CASE REPORT

Pulmonary rehabilitation after lung transplantation with severe complications: A case report

Guo-Qiang Jing[1], Jie Li MS RRT NPS ACCS[2,3], Bing Sun MD[3], Huiwen Chu[3], Haichao Li[3], Xue Wang[3], Xiao Tang MD[3]

GQ Jing, J Li, B Sun, H Chu, H Li, X Wang, X Tang. Pulmonary rehabilitation after lung transplantation with severe complications: A case report. Can J Respir Ther 2017;53(3):45–47

This case study describes a 59-year-old male with a body mass index of 14.4 kg/m^2 and a diagnosis of interstitial lung disease, pneumoconiosis, and severe pulmonary hypertension who received a bilateral lung transplant in a hospital in mainland China. Veno-arterial extracorporeal membrane oxygenation (VA-ECMO) was initiated before the lung transplant; in addition, an emergency thoracotomy was performed three hours afterwards due to uncontrolled bleeding. VA-ECMO was weaned 34 hours later, but weaning from the ventilator failed multiple times due to bilateral pneumothorax, weak neuromuscular drive, and muscle strength. A full, personalized rehabilitation program was initiated with the help of a respiratory therapy team and the physician, drawing on the American Thoracic Society/European Respiratory Society Statement on Pulmonary Rehabilitation. This included nutrition support, draining air from the chest pleural cavity, aggressive bronchial-hygiene therapy, a weaning plan, breathing and physical exercises, and psychological support. Eighty-one days after the tracheotomy, the patient was successfully weaned, decannulated, and discharged. A careful, ongoing evaluation and a personalized program assisted with weaning this difficult patient.

Key Words: *lung transplantation; weaning failure; severe malnutrition; rehabilitation*

INTRODUCTION

Lung transplantation is an effective treatment for end-stage lung disease [1]. However, a recent meta-analysis demonstrated that pretransplant patients who were underweight had 1.36 times higher risk for post-transplant mortality than patients with a normal body mass index (BMI) [2]. Patients with poor nutrition had higher in-hospital mortality rates after lung transplant due to a higher rejection rate and a higher rate of infectious episodes [3, 4]. Thus, a nutritional disorder is considered as a relative contraindication for a lung transplant [1].

According to a recent study by Hadem et al. [5], the need for postlung transplantation mechanical ventilation for more than 21 days is commonly required in 13.8% (95/690) of cases. Prolonged mechanical ventilation increases the possibility of acquiring infection and ventilator-induced diaphragm dysfunction, which worsens weaning difficulties [5]. However, with early intervention, multidisciplinary teams—including respiratory therapists (RTs)—can help lung transplant patients' rehabilitation and accelerate weaning [6].

In the case presented here, pursuant to the American Thoracic Society/European Respiratory Society Statement on Pulmonary Rehabilitation [7], a rehabilitation plan was made and implemented by RTs in conjunction with a multidisciplinary team for a patient after lung transplantation. A variety of movement exercises in the statement were applied to the plan, which included interval strength and endurance training for upper and lower extremities as well as inspiratory muscle training. Moreover, bronchial hygiene was utilized to improve secretion clearance and reduce airway resistance as well as to minimize work of breathing for this particular case due to his muscle weakness and surgical injury. As for ventilator management, careful progressive attempts at weaning were the key to the success. It should be noted that most hospitals in mainland China do not have RTs [8]; therefore, the participation of an RT in our team plays a very important role in this patient's rehabilitation.

Ethical approval was sought for this case study through Beijing Chaoyang Hospital's institutional review board and it was deemed unnecessary (06/02/2017).

CASE PRESENTATION

A 59-year-old male with a BMI of 14.36 kg/m^2 (40/1.67^2) was admitted to the hospital for a lung transplant in March 2014. He was diagnosed with interstitial lung disease, pneumoconiosis, and severe pulmonary hypertension five prior to admission. One year prior, he started home oxygen (nasal cannula) and his six-minute walk distance was less than 100 m. On admission, his muscle strength was found to be very weak. His upper limbs could not defend against resistance by the examiner, and his lower extremities could move, but not against gravity. Echocardiography showed mild to moderate systolic tricuspid valve regurgitation, with systolic pulmonary artery pressure (sPAP) of 93 mm Hg. Before surgery, he was placed on veno-arterial extracorporeal membrane oxygenation (VA-ECMO) with settings of 2531 rpm/min, blood flow 1.89 L/min, and oxygen flow 2 L/min to assist with the bilateral lung transplant. Three hours after surgery, the patient returned for a second thoracotomy surgery to stop the bleeding.

On the first postop day, sPAP was 26 mm Hg and hemoglobin was 84 g/L. ECMO was weaned 34 hours later. However, the attempt to switch ventilator mode from pressure-assist control (P-AC) to pressure support ventilation (PSV) failed. Electrical activity of the diaphragm showed weak neuromuscular drive. A chest computed tomography (CT) scan found bilateral collusive pneumothorax (Figure 1). Percutaneous tracheotomy was performed at the bedside on postop day five.

The patient's muscle strength decreased after surgery (muscle strength grade 2) due to immobility for a period of time (Figure 2). Passive limb functional exercise was initiated, followed by combined passive and active limb exercises four times a day. Daily therapeutic bronchoscopy was performed to help clear the copious amount of secretions. Ventilator settings were carefully titrated based on vital signs and subjective complaint. Eight days later, he was placed on Optiflow via a T-piece with FiO_2 0.40–0.60 and flow 30–50 L/min. However, his $PaCO_2$ gradually increased from 35 mm Hg to 66 mm Hg in the following three days. He also felt short of breath and was diaphoretic and was then placed back on the ventilator with P-A/C. A chest CT showed some improvement in the right-side pneumothorax, but worsening consolidation and a

[1]*Binzhou Medical University, Binzhou Medical University Hospital, Intensive Care Unit, Binzhou, Shandong, 256600, PR China;* [2]*Department of Cardiopulmonary Sciences, Division of Respiratory Care, Rush University Medical Center, Chicago, IL. 60612, USA;* [3]*Pulmonary and critical care medicine, Beijing Chao-Yang Hospital, Capital Medical University, Beijing Institute of Respiratory Medicine, Beijing 100020, PR China*

Correspondence: Jie Li. e-mail: Jie_Li@rush.edu

OPEN ACCESS

This open-access article is distributed under the terms of the Creative Commons Attribution Non-Commercial License (CC BY-NC) (http://creativecommons.org/licenses/by-nc/4.0/), which permits reuse, distribution and reproduction of the article, provided that the original work is properly cited and the reuse is restricted to noncommercial purposes. For commercial reuse, contact editor@csrt.com

FIGURE 1

Chest CT on postoperative days 4, 11, 24, and 73 (from left to right). CT, computed tomography.

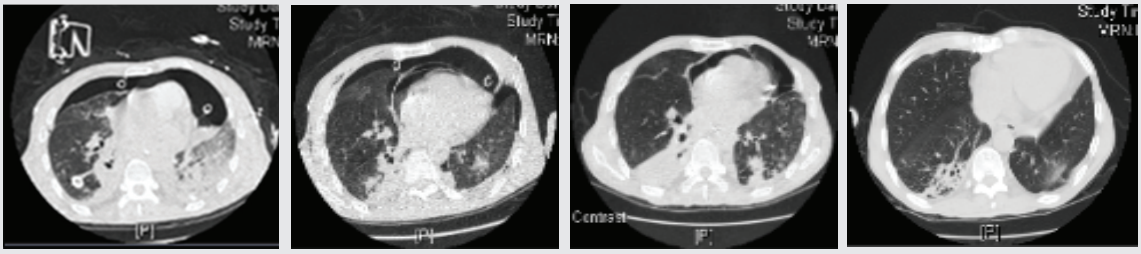
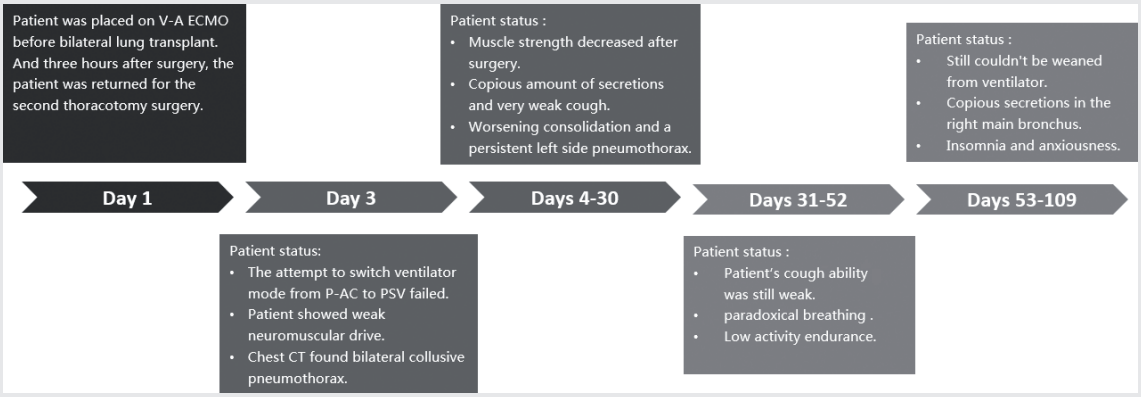


FIGURE 2

Patient information timeline.



persistent left-side pneumothorax (Figure 1). Five days later, the T-piece with Optiflow was again attempted intermittently. However, on day three the patient became drowsy, with diminished and coarse breath sounds in the left lung. Arterial blood gas (ABG) showed hypercapnia (pH 7.279; $PaCO_2$ 85.7 mmHg; PaO_2 206.9 mmHg). He then was placed back on mechanical ventilation with PSV: PS 16 cm H_2O, positive end-expiratory pressure (PEEP) 6 cmH_2O, FiO_2 30%.

Nutritional support was reevaluated and adjusted, and a percutaneous gastrointestinal ostomy was performed at bedside on week six. Slight suction pressure was connected with a left chest tube to help drain gas and his paradoxical breathing gradually improved. His cough ability was still weak, but the need for bronchoscopy decreased. We initiated as aggressive bronchial-hygiene therapy as he was able to tolerate, such as postural drainage and chest percussion three to four times a day. He was mobilized to the chair at bedside and given active resistance muscle exercises. Ventilator settings were gradually reduced, and he was intermittently switched from the ventilator to the T-piece with Optiflow, and his ABG became stable.

The patient was able to sit on a chair without assistance and stand up at bedside on week eight (limb muscle strength grade 4). At week 10, he was able to perform assisted walking with ventilator support. Ventilator settings were adjusted based on his vital signs and subjective complaint. A chest CT on week 11 displayed no presence of pneumothorax, and consolidation in the right lower lobe had improved. However, a bronchoscopy showed copious secretions in the right main bronchus. Chest wall oscillation was used to clear secretions. During this time, the patient started exhibiting insomnia and anxiousness. An antidepressant and sleep medication were prescribed by a consulting psychologist. The patient was weaned intermittently from the ventilator to the T-piece (F_IO_2 24%–28%) on week 13. Finally, a cuffless tracheostomy tube was placed on week 14 and capped 5 days later. He was decannulated with 2 L/min nasal cannula on week 15, and discharged from the intensive care unit with a BMI of 16.06 kg/m^2.

DISCUSSION

This patient was a poor candidate for a lung transplant due to severe malnutrition, advanced age, the need for ECMO support during surgery, and the need for long-term mechanical ventilation after the transplant. Additionally, this patient had numerous complications immediately after the transplant, such as bleeding and bilateral collusive pneumothorax. Pulmonary rehabilitation has a vital role in the treatment of lung transplantation patients [7]. After a full evaluation of this case, the multidisciplinary team listed and prioritized 5 key treatable problems: secretion retention, respiratory dysfunction, skeletal muscle weakness, malnutrition, and psychological anxiety. A multidisciplinary rehabilitation program was created specifically for this difficult patient.

Secretion retention

Tomkiewicz et al. [9] reported that ciliary function, or mucus properties, were significantly altered in a canine model of single lung autotransplantation, and that this abnormality lasted four months postoperation. Our case was also found to have secretion retention, especially in the early phase postoperation. Esguerra-Gonzales et al. [10] found that

four daily bronchial hygiene treatments provided to lung transplant patients improved peak expiratory flow from 205 L/min to 225 L/min as well as improving patients' dyspnea scores and oxygenation. For this patient, chest percussion combined with postal drainage and high-frequency chest wall oscillation were provided to help mobilize secretions; cough assist and bronchoscopy were also used to assist with secretion clearance.

Respiratory dysfunction

The possibility of weaning this patient from the ventilator was monitored closely, and weaning was progressively attempted. Physical signs, symptoms, and subjective feelings were utilized to evaluate the patient's tolerance and to determine the next step in weaning attempts.

Skeletal muscle weakness

For this specific patient, physical therapy was introduced early, immediately after the patient was removed from ECMO. Passive exercises were provided when his muscle strength was low and active exercises were initiated as he was gaining muscle strength. To encourage the patient to exercise, ventilator support was increased during exercise to provide sufficient ventilation and oxygen delivery. Ventilator settings were carefully titrated by the RT, based on the patient's progress. At the late phase, the RT walked the patient with the ventilator and adjusted settings for the patient. Every time the patient was doing exercises, the RT always stayed aside and made decisions on when to discontinue and when to resume exercises.

Malnutrition

Nutrition disorder is one of the major issues in this individual case, as malnutrition limited his rehabilitation. After a full assessment by the physician, different ways of feeding (intravenous and enteral nutrition support) were utilized in different phases of recovery. A nutrition plan was evaluated and revised daily. Also, a high-protein, high-fat, and low-carbohydrate diet was given to reduce carbon dioxide production along with oxygen consumption on the metabolic process.

Psychological anxiety

Psychological counseling helps lung transplant recipients improve rehabilitation and their life quality [11]. When the patient reported insomnia and anxiousness, a psychologist was consulted, and an antidepressant and sleep medication were prescribed.

In this case, a multi-disciplinary intervention played a key role. As part of the team, RTs spent a vast amount of time and effort in the patient's rehabilitation in respiratory dysfunction, ventilator support, and bronchial hygiene, in addition to physical therapy. The RT took a leadership role in this patient's rehabilitation, including the patient's physical therapy needs. The explanation as to why the RT was more involved in the physical therapeutics is because of the physical therapist's unfamiliarity with ventilator support. In addition, the physical therapist's time with the patient was limited, only working with the patient twice a day during the week. Importantly, the RTs in our hospital were designated to a specific ICU and built a relationship with this patient over extensive time, thus the RTs were more familiar with the patient's needs and preferences.

CONCLUSION

This case demonstrated that careful evaluation and an individual systematic rehabilitation program from a multidisciplinary team with early intervention may help lung transplanted patients' rehabilitation and accelerate weaning. Most hospitals in China do not have access to the services of RTs. This novel case study importantly records the role of the RT within the evolving context of Chinese healthcare and rehabilitation systems. The RTs involved in this case demonstrated their ability to provide a unique and indispensable role within the team, including careful evaluation, airway clearance, breathing exercises, early mobility, and physical intervention.

ACKNOWLEDGEMENTS: We thank J. Brady Scott MSc RRT-ACCS FAARC and Tyler Weiss MSc RRT-ACCS AE-C for reviewing the manuscript.

REFERENCES

1. Weill D, Benden C, Corris PA, et al. A consensus document for the selection of lung transplant candidates: 2014 – An update from the Pulmonary Transplantation Council of the International Society for Heart and Lung Transplantation. J Heart Lung Transplant 2015; 34(1):1–15. doi: 10.1016/j.healun.2014.06.014.
2. Upala S, Panichsillapakit T, Wijarnpreecha K, et al. Underweight and obesity increase the risk of mortality after lung transplantation: A systematic review and meta-analysis. Transpl Int 2016;29:285–96. doi: 10.1111/tri.12721.
3. Hollander FM, van Pierre DD, de Roos NM, van de Graaf EA, Iestra JA. Effects of nutritional status and dietetic interventions on survival in Cystic Fibrosis patients before and after lung transplantation. J Cyst Fibros 2014;13(2):212–18. doi: 10.1016/j.jcf.2013.08.009.
4. Lowery EM, Bemiss B, Cascino T, et al. Low vitamin D levels are associated with increased rejection and infections after lung transplantation. J Heart Lung Transplant 2012;31(7):700–7. doi: 10.1016/j.healun.2012.02.012.
5. Hadem J, Gottlieb J, Seifert D, et al. Prolonged mechanical ventilation after lung transplantation-A single-center study. Am J Transplant 2016;16(5):1579–87. doi: 10.1111/ajt.13632.
6. Fuehner T, Kuehn C, Welte T, Gottlieb J. ICU care before and after lung transplantation. Chest 2016;150(2):442–50. doi: 10.1016/j.chest.2016.02.656.
7. Spruit MA, Singh SJ, Garvey C, et al. An official American Thoracic Society/European Respiratory Society statement: Key concepts and advances in pulmonary rehabilitation [J]. Am J Respir Crit Care Med 2013;188(8):e13–64. doi: 10.1164/rccm.201309-1634ST.
8. Li J, Zhan QY, Liang ZA, et al. Respiratory care practices and requirement for respiratory therapists in Beijing ICUs. Respir Care 2012;57(3):370–6.
9. Tomkiewicz RP, App EM, Shennib H, Ramirez O, Nguyen D, King M. Airway mucus and epithelial function in a canine model of single lung autotransplantation. Chest 1995;107(1):261–5. doi: 10.1378/chest.107.1.261.
10. Esguerra-Gonzales A, Ilagan-Honorio M, Kehoe P, et al. Effect of high-frequency chest wall oscillation versus chest physiotherapy on lung function after lung transplant. Appl Nurs Res 2014;27(1):59–66. doi: 10.1016/j.apnr.2013.11.005.
11. Goetzmann L, Irani S, Moser KS, et al. Psychological processing of transplantation in lung recipients: A quantitative study of organ integration and the relationship to the donor. Br J Health Psychol 2009;14:667–80. doi: 10.1348/135910708X399447.