Hemodynamic and Electrocardiographic Changes After Reperfusion in Lung Transplantation

To the Editor: Lung grafts may be preserved with intracellular or extracellular solutions.[1-3] Reperfusion of the graft causes an inflammatory cascade known as an ischemic–reperfusion injury, which affects gas exchange and also causes hemodynamic changes of varying intensity. In this context, we aimed to compare hemodynamic and electrocardiographic abnormalities occurring in transplanted patients after reperfusion of the lung grafts preserved with a potassium–rich solution (Euro-Collins, Frusen, Hamburg, Germany) versus a low–potassium, dextran solution (Perfadex, Vitrolife, Gothenburg, Sweden).

To this end, we retrospectively reviewed 102 cases (from October 1999 to October 2005) of lung transplantation for terminal respiratory failure. Five patients undergoing a second transplant operation were excluded, leaving 98 valid cases for the study. The Euro-Collins preservation solution was used in 54 cases, in which 33 double- and 21 single-lung transplants were performed. The Perfadex preservation solution was used in 44 cases, of which 2 were double- and 19 single-lung transplants. We compared hemodynamic and electrocardiographic changes occurring after reperfusion of 87 lungs in the Euro-Collins group and 69 in the Perfadex group. The variables analyzed were heart rate, mean arterial pressure, mean pulmonary artery pressure, and cardiac index. Measurements were taken 5 minutes before reperfusion and 1, 3, and 10 minutes after reperfusion. Electrocardiography was recorded during the first 5 minutes after reperfusion, and potassium concentrations and core body temperature were measured by pulmonary artery catheter 5 minutes before and 3 minutes after reperfusion. Graft reperfusion was performed according to protocol, initially in a retrograde direction until blood flowed freely through the pulmonary artery (purging the preservation solution), and subsequently by gradually releasing the clamp from the pulmonary artery for final anterograde perfusion over a period of no less than 5 minutes. Statistical analysis was performed using the standard test to predict analysis of variance (GraphPad Instat Software, San Diego, California, USA). There were no significant differences in age, sex, and the reason for transplantation between the 2 groups. Hemodynamic data and electrocardiographic changes are shown in the Table.

Reperfusion of the lung graft is accompanied by a local inflammatory response characterized by such phenomena as endothelial damage, platelet and neutrophil aggregation–activation, epithelial damage, and surfactant deficiency, which causes an increase in pulmonary vascular permeability and alveolointerstitial edema. In many patients, the hemodynamic pattern immediately after reperfusion is characterized by hypotension and electrocardiographic changes such as ST elevation, widening of the QRS, and arrhythmias of varying intensity and severity. Such behavior is multifactorial in origin, arising from the following causes: *a)* loss of volume through purging of the graft preservation solution; *b)* possible embolism (air, atheromatous plaques, or thrombi) in a coronary artery, particularly the right coronary artery; *c)* release of cytokines with depressor cardiovascular effects; *d)* release of prostaglandins present in the lung from preservation, with potent systemic vasodilatory effects; *e)* myocardial hypothermia as a side effect of reperfusion of the graft (preserved at 4ºC to 6ºC), causing a state of cardiac "confusion" or pseudo–cardioplegia; and *f)* hyperpotassemia secondary to the release of remaining Euro-Collins solution (which has 115 mmol/L of potassium), an event which would be responsible for most electrocardiographic abnormalities and a coadjuvant of the pseudo–cardioplegic effect of hypothermia. In comparison, although the hemodynamic pattern after reperfusion was similar in the 2 groups, hypotension and electrocardiographic abnormalities were more frequent and more severe in the Euro-Collins group than in the Perfadex group. Although the reduction in temperature was similar, hyperpotassemia (despite recirculation) in the Euro-Collins group may have caused this behavior. Similarly, the greater reduction in pulmonary pressures in the Perfadex group compared to the EC group points to better quality preservation in the latter.

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TABLE 1
Comparison of Percentage Changes in Mean Arterial Pressure, Mean Pulmonary Artery Pressure, and Cardiac Index Between Groups and Between Baseline (5 Minutes Before Reperfusion) and 3 and 10 Minutes After Reperfusion and in Electrocardiographic Variables 3 Minutes After Reperfusion

	R-1		R-3		R-10	
	ECG	PG	ECG	PG	ECG	PG
Mean arterial pressure	–35%	–19%[a]	–21%	–16%	–12%	–10%
mPAP	–25%	–40%[a]	–34%	–43%a	–44%	–56%[a]
Cardiac index	–	–	+20%	+23%	+30%	+36%[a]
Bradycardia			9%	2%		
ST elevation > 2 mm			37%	4%[a]		
Atrial fibrillation			1.5%	0%		
VT/VF			5.5%	0%		
Increase in potassemia, mEq/L, mean (SD)			1.1 (0.2)	0.2 (0.05)[a]		
Reduction in temperature, ºC, mean (SD)			1.3 (0.4)	1.2 (0.2)		

Abbreviations: ECG, Euro-Collins preservation solution group; mPAP, mean pulmonary artery pressure; PG, Perfadex preservation solution group; R-1, reperfusion, 1 min; R-3, reperfusion, 3 min; R-10, reperfusion, 10 min; VT/VF, ventricular tachycardia without pulse or ventricular fibrillation.
[a]*P*<.05.