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Case report

Myocardial revascularization and bilateral lung transplantation without cardiopulmonary bypass ☆

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Abstract

Coronary artery disease is occasionally encountered in lung transplant recipients and is a risk factor for perioperative complications and poor survival. Besides combined heart–lung transplantation, various techniques of myocardial revascularization can be performed before, or at the time of lung transplantation. We report herein a patient with end-stage bronchoemphysema and two-vessel coronary disease who underwent 'off-pump' coronary artery bypass graft immediately followed by bilateral lung transplantation. © 2001 Elsevier Science B.V. All rights reserved.

Keywords: Coronary artery disease; Emphysema; Lung transplantation

1. Introduction

Coronary artery disease (CAD) is documented in up to 17% patients referred for lung transplantation (LT) and is traditionally considered an exclusion criterion [1]. Despite these limitations, the International Lung Transplant Registry reported a 5% perioperative mortality in lung transplant recipients due to myocardial infarcts and 3% unexplained sudden deaths where CAD could be a contributor [2].

Anecdotal reports have described combined heart–lung transplantation, simultaneous CABG surgery and LT with cardiopulmonary bypass (CPB) or a two-stage procedure involving myocardial revascularization (prior to LT) through percutaneous angioplasty (PTCA), conventional CABG or a minimally invasive approach [3–5]. In this report, we describe the first patient with end-stage chronic obstructive pulmonary disease (COPD) and two-vessel CAD who underwent 'off-pump' CABG and LT.

2. Case report

A 57-year-old man with a history of smoking presented with end-stage COPD (forced expiratory volume in 1 s (FEV_1) of 1.7 l) and major limitations of exercise capacity despite oxygen administration (100 m at 6-min walk test; maximal oxygen consumption, 18% of predicted value).

During stress echocardiography, new wall motion abnormalities were induced in the antero-apical part of the left ventricle (LV), although a stent had been inserted in the left anterior descending (LAD) artery 3 years previously. The angiogram showed a moderately depressed systolic LV function (LV ejection fraction, ~40%), an occluded right coronary artery (RCA), and 70% stenosis of the LAD artery that was not suitable for PTCA. Therefore, the surgical plan was to perform simultaneous CABG and LT on a 'beating' heart with a local donor in order to limit the ischemia duration.

After anesthesia induction, a double-lumen tube was inserted for selective pulmonary ventilation, and the femoral vessels were prepared for eventual CPB and/or intraaortic balloon pump. In addition to standard monitors, an oximetric pulmonary artery catheter and transesophageal echocardiography (TOE) were applied to assess the cardiovascular status. Normothermia was maintained by warming i.v. fluids and using a thermostatic water mattress and a forced warm air device.

Surgery proceeded through a clam-shell thoraco-sternal incision. The target coronary artery was stabilized with a mechanical retractor (Octopus, Medtronic, Minneapolis, MN) and the territory of the LAD was 'preconditioned' by two short periods of complete ischemia (~2–3 min).

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Grafting of the LAD (with the left internal mammary artery, 22 min occlusion) and the RCA (with a saphenous vein, 20 min occlusion) was performed without circulatory deterioration or ST/T segment changes.

Sequential LT was then performed in a 30° lateral tilted position. Clamping of the left pulmonary artery produced moderate pulmonary hypertension without further enlargement of the right ventricle or worsening of the tricuspid regurgitation. Left and right pulmonary grafts were reperfused after ischemic durations of 120 and 220 min, respectively. Positive end expiratory pressure (5–10 cmH_2O) was applied and nitroglycerine (0.5–2 μg/kg per min) was continuously infused until the end of surgery.

The combined CABG and LT procedure lasted a total of 10 h and 30 min. Two units of red blood cell concentrates were transfused to keep the hematocrit above 26%; i.v. crystalloid and colloids (3.5 l) were infused to maintain the circulatory volume while keeping the occluded pulmonary arterial pressure below 12 mmHg.

Postoperatively, supraventricular arrhythmias were treated with i.v. amiodarone, and no myocardial injury was detected (peak plasma troponin I, 0.9 μg/l). Weaning from the ventilator was successful 18 h after surgery and pulmonary gas exchange remained satisfactory thereafter ($PaO_2 = 16$ kPa with an inspiratory O_2 concentration (FIO_2) of 28%). An exercise rehabilitation program was initiated and the patient was discharged home after a total hospital stay of 29 days. At the 18-month follow-up, he was able to exercise without angina, the FEV_1 was increased at 85% of the predicted value, and the LV ejection had improved from 40 to 55%.

3. Discussion

Cardiac testing is routinely performed in LT candidates with two or more risks factors for CAD [2]. To improve survival after LT, myocardial revascularization is recommended when coronary stenosis is associated with 'areas at risk' detected by dobutamine stress test or thallium-dipyridamole scanning [6]. However, after conventional CABG with hypothermic CPB, COPD patients are prone to develop ventilator-associated bronchopneumonia as a result of diaphragmatic dysfunction, atelectasis, pleural effusion and interstitial lung edema [7]. Obviously, some patients may benefit from PTCA or from lesser invasive revascularization techniques (mini-thoracotomy) that minimize respiratory-related morbidity [8].

In our patient, we elected to perform 'open' myocardial revascularization immediately followed by LT since coronary artery lesions were not amenable to PTCA. The decision to proceed to a combined or separate cardiac–lung procedure should take into account the severity of both cardiac and pulmonary diseases, the general condition of the potential LT recipient, but also the available medical expertise on 'off-pump' coronary grafting and the necessity to have a local donor in order to shorten lung ischemic time. Noteworthy, patients with CAD may die from myocardial infarcts in centers with long waiting lists, before suitable heart–lung organs are proposed.

Intraoperatively, stabilization of the target coronary artery with a mechanical retractor provided an immobile and bloodless surgical field that obviated the need to slow the heart rate with β-blockers. The use of an intracoronary shunt would have been a suitable alternative to ischemic preconditioning. Importantly, avoidance of CPB contributed to reduced bleeding (due to anticoagulation and platelet dysfunction), and possibly attenuated graft dysfunction since impaired pulmonary vascular relaxation has been associated with the inflammatory response to CPB [9]. Nitroglycerine — a nitric oxide donor — that was given to attenuate myocardial ischemia, could also confer cytoprotective effects in the reperfused allograft via direct stimulation of the 3′,5′-cyclic guanosine–monophosphate pathway [10].

The need for CPB could have been justified at different steps of the surgical procedure: (1), unstable hemodynamic conditions due to myocardial ischemia during clamping of the LAD artery; (2), right ventricular failure secondary to clamping of the pulmonary artery; (3), arrhythmias and/or underfilling of the heart during surgical manipulations; (4), impaired gas exchange during one-lung ventilation; (5), acute graft dysfunction. Continuous monitoring with ECG, TOE and an oximetric pulmonary artery catheter helped us to detect and treat the early signs of cardiac and respiratory disturbances.

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