Emergency Parallel Mechanical Circulatory Support for Ventricular Fibrillation

Thomas Fux, MD; Anders Gabrielsen, MD, PhD; Karl-Henrik Grinnemo, MD, PhD; Jan van der Linden, MD, PhD; Peter Svenarud, MD, PhD; Lars H. Lund, MD, PhD

Extracorporeal and implantable mechanical circulatory support devices are increasingly used for refractory cardiogenic shock. We describe a patient with a continuous-flow left ventricular assist device (LVAD) who developed refractory ventricular fibrillation (VF) and deteriorating right ventricular function, requiring emergency implantation of venoarterial extracorporeal membrane oxygenation (ECMO), which supported the patient for 23 days of continuous VF until urgent transplantation. We illustrate challenges in managing parallel competing flows in the 2 circuits (Figure).

The patient is a 45-year-old man with dilated cardiomyopathy and a HeartMate II (Thoratec, Pleasanton, CA) as a bridge to heart transplantation. Over 1 year post LVAD, the patient’s clinical status and conditioning improved dramatically but he had increasing ventricular tachycardia and implantable cardioverter-defibrillator discharges, despite fluid and LVAD optimization to avoid suction.

Now he presented with repetitive implantable cardioverter-defibrillator discharges. He was in sinus rhythm and awake but anxious. HeartMate II rpm was 9400, providing a calculated flow of 4.5 to 5.5 L/min, with left ventricular ejection fraction of 10%, left ventricular end-diastolic diameter of 85 mm, and dilated right ventricle with poor function. He developed intractable VF and incessant implantable cardioverter-defibrillator discharges, despite intravenous amiodarone, lidocaine and magnesium, and sedation and intubation. The implantable cardioverter-defibrillator was turned off and the patient was initially stable in VF, but calculated LVAD flow declined from 5.5 to 4.0 L/min, sign of increasing right ventricular failure developed, mean blood pressure fell to 30 mmHg, and peripheral venoarterial ECMO (Centrimag, Levitronix, USA and Quadrox oxygenator, Maquet, Germany) was urgently implanted.

ECMO was gradually uptitrated to 4300 rpm, yielding 5.1 L/min flow, whereas HeartMate II rpm was downtitrated to 7400 rpm, where calculated flow is unreliable and displayed as “– – –”. Continuous low-flow alarms suggested a flow <2.5 L/min. The anticoagulation regimen was changed from warfarin to heparin. Because of competitive and thus reduced flows, left ventricular end-diastolic diameter and pulmonary flow by echocardiography, whereas left ventricular end-diastolic diameter and pulmonary flow by Innocor were unchanged (Figure). External cardioversion was attempted repeatedly without success and the patient remained stable and awake in VF for 23 days until transplantation.

This case illustrates several things. First, the natural history of VF is thought to include inevitable progression to asystole, but as this and other reports1 illustrate, VF may be sustained if cardiac and systemic perfusion is secured. Second, perfusion may be secured by, for example, a pulsatile-flow LVAD and a resulting Fontan-like circulation,2 but continuous-flow LVADs provide less unloading and indeed our patient’s right ventricular function deteriorated rapidly. Third, despite concerns about competing flows, blood stagnation, and thrombosis, LVAD and venoarterial ECMO can be sustained in parallel, in particular, in the presence of aortic regurgitation. Interestingly, progressively aortic regurgitation frequently occurs over time with continuous-flow LVADs and was serendipitous in this case. The aortic regurgitation permitted adequate flow through the LVAD and the LVAD accommodated the regurgitant flow that otherwise would cause high left ventricular loads during ECMO.

Disclosures

Drs Lund, K.-H. Grinnemo, and P. Svenarud have received grant support, consulting fees, or speaker honoraria from manufacturers of left ventricular assist devices (Thoratec, HeartWare). Dr Svenarud’s spouse is an employee of Mediplast AB, distributor of HeartWare devices in Scandinavia.

References


Key Words: extracorporeal circulation ■ heart-assist devices ■ ventricular fibrillation

Received November 27, 2013; accepted December 9, 2013.
From the Department of Medicine, Unit of Cardiology (T.F., A.G., L.H.L.) and Department of Molecular Medicine and Surgery (K.-H.G., J.v.d.L., P.S.), Karolinska Institutet, Stockholm, Sweden; and Department of Cardiology (T.F., L.H.L.) and Department of Cardiothoracic Surgery and Anesthesiology (K.-H.G., J.v.d.L., P.S.), Karolinska University Hospital, Stockholm, Sweden.
Correspondence to Lars H. Lund, MD, PhD, Department of Medicine, Karolinska Institutet, N305, 17176 Stockholm, Sweden. E-mail Lars.Lund@alumni.duke.edu
(Circ Heart Fail. 2014;7:229-230.)
© 2014 American Heart Association, Inc.
Circ Heart Fail is available at http://circheartfailure.ahajournals.org
DOI: 10.1161/CIRCHEARTFAILURE.113.001012

Images and Case Reports in Heart Failure
Figure. Schematic illustration of parallel extracorporeal membrane oxygenation (ECMO) and left ventricular assist device (LVAD). The ECMO flow bypasses the lungs and LVAD. The LVAD flow consists of pulmonary venous return and aortic regurgitant flow (illustration AB Typofon).
Emergency Parallel Mechanical Circulatory Support for Ventricular Fibrillation
Thomas Fux, Anders Gabrielsen, Karl-Henrik Grinnemo, Jan van der Linden, Peter Svenarud and Lars H. Lund

Circ Heart Fail. 2014;7:229-230
doi: 10.1161/CIRCHEARTFAILURE.113.001012
Circulation: Heart Failure is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 75231
Copyright © 2014 American Heart Association, Inc. All rights reserved.
Print ISSN: 1941-3289. Online ISSN: 1941-3297

The online version of this article, along with updated information and services, is located on the World Wide Web at:
http://circheartfailure.ahajournals.org/content/7/1/229

Permissions: Requests for permissions to reproduce figures, tables, or portions of articles originally published in Circulation: Heart Failure can be obtained via RightsLink, a service of the Copyright Clearance Center, not the Editorial Office. Once the online version of the published article for which permission is being requested is located, click Request Permissions in the middle column of the Web page under Services. Further information about this process is available in the Permissions and Rights Question and Answer document.

Reprints: Information about reprints can be found online at: http://www.lww.com/reprints

Subscriptions: Information about subscribing to Circulation: Heart Failure is online at: http://circheartfailure.ahajournals.org/subscriptions/