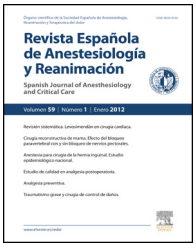
Rev Esp Anestesiol Reanim. 2014;61(8):434–445

Revista Española de Anestesiología y Reanimación

www.elsevier.es/redar



REVIEW

Perioperative management of pulmonary hypertension during lung transplantation (a lesson for other anaesthesia settings)☆

J.M. Rabanal[b,*], M.I. Real[b], M. Williams[a]

[a] Servicio de Anestesiología y Reanimación, Hospital Universitario Marqués de Valdecilla, Santander, Spain
[b] Servicio de Anestesiología y Reanimación, Hospital Universitario 12 de Octubre, Madrid, Spain

Received 11 November 2013; accepted 12 May 2014
Available online 22 August 2014

KEYWORDS
Pulmonary hypertension;
Lung transplantation;
Anaesthesia;
Right ventricular dysfunction;
Inhaled nitric oxide;
Iloprost

Abstract Patients with pulmonary hypertension are some of the most challenging for an anaesthesiologist to manage. Pulmonary hypertension in patients undergoing surgical procedures is associated with high morbidity and mortality due to right ventricular failure, arrhythmias and ischaemia leading to haemodynamic instability. Lung transplantation is the only therapeutic option for end-stage lung disease. Patients undergoing lung transplantation present a variety of challenges for anaesthesia team, but pulmonary hypertension remains the most important. The purpose of this article is to review the anaesthetic management of pulmonary hypertension during lung transplantation, with particular emphasis on the choice of anaesthesia, pulmonary vasodilator therapy, inotropic and vasopressor therapy, and the most recent intraoperative monitoring recommendations to optimize patient care.

PALABRAS CLAVE
Hipertensión Pulmonar;
Trasplante Pulmonar;
Anestesia;
Disfunción ventrículo derecho;
Oxido nítrico inhalado;
Iloprost

Manejo perioperatorio de la hipertension pulmonar durante el trasplante pulmonar (Una lección para otros escenarios anestésicos)

Resumen La presencia de hipertensión pulmonar en el paciente quirúrgico constituye un reto para el anestesiólogo, dado que se asocia con una elevada morbilidad y mortalidad debido a lo frecuente del fallo del ventrículo derecho y colapso circulatorio. El trasplante pulmonar es la última opción terapéutica en los pacientes con insuficiencia respiratoria terminal. Estos pacientes representan un reto para el anestesiólogo siendo la hipertensión pulmonar el más importante. El propósito de esta artículo es la revisión del manejo anestésico de la hipertensión pulmonar durante el trasplante de pulmón, con especial énfasis en la elección del tipo de

☆ This article is part of the Anaesthesiology and Resuscitation Continuing Medical Education Program. An evaluation of the questions on this article can be made through the Internet by accessing the Education Section of the following web page: www.elsevier.es/redar.

* Corresponding author.
E-mail address: jmrabanal@humv.es (J.M. Rabanal).

http://dx.doi.org/10.1016/j.redar.2014.05.015

anestesia, uso de vasodilatadores pulmonares, soporte inotrópico y vasopresor, y monitorización intraoperatoria.

Introduction

Lung transplantation is the only option for mid-term and long-term survival in patients with terminal respiratory failure.[1] Survival rates vary according to the reason for transplantation, but the rate usually exceeds 80% one year and 50% five years after transplantation. Pulmonary hypertension (PH) is a common complication associated with almost all the causes of chronic respiratory failure that are indications for transplantation (emphysema, interstitial pulmonary disease, chronic obstructive pulmonary disease, sarcoidosis, etc.). Idiopathic PH is also an indication for transplantation when vasodilator treatment (calcium channel blockers, endothelin receptor antagonists, phosphodiesterase inhibitors, prostanoids) fails. The overall incidence of severe PH in patients on the lung transplant waiting list has been estimated to be 25–45%.[2]

During the surgical procedure for lung transplantation, PH becomes more evident after clamping of the pulmonary artery for removal of the native lung since all the cardiac output (CO) must circulate through the pulmonary vascular bed of the remaining lung. This may result in right ventricular (RV) failure and the need to initiate cardiopulmonary bypass (CPB), which entails a longer surgical time, greater transfusion requirements, the release of inflammatory mediators, a longer time on postoperative mechanical ventilation, a longer hospital stay, a higher primary graft dysfunction rate and, for some authors, a higher mortality rate.[9] A literature review focused on the perioperative management for lung transplantation, and pathophysiology and treatment of PH. For this, a search was performed in PubMed/Medline using the terms: ''anaesthesia and lung transplantation'' ''pathophysiology of pulmonary hypertension'' ''pulmonary hypertension therapy'' ''right ventricle failure'' ''iloprost'' ''prostacyclin''

Defining pulmonary hypertension

Pulmonary hypertension has been defined as an increase in mean pulmonary arterial pressure (mPAP) to 25 mmHg or greater at rest assessed by right heart catheterization. Table 1 gives different haemodynamic definitions according to various combinations of values of pulmonary wedge pressure (PWP), pulmonary vascular resistance (PVR), and CO. During preoperative assessment, it is important to establish the transpulmonary gradient (TPG) (mPAP-mPWP). A TPG equal to or greater than 12 mmHg implies a disproportionate increase in post-capillary or reactive PVR, and fixed structural obstructive remodelling of the pulmonary artery resistance vessels. It is important to bear this in mind when indicating single or double lung transplantation, since in single lung transplantation there will be no improvement in PH after the procedure.[3] The World Health Organization classification for PH is shown in Table 2

Table 1 Haemodynamic definition of pulmonary hypertension.

Definition	Characteristics	Clinical group
PH	Mean PAP $\geq$ 25 mmHg	All
Pre-capillary PH	Mean PAP $\geq$ 25 mmHg PWP $\leq$ 15 mmHg, CO normal or reduced	1. Pulmonary arterial hypertension 3. PH due lung disease 4. Chronic Thromboembolic PH 5. PH unclear diseases
Pos-capillary PH	Mean PAP $\geq$ 25 mmHg PWP > 15 mmHg, CO normal or reduced	2. PH due left heart disease
Passive	TPG $\leq$ 12 mmHg	
Reactive	TPG > 12 mmHg	

PAP, pulmonary artery pressure; PWP, pulmonary wedge pressure; TPG, transpulmonary; PH, pulmonary hypertension; PAP, pulmonary arterial pressure; PWP, pulmonary wedge pressure; TPG, transpulmonary gradient.

Surgical times in lung transplantation

Onset times for PH in the course of transplant surgery are well-defined, but the time of onset will vary according to the disease and the individual patient. Patients with pulmonary arterial hypertension (PAH), will by definition present with PH, since this is the indication for transplantation. In these cases, most specialists will indicate initiation of CPB from the start and, although lung transplantation can be performed without this support, the risk of acute RV failure and/or postoperative multiple organ dysfunction secondary to a sustained low CO makes initiation of CPB mandatory. The presence of severe PH in the other groups indicated