Left Ventricular Decompression During Peripheral Extracorporeal Membrane Oxygenation Support With the Use of the Novel iVAC Pulsatile Paracorporeal Assist Device

Kyriakos Anastasiadis, Omiros Chalvatzoulis, Polychronis Antonitsis, Paschalis Tossios and Christos Papakonstantinou

Ann Thorac Surg 2011;92:2257-2259
DOI: 10.1016/j.athoracsur.2011.05.063

size. Long-term durability of lung function as the present patient grows remains a major unresolved issue and life-long follow-up should be mandatory in such cases of single-lobe LDLLT.

References

1. Shiraishi T, Hiratsuka M, Munakata M, et al. Living-donor single-lobe lung transplantation for bronchiolitis obliterans in a 4-year-old boy. J Thorac Cardiovasc Surg 2007;134:1092–3.
2. Castillo M. Anesthetic management for lung transplantation. Curr Opin Anaesthesiol 2011;24:32–6.
3. Force SD, Miller DL, Pelaez A, et al. Outcomes of delayed chest closure after bilateral lung transplantation. Ann Thorac Surg 2006;81:2020–5.
4. Chen F, Fujinaga T, Shoji T, et al. Perioperative assessment of oversized lobar graft downsizing in living-donor lobar lung transplantation using three-dimensional computed tomographic volumetry. Transplant Int 2010;23:e41–4.

Left Ventricular Decompression During Peripheral Extracorporeal Membrane Oxygenation Support With the Use of the Novel iVAC Pulsatile Paracorporeal Assist Device

Kyriakos Anastasiadis, MD, FETCS,
Omiros Chalvatzoulis, MD, Polychronis Antonitsis, MD,
Paschalis Tossios, MD, and
Christos Papakonstantinou, MD

Department of Cardiothoracic Surgery, Aristotle University of Thessaloniki, AHEPA Hospital, Thessaloniki, Greece

Extracorporeal membrane oxygenation (ECMO) has become a widely accepted short-term mechanical circulatory support device in patients with refractory cardiogenic shock. A major drawback of the peripheral venoarterial extracorporeal membrane oxygenation is that in patients with profoundly reduced left ventricular contractility associated with high left-heart filling pressure, there is always concern for venting the failing ventricle. We describe a minimally invasive technique for decompressing the left ventricle in this setting using a novel pulsatile paracorporeal assist device, the iVAC 3L (PulseCath, Groningen, The Netherlands). It is implanted through the right axillary artery and provides hemodynamic support while directly offloading the left ventricle.

(Ann Thorac Surg 2011;92:2257–9)

Accepted for publication May 13, 2011.

Address correspondence to Dr Antonitsis, Sakellaridi 25, Thessaloniki, 542 48, Greece; e-mail: antonits@otenet.gr.

Over the last decades, extracorporeal membrane oxygenation (ECMO) has become a widely accepted short-term mechanical circulatory support device in patients with refractory cardiogenic shock [1]. This may stabilize circulation and provide adequate end-organ perfusion. However, a major drawback of the peripheral venoarterial (v-a) ECMO is that in patients with profoundly reduced left ventricular (LV) contractility associated with high left-heart filling pressure there is always concern for venting the failing ventricle [2]. Although percutaneous approaches have been implemented, especially in the pediatric population, few options exist for adult patients on peripheral ECMO.

Herein, we describe a technique for decompressing LV in this setting using a novel pulsatile paracorporeal LV assist device (LVAD), the iVAC 3L (PulseCath, Groningen, The Netherlands). This device is a pulsatile catheter pump which provides adequate mechanical short-term circulatory support in patients with postcardiotomy low cardiac output syndrome and in cases of acute cardiogenic shock [3]. It consists of a 21F (6.9 mm) flexible polyurethane catheter with a single pivoting leaflet at its tip. The tip of the catheter is inserted into the LV cavity, the 2-way valve is positioned in the aorta, and the membrane pump is located outside the body (Fig 1). The 2-way valve is designed to guide the blood in the correct direction. The valve consists of a tubular housing and 1 moving part (leaflet) that pivots around an axis (Fig 2). The membrane pump has a blood chamber and an air chamber, divided by a flexible membrane. The membrane pump is activated by a standard intra-aortic balloon pump (IABP) driver.

A 33-year-old patient presenting with cardiogenic shock due to acute anterior myocardial infarction underwent emergent coronary angiography and subsequent surgical revascularization for tight left main coronary disease. Despite maximum inotropic and IABP support, the patient remained on a low cardiac output state postopera-

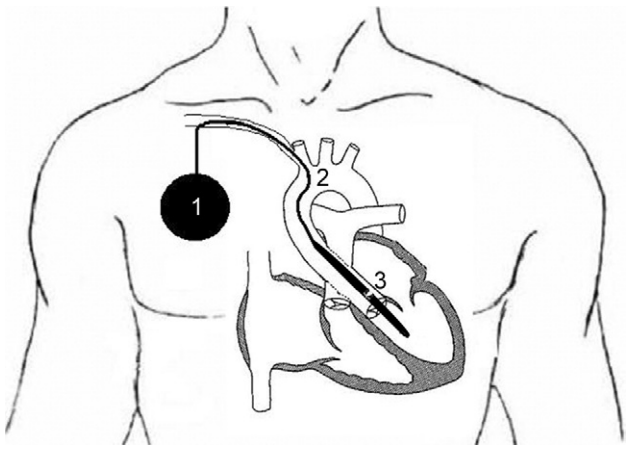

Fig 1. Schematic view of the iVAC pulsatile ventricular assist device (VAD) implanted through the right axillary artery with a subclavicular incision. (1 = Membrane pump; 2 = 21F polyurethane catheter; 3 = pivoting leaflet.)

0003-4975/$36.00
doi:10.1016/j.athoracsur.2011.05.063

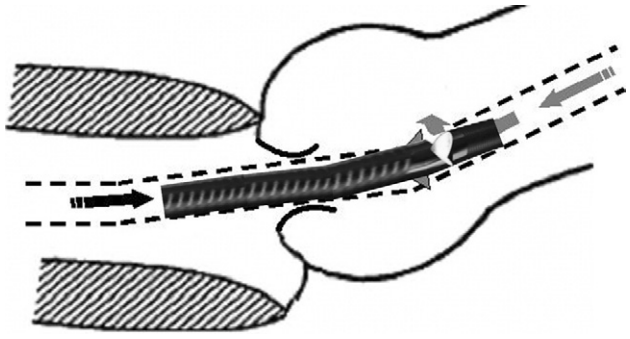

Fig 2. Cutaway schematic view of the aortic valve indicating proper positioning and orientation of the 2-way valve with respect to the native valve. Blood is aspirated to the membrane chamber, which is located outside the body, during systole (black arrows) and returns to the ascending aorta through the pivoting valve on diastole (gray arrows).

tively. On the first postoperative day, the iVAC LVAD was implanted via an 8 mm vascular graft from the right axillary artery. An angled pigtail catheter was inserted over a guidewire through the aortic valve to the LV. The device was then guided over the pigtail catheter until the distal tip reached the cavity of the LV (Fig 1). Correct positioning was confirmed with transesophageal echocardiography. The membrane pump was primed with heparinized saline. It was then connected to the connector of the catheter on 1 side and to the air line of an IABP console (Arrow AutoCAT 2 WAVE IABP System, Arrow International Inc, Boston, MA). Electrocardiographic triggering was applied in a 1:1 mode. The timing of the IABP driver was similar to standard IABP. Inflation was set at the dicrotic notch, while deflation was set before the next systole. The cardiac output was continuously monitored through a Swan-Ganz catheter with the Vigilance II monitor (Edwards Lifesciences LLC, Irvine, CA). On the following day, after bleeding had stopped, continuous heparin infusion was initiated with a target activated clotting time of 160 to 200.

Besides an initial improvement, the patient's condition deteriorated by developing respiratory failure, refractory pulmonary hypertension, and profound right ventricular failure with hepatic venous congestion. On the fourth postoperative day a v-a ECMO was implanted via the femoral vessels for biventricular and respiratory support. The iVAC device was kept in place in order to unload the distended and severely failing LV. Left ventricular size and function improved gradually as evidenced by transesophageal echocardiography. Having given sufficient time for the heart to recover from both the anterior myocardial infarction and the myocardial postoperative stunning, the patient was successfully weaned from both devices on the 10th postoperative day on minimal inotropic support. During the period of ECMO and LVAD support, hemolysis was not significant (mean plasma free hemoglobin levels: 100 mg/dL), while the platelet count was kept around 70,000/μL.

Comment

The iVAC is a minimally invasive circulatory assist device that effectively generates up to 3 L/minute of cardiac output. It is implanted through the right axillary artery and it directly unloads the LV by active blood aspiration during systole while it creates pulsatile flow into the ascending aorta in diastole. The device is pneumatic and it can be used with any standard IABP driver unit; thus, no dedicated hardware or other equipment is necessary. Considering that the membrane chamber can deliver around 30 mL of blood with every pump, flow through the device can be increased proportional to the heart rate at a range from 60 to 120 bpm [4]. Side effects from its use are mainly hemolysis, which is more evident within the first 2 days, and platelet consumption due to shear stress and fragmentation; however, both are minimal and comparable to other pulsatile devices. On the other hand, simplicity in the insertion technique precluding sternal splitting as well as the need for catheterization renders iVAC as a first-line option in severe acute LV failure [3].

A common clinical scenario during peripheral v-a ECMO support for acute cardiogenic shock is LV distension. Increased wall stress leads to subendocardial ischemia, which jeopardizes myocardial recovery. In such circumstances, reducing the LV load may be of paramount importance. This may promote myocardial recovery by decreasing myocardial oxygen consumption and subsequently preserves coronary blood flow. Different techniques have been described for decompressing the LV during peripheral ECMO support, such as central ECMO cannulation for improved preload capture through a full sternotomy, transapical LV venting through a mini lower sternotomy or left thoracotomy, as well as atrial septostomy for decompressing the left atrium and reduce pulmonary congestion [5, 6]. However, these techniques are more invasive, complex, and technically demanding than the suggested iVAC use and they may add unnecessary morbidity in this high-risk cohort of patients.

In conclusion, the iVAC is a minimally invasive device which requires a peripheral route for access, it is easy to implant, and there is no need for additional technical equipment beyond a standard IABP driver unit and a transesophageal echocardiography. Literally, it is a catheter-mounted transvalvular LVAD which may provide a marked hemodynamic improvement by directly unloading the LV. Our case highlights the potential use of this device for decompression of the LV during peripheral v-a ECMO support and represents a novel strategy to optimize survival and resource utilization.

References

1. Formica F, Avalli L, Colagrande L, et al. Extracorporeal membrane oxygenation to support adult patients with cardiac failure: predictive factors of 30-day mortality. Interact Cardiovasc Thorac Surg 2010;10:721–6.
2. Guirgis M, Kumar K, Menkis AH, Freed DH. Minimally invasive left-heart decompression during venoarterial extra-

FEATURE ARTICLES

corporeal membrane oxygenation: an alternative to a percutaneous approach. Interact Cardiovasc Thorac Surg 2010;10:672–4.
3. Mariani MA, Diephuis JC, Kuipers MJ, Gianoli M, Grandjean JG. Off-pump coronary artery bypass graft surgery with a pulsatile catheter pump for left ventricular dysfunction. Ann Thorac Surg 2007;84:690–2.
4. Amico A, Brigiani MS, Vallabini A, et al. PulseCath, a new short-term ventricular assist device: our experience in off-pump coronary artery bypass graft surgery. J Cardiovasc Med (Hagerstown). 2008;9:423–6.
5. Hlavacek AM, Atz AM, Bradley SM, Bandisode VM. Left atrial decompression by percutaneous cannula placement while on extracorporeal membrane oxygenation. J Thorac Cardiovasc Surg 2005;130:595–6.
6. Vlasselaers D, Desmet M, Desmet L, Meyns B, Dens J. Ventricular unloading with a miniature axial flow pump in combination with extracorporeal membrane oxygenation. Intensive Care Med 2006;32:329–33.

Transcatheter Repair of Combined Ascending Aortic Pseudoaneurysm and Aortic Arch Aneurysm Through a Cardiac Transapical Approach

Gino Gerosa, MD, Roberto Bianco, MD, Andrea Bortolami, MD, Carlo Dal Lin, MD, Paolo Frigatti, MD, Giuseppe Tarantini, MD, Giambattista Isabella, MD, and Franco Grego, MD

Department of Cardiac, Thoracic and Vascular Sciences, Section of Cardiac Surgery, Section of Vascular Surgery, and Section of Cardiology, University of Padova, Padova, Italy

We describe a new surgical technique performed in a heart-transplanted patient who underwent transcatheter repair of combined ascending aortic pseudoaneurysm and aortic arch aneurysm. The endografts were deployed through a left ventricular transapical approach by using a left mini-thoracotomy after previous debranching of the brachiocephalic vessels.

(Ann Thorac Surg 2011;92:2259–62)

Transcatheter repair of aortic arch aneurysms is a well-defined procedure with consistent results [1, 2], transcatheter repair of ascending aortic aneurysms [3, 4] is seldom reported because of technical difficulties related to endograft deployment [5, 6]. We report a case of a patient who underwent a heart transplant who had transcatheter repair of combined ascending aortic pseudoaneurysm and aortic arch aneurysm through a left ventricular transapical approach.

A 52-year-old patient with a previous heart transplant was admitted to the hospital with an ascending aortic pseudoaneurysm at the level of the end-to-end anastomosis between donor and recipient aorta and an aortic arch aneurysm. A 3-dimensional (3D) computed tomography (CT) scan showed heavy calcification of the abdominal aorta and severe stenosis of the iliacofemoral vessels. The patient had moderate renal insufficiency (creatinine 170 μmol/L) and, according to logistic Euroscore, the operative risk was 37%.

A conventional open repair using cardiopulmonary bypass, hypothermic circulatory arrest, and selective antegrade cerebral perfusion was considered to be inappropriate for this patient because of significant comorbidities, renal failure, previous sternotomy, and the anatomic characteristics of the aortic pathology. We planned a novel strategy including extra-anatomic bypass of the supra-aortic vessels followed by transcatheter repair us-

Accepted for publication May 13, 2011.

Address correspondence to Dr Gerosa, Cardiac Surgery Unit, University of Padova Medical School, Via Giustiniani 2, 351278 Padova, Italy; e-mail: gino.gerosa@unipd.it.

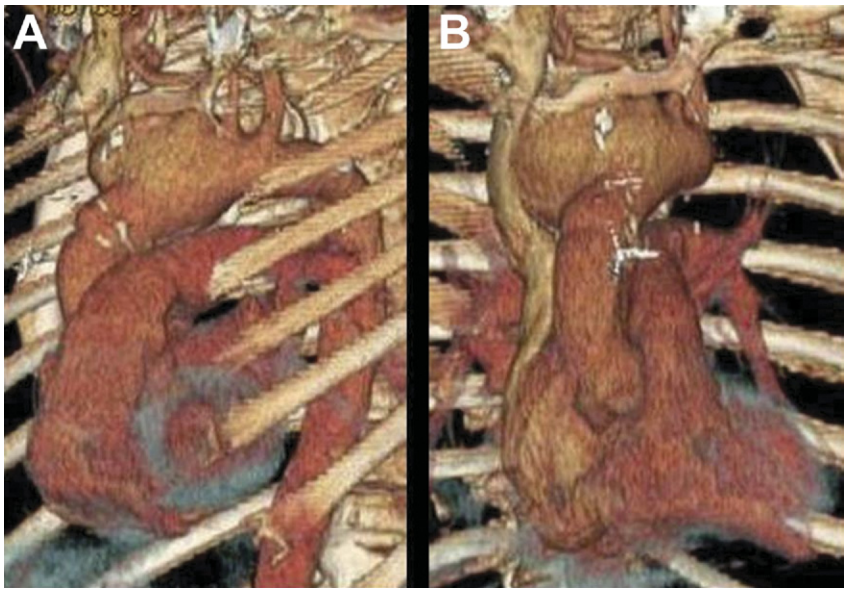

Fig 1. Preoperative three-dimensional (3D) computed tomography (CT) scan showing the ascending aortic pseudoaneurysm and aortic arch aneurysm (A) Left anterior lateral view; (B) frontal view.

FEATURE ARTICLES

0003-4975/$36.00
doi:10.1016/j.athoracsur.2011.05.040

Left Ventricular Decompression During Peripheral Extracorporeal Membrane Oxygenation Support With the Use of the Novel iVAC Pulsatile Paracorporeal Assist Device

Kyriakos Anastasiadis, Omiros Chalvatzoulis, Polychronis Antonitsis, Paschalis Tossios and Christos Papakonstantinou

Ann Thorac Surg 2011;92:2257-2259
DOI: 10.1016/j.athoracsur.2011.05.063