

CONFLICTS OF INTEREST

C. Moris is proctor for Medtronic.

Daniel Hernández-Vaquero,^{a,b} Rocío Díaz,^{a,b} Isaac Pascual,^{a,b,c,*}
Pablo Avanzas,^{a,b,c} Jacobo Silva,^{a,b,c} and César Moris^{a,b,c}

^aÁrea del Corazón, Hospital Universitario Central de Asturias, Oviedo, Asturias, Spain

^bInstituto de Investigación Sanitaria del Principado de Asturias, Oviedo, Asturias, Spain

^cFacultad de Medicina, Universidad de Oviedo, Oviedo, Asturias, Spain

* Corresponding author:

E-mail address: ipascua@live.com (I. Pascual).

Available online 25 May 2019

REFERENCES

1. Pahn K, Zhao DF, Wang N, et al. Transcatheter valve-in-valve implantation versus reoperative conventional aortic valve replacement: a systematic review. *J Thorac Dis.* 2016;8:E83–E93.
2. Austin PC. An introduction to propensity score methods for reducing the effects of confounding in observational studies. *Multivariate Behav Res.* 2011;46:399–424.
3. Ejiofor JI, Yammine M, Harloff MT, et al. Reoperative surgical aortic valve replacement versus transcatheter valve-in-valve replacement for degenerated bioprosthetic aortic valves. *Ann Thorac Surg.* 2016;102:1452–1458.
4. Díaz R, Hernández-Vaquero D, Silva J, et al. Real structural valve deterioration of the mitroflow aortic prosthesis: competing risk analysis. *Rev Esp Cardiol.* 2017;70:1074–1081.

<https://doi.org/10.1016/j.rec.2019.02.022>

1885-5857/

© 2019 Sociedad Española de Cardiología. Published by Elsevier España, S.L.U. All rights reserved.

Cardiopulmonary Resuscitation With Percutaneous ECMO in Refractory In-hospital Cardiac Arrest: A Single-center Experience



Reanimación cardiopulmonar con ECMO percutáneo en parada cardíaca refractaria hospitalaria: experiencia de un centro

To the Editor,

Refractory in-hospital cardiac arrest (RIHCA) refers to an arrest that persists beyond 10 minutes of advanced cardiopulmonary resuscitation.^{1,2} The probability of return of spontaneous circulation drops rapidly after 15 minutes, and survival is less than 5%.^{2,3} Most RIHCAs due to ventricular fibrillation are secondary to heart disease, especially acute coronary syndrome, for which revascularization is essential but normally not possible without return of spontaneous circulation.

In this context, there is a role for venoarterial extracorporeal membrane support oxygenation (VA-ECMO), or “extracorporeal CPR” (E-CPR). In previous series, E-CPR helped reach survival rates of more than 25%.^{4,5} However, barriers to its use include availability, potential complications, and the need for a team specialized in its implantation and management.

We report here on the experience of our center, in which VA-ECMO was considered in RIHCA with early (< 5 minutes) initiation of basic CPR, with the call for ECMO made after 10 minutes of advanced life support. The interventional cardiologist implanted the device (Cardiohel) via percutaneous cannulation with fluoroscopy guidance (if implanted in the cardiac catheterization laboratory) and/or ultrasound (transesophageal ultrasound was not used routinely). Implantation was performed at the site of RIHCA occurrence to minimize the time to E-CPR. All cases were attended by 2 clinical cardiologists, 2 catheterization laboratory nurses, and 1 or 2 interventional cardiologists. The priming of the ECMO was managed by the nurses or clinical cardiologists (who had undergone a specific training period). Patients were subsequently transferred to the catheterization laboratory or the coronary care unit.

Between November 2013 and October 2018, E-CPR was used in 25 patients. The baseline patient characteristics are shown in Table 1. The mean age was 54.2 years, 80% were men, and 76% of cases were due to acute myocardial infarction. ECMO placement was performed in the catheterization laboratory in 13 patients

Table 1

Patient characteristics

Patients, n	25
Men	20 (80)
Age (y)	54.1 ± 11.01
Cause of arrest	
Acute myocardial infarction	19 (76)
Pulmonary embolism	2 (8)
Chronic cardiac graft failure	1 (4)
Electrical storm (dilated cardiomyopathy)	1 (4)
Anaphylaxis to gadolinium (hypertrophic cardiomyopathy)	1 (4)
Airway obstruction due to lymphoma	1 (4)
First recorded rhythm	
Ventricular fibrillation	11 (44)
Ventricular tachycardia	3 (12)
Pulseless electrical activity	5 (20)
Asystole	6 (24)
Location of CPR	
Catheterization laboratory	13 (52)
CCU	5 (20)
Emergency department	4 (16)
Thoracic surgery operating room	1 (4)
Radiology	1 (4)
Cardiology ward	1 (4)
Time of implantation	
Working hours: Monday to Friday, 8.00–22.00	18 (72)
Out-of-hours code	7 (28)
Time	
From decision to starting implantation (min)	6.8 ± 5.48
For cannulation (min)	28.7 ± 9.80
Total CPR (min)	43.8 ± 11.02
Hypothermia	9 (36)
Preimplantation LVEF (%)	27.2 ± 20.87
Preimplantation lactate (mmol/L)	12.5 ± 4.40
ECMO duration (d)	2 [1–4]
Intra-aortic counterpulsation balloon	17 (68)
Impella CP	3 (12)

Table 1 (Continued)
Patient characteristics

<i>Invasive procedures</i>	
Coronary revascularization	18 (72)
Mechanical thrombectomy	2 (8)
Change to central ECMO	4 (16)
Change to left Centrimag	1 (4)
Heart transplant	1 (4)
ECMO weaning	8 (32)
<i>Complications</i>	
Acute renal failure	8 (32)
Major bleeding	9 (36)
Lower limb ischemia	1 (4)
Vascular injury	1 (4)
Stroke	2 (8)
Infection	1 (4)
Membrane thrombosis	4 (16)
<i>Cause of death</i>	
Multiorgan failure	8 (42.1)
Anoxic brain injury	2 (10.5)
Major bleeding	5 (26.3)
Cannulation impossible	2 (8)
Accidental decannulation	1 (4)
Electrical storm	1 (4)
<i>Survival</i>	
Return of spontaneous beating	23 (92)
24 h	19 (76)
Decannulation	9 (36)
Discharge	6 (24)
1-y follow-up	6 (24)
Complete neurological recovery [*]	6 (100)

CCU, coronary care unit; CPR, cardiopulmonary resuscitation; ECMO, extracorporeal membrane oxygenator; LVEF, left ventricular ejection fraction. Unless otherwise indicated, values are expressed as No. (%), mean $\pm$ standard deviation, or median [interquartile range].

^{*} Of the survivors (n = 6).

(52%), in the coronary care unit in 5 (20%), and in the emergency department in 4 (16%). Eighteen patients (72%) were treated during normal working hours and 27 (28%) out of hours. The mean time from arrest to starting VA-ECMO (total CPR time) was 43.8 minutes and the mean time required for cannulation was 28.7 minutes. ECMO was used to induce hypothermia at 34 °C in 9 patients (35%), and in the rest, temperature was controlled at 36 °C, according to the clinical judgement of the treating cardiologist, depending on the hemodynamic and electrical instability and the presence of coagulopathy. Cannulation was successful in 23 patients (92%), who had return of spontaneous beating within a few minutes. This allowed treatment to progress to percutaneous coronary revascularization in 18 patients (72%) and percutaneous mechanical thrombectomy in 2 patients with pulmonary thromboembolism (8%). The median time spent on ECMO was 2 (range, 1–10) days; 4 patients subsequently required central VA-ECMO. One of the patients received a successful transplant after E-CPR with peripheral VA-ECMO changed to central VA-ECMO due to left ventricular distension. The leading cause of death was multiorgan failure in 8 patients (32%), followed by major hemorrhage in 5 (20%). Decannulation was possible in 9 patients: 3 with percutaneous closure (33.3%) and 6 with surgical repair (66.6%). Six patients (24%) survived to discharge with good neurological

recovery, significantly more in shockable than nonshockable rhythms (38.5% vs 8.3%; $P < .001$). After 1 year of follow-up, the surviving patients remained stable with no further cardiac events. However, active treatment was limited in 2 patients with irreversible neurological damage, 1 of whom was an organ donor.

The results of our experience overlap with those found in the literature.^{4,5} Of note, percutaneous implantation has been demonstrated to be feasible in this situation, with relatively short cannulation times and even better results than surgical implantation.⁶

In line with previous reports, we observed higher complication rates in cannulation than in elective implantation, the most common being major bleeding at the insertion site (33%), in the context of an emergency implantation in a pulseless patient and with the coagulopathy associated with prolonged CPR.⁶

In our experience, the use of E-CPR in patients with RIHCA is feasible and appears to improve survival in selected patients, especially those with acute myocardial infarction and shockable rhythms, with substantially worse outcomes in nonshockable rhythms. The success of the treatment is based on the creation of a protocol, with early call for E-CPR and prompt placement at the location where the arrest occurs. We also consider the role of the critical care specialist to be key in the management of VA-ECMO and postarrest care. In our opinion, undergoing VA-ECMO implantation and post-care managed wholly by the cardiology department provides results comparable to those published, with the benefit of the potential expansion to centers with interventional cardiology teams and the organization of a care network for shock and RIHCA.

This study has the limitations inherent to its retrospective nature, small sample size, and lack of control group. However, it is interesting because it is the first series on E-CPR in Spain, and to our knowledge the only one reporting treatment entirely managed by cardiologists.

Jorge García-Carreño,^a Iago Sousa-Casasnovas,^{a,*}
Carolina Devesa-Cordero,^a Enrique Gutiérrez-Ibañes,^a
Francisco Fernández-Avilés,^{a,b} and Manuel Martínez-Sellés^{a,b,c}

^aDepartamento de Cardiología, Hospital General Universitario Gregorio Marañón, Centro en Investigación Biomédica en Red Enfermedades Cardiovasculares (CIBERCV), Madrid, Spain

^bFacultad de Medicina, Universidad Complutense de Madrid, Madrid, Spain

^cFacultad de Medicina, Universidad Europea, Madrid, Spain

* Corresponding author:

E-mail address: iagosousa@yahoo.es (I. Sousa-Casasnovas).

Available online 17 May 2019

REFERENCES

- Fagnoul D, Combes A, De Backer D. Extracorporeal cardiopulmonary resuscitation. *Curr Opin Crit Care*. 2014;20:259–265.
- Siao FY, Chiu CC, Chiu CW, et al. Managing cardiac arrest with refractory ventricular fibrillation in the emergency department: Conventional cardiopulmonary resuscitation versus extracorporeal cardiopulmonary resuscitation. *Resuscitation*. 2015;92:70–76.
- Cooper S, Janghorbani M, Gooper G. A decade of in-hospital resuscitation: Outcomes and prediction of survival. *Resuscitation*. 2006;68:231–237.
- Chen YS, Lin JW, Yu HY, et al. Cardiopulmonary resuscitation with assisted extracorporeal life-support versus conventional cardiopulmonary resuscitation in adults with in-hospital cardiac arrest: an observational study and propensity analysis. *Lancet*. 2008;372:554–561.

5. Shin TG, Jo JJ, Sim MS, et al. Two-year survival and neurological outcome of in-hospital cardiac arrest patients rescued by extracorporeal cardiopulmonary resuscitation. *Int J Cardiol.* 2013;168:3424–3430.
6. Thiagarajan RR, Brogan TV, Scheurer MA, Laussen PC, Rycus PT, Bratton SL. Extracorporeal membrane oxygenation to support cardiopulmonary resuscitation in adults. *Ann Thorac Surg.* 2009;87:778–785.

<https://doi.org/10.1016/j.rec.2019.02.019>
1885-5857/

© 2019 Sociedad Española de Cardiología. Published by Elsevier España, S.L.U. All rights reserved.

Successful Combined Bilateral Lung Transplant and Congenital Heart Disease Repair in a Pediatric Patient



Éxito de la cirugía combinada de trasplante bipulmonar y reparación de cardiopatía congénita en paciente pediátrico

To the Editor,

The usual treatment for patients with congenital heart disease (CHD) who develop severe pulmonary hypertension (PHT) is medical treatment with pulmonary vasodilators and repair of the heart defect if possible. When this is not possible due to severe PHT with fixed pulmonary resistance refractory to medical treatment, heart and lung transplant or lung transplant (LT) combined with repair of the defect may be considered. Since the first description of successful repair of CHD plus LT in 1990,¹ several cases have been reported.^{2–4} In Spain, a few cases have been published of adults with simple heart defects,⁵ but there are no reports of pediatric cases with these characteristics.

We report the case of a 15-year-old male patient with severe PHT and CHD consistent with anomalous pulmonary and systemic venous drainage with a large atrial septal defect (ASD). The patient presented with dyspnea at rest and on minimal exertion, with precordial pain characteristic of angina despite treatment with oral sildenafil and bosentan and subcutaneous treprostinil.

Computed tomography showed interruption of the inferior vena cava with azygous continuation to the left superior vena cava,

draining into the coronary sinus (brachiocephalic vein absent). The right pulmonary venous drainage was via 2 pulmonary veins draining to the right atrium (Figure 1A). The images also showed a giant aneurysm (more than 8 cm) of the pulmonary artery that was displacing and compressing the neighboring structures (Figure 1B). Finally, there was an ostium secundum ASD with right-to-left shunt.

Echocardiography showed severe hypertrophy of the right ventricle (Figure 2A), severe tricuspid regurgitation with supra-systemic pulmonary pressure (Figure 2B) and a large pulmonary artery aneurysm.

Preoperative workup confirmed the previous findings: supra-systemic PHT (mean pulmonary artery pressure > 90 mmHg and pulmonary vascular resistance of 32 UW). In addition, there was compression of the left main coronary artery due to the pulmonary aneurysm.

It was decided to perform bilateral LT with repair of the CHD in the same procedure. The operation was carried out with extracorporeal circulatory assistance. The 3 venae cavae and the ascending aorta were cannulated. After performing bronchial anastomosis on the right side, the aorta was cross-clamped and cardioplegia was administered to induce cardiac arrest. Next, the right atrium was opened and, via the ASD, the left atrium was identified and the cuff of the right pulmonary veins of the donor was anastomosed to the body of the left atrium of the recipient (Figure 1C). Finally, the ASD and the right atriotomy were closed and the left lung was implanted. Ischemia time and extracorporeal

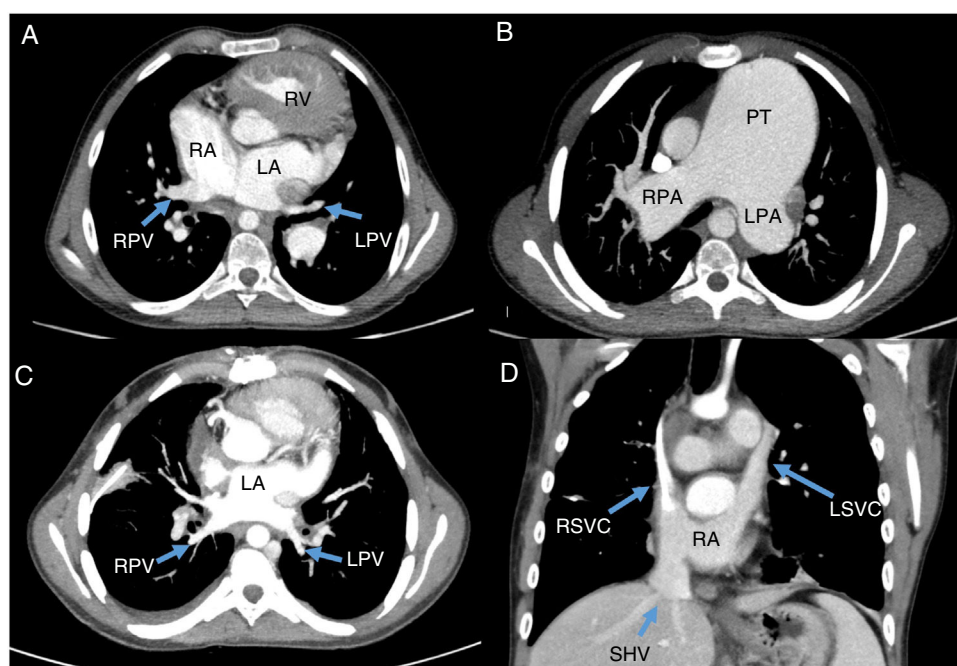


Figure 1. Preoperative computed tomography and result after transplant. A: anomalous pulmonary venous drainage. B: pulmonary aneurysm. C: pulmonary venous drainage. D: systemic venous drainage. LA, left atrium; LPA, left pulmonary artery; LPV, left pulmonary vein; LSVC, left superior vena cava; PT, pulmonary trunk; RA, right atrium; RPA, right pulmonary artery; RPV, right pulmonary vein; RSVC, right superior vena cava; RV, right ventricle; SHV, suprahepatic veins.