Case Report

The Role of Transesophageal Echocardiography in Evaluation and Management of Hypoxia Following Lung Transplantation

Hemamalini P, Shanmugaperumal Paramasivan[1], Prabhat Dutta[2], Sandeep Attawar[3]

Consultant Cardiac Anesthesia, [1]Adult Cardiothoracic Anesthesia, MIOT International Hospitals, Chennai, Tamil Nadu, [2]Additional Director, Heart Lung Transplant Institute, [3]Founder Director and Chair of Advanced Heart Failure, Terminal Lung Diseases and The Solid Thoracic Organ Transplant Program, KIMS Institute of Heart, Lung Transplantation, Secunderabad, Telangana, India

ABSTRACT

Pulmonary vein thrombosis (PVT) is a potentially fatal complication following lung transplantation (LT). The clinical presentation of PVT is nonspecific and mimics other common postoperative complications such as reperfusion injury, infection, and rejection. Transesophageal echocardiography (TEE) plays a pivotal role in detecting abnormalities of the pulmonary venous anastomosis in the perioperative period. Echocardiographic findings that warrant concern include a visible thrombus in pulmonary vein, pulmonary vein diameter <5 mm, turbulence on color Doppler, and peak systolic velocity >100 cm/s. Transplant centers should strongly consider TEE in individual patients with unexplained graft failure.

Keywords: Lung transplantation, pulmonary vein thrombosis, transesophageal echocardiography

Address for correspondence: Dr. Hemamalini P, No 15, Sri Rajarajeshwari Nagar, 1st Main Road, Old Perungalathur, Chennai - 600 063, Tamil Nadu, India.
E-mail: drhema07@yahoo.com

Submitted: 18-Jul-2021 **Revised:** 11-Sep-2021 **Accepted:** 12-Sep-2021 **Published:** 05-Jul-2022

INTRODUCTION

Lung transplantation (LT) is now an established treatment modality for patients with end-stage lung disease, refractory to medical therapy. Although early graft failure and infection remain the commonest causes of early mortality,[1] pulmonary vascular complications are well recognized as a potentially fatal complication of LT.[2,3] Pulmonary venous obstruction is a rare, potentially fatal complication following LT. Obstruction may be caused by thrombus, surgical stenosis, torsion, or external compression and can lead to hypoxemia, pulmonary edema, and allograft failure. This case report illustrates the usefulness of transesophageal echocardiography (TEE) in the early diagnosis and management of pulmonary vein thrombosis (PVT) in the postoperative period following LT.

Access this article online	
Quick Response Code:	Website: www.annals.in
	DOI: 10.4103/aca.ACA_96_21

CASE HISTORY

A middle-aged patient was listed for LT for end-stage lung disease due to interstitial lung disease and evaluated for the same. His/Her past medical history was notable for type 2 diabetes mellitus. His/Her forced expiratory volume in 1 s was 34% of predicted. Preoperative evaluation showed that his/her hematological, biochemical, and coagulation parameters were within normal limits. Cardiac catheterization revealed mild pulmonary hypertension with a pulmonary artery pressure of 52/25 mmHg, mean pulmonary artery pressure of 34 mmHg, central venous pressure (CVP) of 10, and pulmonary capillary wedge pressure (PCWP) of 9 mmHg.

How to cite this article: Hemamalini P, Paramasivan S, Dutta P, Attawar S. The role of transesophageal echocardiography in evaluation and management of hypoxia following lung transplantation. Ann Card Anaesth 2022;25:356-8.

The patient underwent bilateral sequential LT off cardiopulmonary bypass, during an admission with respiratory failure. Conventional monitors and a radial arterial catheter for blood pressure monitoring were applied while the patient was awake. Anesthetic induction was performed with fentanyl (5 mcg/kg), propofol (2 mg/kg), and vecuronium (0.1 mg/kg) and patient was intubated with 35-Fr left-sided double-lumen tube. Isoflurane (0.4–1%) was used for maintenance supplemented by midazolam (5–10 mg) and fentanyl (5 mcg/kg). Other monitors were inserted after anesthetic induction including a pulmonary arterial catheter and a TEE probe. Immunosuppression comprising mycophenolate mofetil, basiliximab, and methylprednisolone was commenced. About 2 mg/kg of heparin was administered intravenously before clamping the right pulmonary vasculature and a further 1 mg/kg of heparin was administered for clamping left pulmonary hilum. Activated clotting time (ACT) was monitored throughout the procedure with a target of 250–300 s. Reperfusion of both lungs was uneventful with a total ischemic time was 4 h 25 min for the right lung and 6 h 10 min for the left lung. Due to surgical concerns of ongoing bleeding, 50 mg of protamine was administered along with two units of fresh frozen plasma. The final ACT was 184 s. Intraoperative TEE demonstrated patent pulmonary venous and right pulmonary artery anastomoses with a normal flow velocity profile. However, left pulmonary artery could not be visualized. The patient was then shifted to critical care unit with stable hemodynamics and good gas exchange.

Few hours after surgery, in the critical care unit, the patient started having a worsening gas exchange, lung compliance, and frothy secretions from the endotracheal tube. Chest X-ray revealed a unilateral diffuse interstitial opacity of the left lung. Initially, this was thought to be reperfusion injury, occasionally seen after LT. However, a persistently high CVP of 13–18 mmHg and PCWP of 14–16 mmHg, aggravating hypoxia (paO_2 = 55 mmHg at fractional inspired oxygen concentration of 1), and increasing unilateral interstitial opacity on chest X-ray raised the suspicion of vascular complication following LT. TEE performed at the bedside and showed an echogenic mass (32 × 5 mm), suggestive of thrombus, arising out of the left upper pulmonary vein, and extending into the left atrium [Figure 1]. Color Doppler showed turbulence at the site of left pulmonary venous anastomosis [Figure 2] and elevated systolic velocities were evident on spectral Doppler [Figure 3]. The other pulmonary veins were normal.

The patient underwent emergency surgical thrombectomy. During the reoperation, there was no suggestion of narrowing of the venous anastomosis. Inspection of the branch pulmonary arteries, right pulmonary venous, and

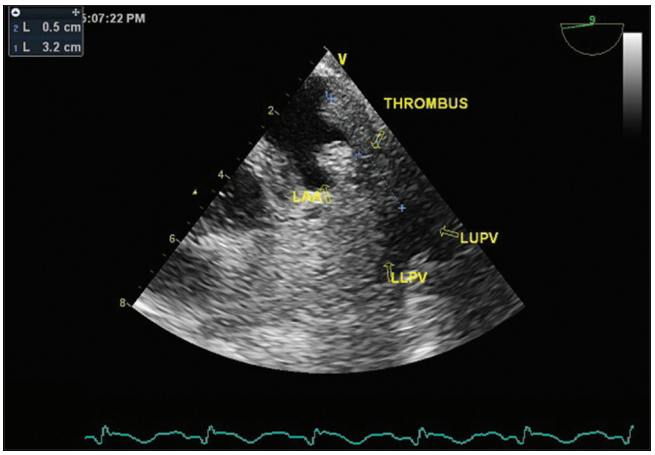

Figure 1: Thrombus visualized in the left upper pulmonary vein on 2D imaging

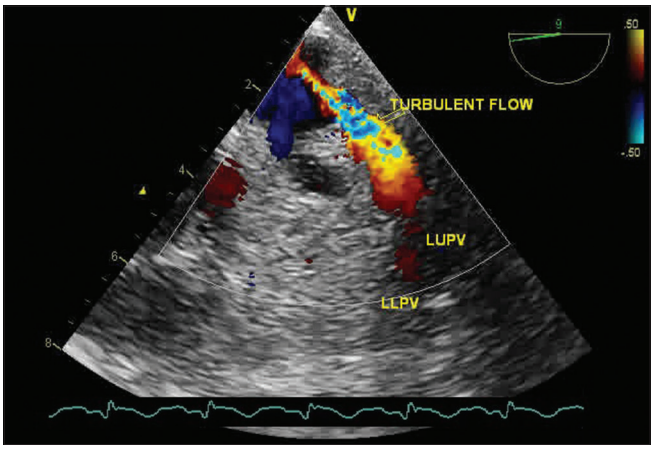

Figure 2: Color Doppler of the left upper pulmonary vein showing turbulence

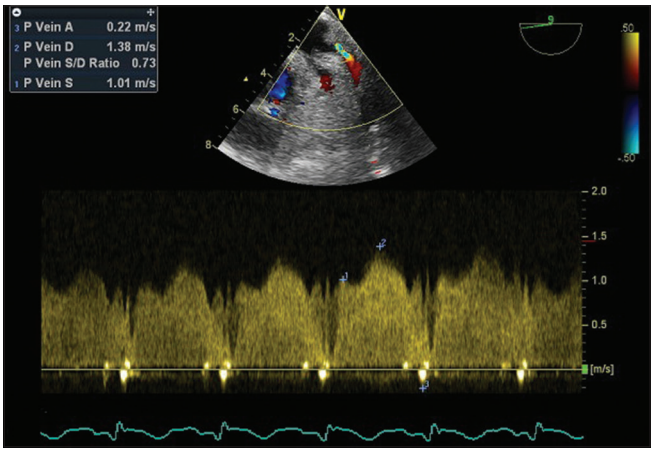

Figure 3: Spectral Doppler of the left upper pulmonary vein showing elevated velocities

bronchial anastomoses showed no abnormalities. Repeat TEE confirmed the patency of pulmonary veins and no residual thrombus. However, due to persistent hypoxemia, venovenous extracorporeal membrane oxygenation (ECMO) was instituted under TEE guidance. The patient was weaned

off ECMO on postoperative day five but succumbed to septic shock with multiorgan failure on postoperative day 16.

DISCUSSION

PVT occurs in up to 15% of patients undergoing LT in the early postoperative period.[2] It predisposes to allograft failure and systemic embolization and carries a 90-day mortality of 38%.[2] The exact etiology of PVT following LT remains unclear. No donor or recipient characteristics have been identified as predisposing factor. Though previous reports have suggested that abnormalities at the venous anastomotic site may be a potential contributory factor, in most of the cases, no abnormality has been found. Intraoperatively, no particular problems in performing the venous or arterial anastomoses were noted in this patient.

The clinical presentation of PVT is nonspecific and can mimic acute graft rejection, infection, right ventricular failure, or reperfusion injury. The two major recognized complications are allograft failure and stroke.

The imaging modalities available for diagnosis of PVT include echocardiography, pulmonary angiography, computed tomography (CT), and magnetic resonance imaging (MRI). TEE is able to detect abnormalities of the pulmonary veins when transthoracic echocardiography cannot and TEE also obviates the need for angiography. CT and MRI provide excellent resolution but mandate transportation of the critically ill patient to another facility and are time-consuming. The pulmonary venous and right pulmonary artery anastomoses can be visualized with TEE in most cases, whereas left pulmonary artery anastomosis can only be identified in 71% of the cases due to location of the left hilum. The diagnostic accuracy of TEE for detecting intra-cardiac thrombus is very high. Manning *et al*.[4] demonstrated 100% sensitivity and 99% specificity of TEE in detecting left atrial thrombi.

In addition to visualizing intraluminal abnormalities, TEE can also provide an estimate of thrombus size, residual pulmonary vein diameter, and flow velocity across a narrowed segment. These parameters may be used to guide management and prognosis. In some instances, as in this case, an echogenic mass may be seen on 2D echocardiographic imaging originating from one of the pulmonary veins and extending into the left atrium, suggestive of thrombus. Even when a mass is not visualized, Doppler should be performed to aid in the diagnosis of PVT. Expected values for both S and D waves range from 30 to 60 cm/s.[5] A velocity >100 cm/s by spectral Doppler and turbulence on color flow Doppler or deviation from systolic flow predominance (S < D) may be suggestive of clinically significant PVT and warrant further investigation. In LT recipients without pulmonary venous abnormalities, the mean pulmonary vein diameter is 1.4 ± 0.16 cm. A pulmonary vein diameter <0.5 cm is suggestive of significant narrowing and diameter <0.25 cm has been described as a threshold for graft failure.[6] Small, nonobstructive thrombi can be managed conservatively, whereas larger, obstructive thrombi require surgical thrombectomy.

TEE also plays a crucial role at every step of institution of ECMO. Echocardiography guides in patient selection, insertion, and placement of cannulas, monitors progress, detects complications, and helps in determining recovery and weaning.[7]

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient (s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

CONCLUSION

TEE serves as the best imaging modality for perioperative diagnosis and management of PVT following LT.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

REFERENCES

1. Studer SM, Levy RD, McNeil K, Orens JB. Lung transplant outcomes: A review of survival, graft function, physiology, health-related quality of life and cost-effectiveness. Eur Respir J 2004;24:674-85.
2. Schulman LL, Anandarangam T, Leibowitz DW, Ditullio MR, McGregor CC, Galantowicz ME, *et al*. Four-year prospective study of pulmonary venous thrombosis after lung transplantation. J Am Soc Echocardiogr 2001;14:806-12.
3. Leibowitz DW, Smith CR, Michler RE, Ginsburg M, Schulman LL, McGregor CC, *et al*. Incidence of pulmonary vein complications after lung transplantation: A prospective transesophageal echocardiographic study. J Am Coll Cardiol 1994;24:671-5.
4. Manning WJ, Weintraub RM, Waksmonski CA, Haering JM, Rooney PS, Maslow AD, *et al*. Accuracy of transesophageal echocardiography for identifying left atrial thrombi. A prospective, intraoperative study. Ann Intern Med 1995;123:817-22.
5. Gentile F, Mantero A, Lippolis A, Ornaghi M, Azzollini M, Barbier P, *et al*. Pulmonary venous flow velocity patterns in 143 normal subjects aged 20 to 80 years old. An echo 2D colour Doppler cooperative study. Eur Heart J 1997;18:148-64.
6. Huang YC, Cheng YJ, Lin YH, Wang MJ, Tsai SK. Graft failure caused by pulmonary venous obstruction diagnosed by intraoperative transesophageal echocardiography during lung transplantation. Anesth Analg 2000;91:558-60.
7. Platts DG, Sedgwick JF, Burstow DJ, Mullany DV, Fraser JF. The role of echocardiography in the management of patients supported by extracorporeal membrane oxygenation. J Am Soc Echocardiogr 2012;25:131-41.