hepatitis, HIV, CMV and EBV are performed on all potential lung donors. Size matching, especially in patients with emphysema, is critically important in selecting a prospective donor because a too large graft may impede venous return and a too smaller graft may cause pleural space problems due to the large thoracic cavity in patients with emphysema.

Lung transplantation, particularly when performed bilaterally, "cures" the emphysema, but introduces a new disease, "complications of lung transplantation".²⁸ With the purpose of avoiding these complications caused by lung transplantation, the concept of LVRS was introduced by Cooper.²⁹ The original concept of LVRS was reported by Brantigan and Mueller in 1957, which involved resection of the useless, but space-occupying part of the lung causing the elasticity of the healthy portion of the lung to expand more to restore its physiologic function.³⁰ This concept was further expanded by Cooper, who performed a pneumectomy, which has subsequently been termed LVRS, and reported dramatic results following surgery, which have also been shown by others.^{31,32} A factor in choosing either LVRS or lung transplantation is from the radiological findings of the extent and distribution of emphysema. In patients with a homogenous disease, there are no specific emphysematous lungs to be removed, and these patients can not benefit from LVRS and should undergo lung transplantation.

In contrast, patients with upper-lobe predominant emphysema associated with good target zones for resection may be better candidates for LVRS. There are limited data comparing LVRS with lung transplantation. A study comparing three different cohorts of patients treated surgically by LVRS, SLT and BLT have been reported, and the overall mortality was somewhat higher in the transplant group; although spirometric improvement was greater after transplantation (BLT >> SLT > LVRS).³³

Single lung transplantation is a simpler, shorter procedure with a lower perioperative complication rate than BLT.⁸ The ISHLT registry has reported that 27.9% of worldwide emphysema patients receive BLT, but some institutes strongly favor BLT, 71.9%,²³ because patients receiving BLT had a significantly higher 5-year survival, at 66.7%, as compared with that of 44.9% of SLT recipients. In patients with a similar emphysematous change between the two native lungs, SLT in either right versus left side has no significant affect in the lung function postoperatively.³⁴ Deciding on which side to transplant depends on anatomical, pathological and physiological factors, and the side demonstrating the worst function, based on ventilation/perfusion mismatch, should be chosen, and the non-operated side in patients with previous thoracic operation or chemical pleurodesis is also preferred. In COPD patients, the right side is favored because the emphysematous native lung has a propensity for hyperinflation and there is more space for the left lung to expand by displacing the left diaphragm downward and minimizes the potential for herniation across the mediastinum.

Standard pulmonary function test results have been better after BLT, but the difference in the exercise capacity has been less dramatic.^{6,35,36} Improved long-term survival following BLT primarily occurs in younger patients and survivals at three and five years compared to SLT are 72 versus 60% and 68 versus 43%, respectively.³⁷ However, this trend was reversed for patients older than 60, where SLT improved the survival at three years (54 versus 45% with BLT) implying that the simpler procedure may result in improved survival.⁷ The advantages of BLT are: uniform distribution of pulmonary blood flow to both lungs, the avoidance of severe postoperative

pulmonary edema from receiving all cardiac outputs, and better postoperative pulmonary function and exercise capacity. By having two grafts, the lungs have more reserve with less chance of acute graft failure and chronic rejection.^{4,10,38} Most institutes favor BLT due to the superior survival and easier postoperative ventilator management.³⁹ BLT, although it takes a longer time, is mostly performed in younger or healthier recipients who are more able to tolerate a bilateral procedure, and the procedure itself is no more difficult. However, one must always consider preserving and protecting the second lung during the implantation since all the blood flow will go to the implanted lung.^{25,40,41,42} Our results only include data for SLT due to its less aggressive approach at the beginning of the lung transplant program, although our survival data strongly supports BLT over that of SLT.

Cardiopulmonary bypass (CPB) may help avoid acute lung injury in the first implanted lung by lessening the cardiac output during the second lung implantation procedure, although 9.5% of BLT procedures were performed with the assistance of CPB, compared to only 3.5% with SLT procedures.⁴³ CPB should only be used after considering its advantages since transplantation under CPB is one of the risk factors associated with the potential sequelae of coagulopathy, neurological dysfunction and renal impairment, which result in higher morbidity and mortality.^{44,45} Hemodynamic instability, the inability to adequately oxygenate or ventilate with one lung, dramatic increases in pulmonary arterial pressures with unilateral pulmonary artery clamping, and deterioration of right ventricular function as measured by transesophageal echocardiogram are all indications for CPB.

The main features of postoperative care include management of the reimplantation response, ventilatory care, hemodynamics, immunosuppression, infection, nutritional support and close follow-up. Lung rejection occurs more frequently during the first 3 months, and these patients present with a febrile illness, decreased oxygen saturations and infiltrate on chest x-ray. Surveillance bronchoscopy, with a transbronchial biopsy, should be performed once a month during the first 3 months, and again at 6 and 12 months after

transplantation, as well as the clinical indications for suspected rejection, infection or other pulmonary problems. Bronchoscopic specimens are sent for gram stain, bacterial, fungal and viral cultures, and if infection is excluded, episodes of acute rejection are usually treated with a 3-day course of high-dose methylprednisolone (500 to 1,000 mg/day) and the maintenance prednisone dose boosted to 0.5 mg/kg per day, with gradually reduction back to the original dose over 2 to 4 weeks.

When considering ventilatory care, the immediate goal is to achieve the lowest fractional inspired oxygen concentration. Maintaining the PaO₂ at least 100 mmHg, while limiting the airway pressure to less than 30 cmH₂O, is adequate. The characteristics of the native lung will greatly influence the ventilation and affect hemodynamic relationship, and especially in patients with emphysema, the native lung is highly compliant relative to the new lung; therefore, receives a greater proportion of the ventilation. This disproportionate amount of ventilation leads to over-distension resulting in the development of autoPEEP and, therefore, inadequate deflation of the native lung prior to delivery of the next ventilator breath. The lungs are also susceptible to edema formation due to the division of lymphatic drainage, with the combination of an infusion of colloid solution pressor agent.

All patients are immune suppressed and therefore have a higher chance of acquiring an infection necessitating a prophylactic management of the infectious disease. Early postoperative infection is usually caused by an organism transferred from the donor. Bacterial infections peak within 4 weeks, and the most common organisms are *Pseudomonas aeruginosa* and *Staphylococcus*. All patients have a high chance of CMV infection, particularly in those with mismatches (donor CMV seropositive and recipient seronegative), who are treated with ganciclovir. Other less common viral infections are respiratory syncytial virus, herpes and adenovirus. *Candida* and *Aspergillus* are common fungal infections, where prophylactic treatment with amphotericin B can be used until the patient becomes tolerable to oral itraconazole.

The development of a post-transplant lympho-

proliferative disease (PTLD) is a serious, often fatal complication after solid organ transplantation,⁴⁶ and the incidence after lung transplantation is higher (12%) compared to those of the liver (2%), kidney (1-3%) and bone marrow (1-2%).^{47,48} The peak incidence of PTLD occurs 3 to 4 months after transplantation, with early onset PTLD occurring within the first year and having a better prognosis than those developing a later disease.⁴⁶ Lung involvement by PTLD may present as nodular or diffuse reticulonodular infiltrates, solitary or multiple lung masses or hilar and mediastinal lymphadenopathy.⁴⁹ EBV infection, either preexisting in the recipient or acquired from the donor, is strongly implicated in the pathogenesis of PTLD⁴⁸ in which immunosuppression causes uncontrolled proliferation of EBV-stimulated B cells by inhibiting suppressor T cells, and leads to a fully malignant behavior and loss of responsiveness to restored immune regulation.⁴⁷ As in our first case, every effort should be made to diagnose a newly developed mass lesion in the transplanted lung in order to avoid unnecessary treatment and for the initiation of chemotherapy if diagnosed as PTLD. Prolongation of survival may be possible with immediate treatment by chemotherapy.

Most patients waiting for transplantation are cachexic due to chronic hypoxemia, and perioperative nutritional support is needed. Total parenteral nutritional support is given to patients intolerant to an oral diet. As in the third case, the perioperative course was good, other than the symptoms of nausea and vomiting that resulted in weight loss and general fatigue. Better nutritional support might have been helpful in avoiding complications that resulted in death.

CONCLUSION

COPD is a common disease that causes a great number of morbidity and mortality throughout the world. The total number of lung transplantations performed at our institute is minimal, with the number of emphysema patient being even smaller. The number of candidates waiting for lung transplantation has not increased, thus limiting the clinical experience necessary for impro-

vements in the perioperative management. Since COPD is a systemic and heterogeneous disease, certain aspects, such as smoking cessation and proper medical treatment, remain the cornerstone of COPD management. In patients with progressive diseases, either single or bilateral lung transplantation can be performed, but bilateral lung transplantations are recommended in all candidates, especially in otherwise young healthy patients.

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