© 2012 Wiley Periodicals, Inc.

CASE REPORT

Transcatheter Closure of Patent Foramen Ovale for Hypoxemia During Left Ventricular Assist Device Support

Antonio Loforte, M.D.,* Roberto Violini, M.D.,† and Francesco Musumeci, M.D.*

**Department of Cardiac Surgery and Transplantation; and †Department of Cardiology, San Camillo Hospital, Rome, Italy*

ABSTRACT The diagnosis of a patent foramen ovale (PFO) is a dynamic process and it is based on the detection of blood shunting at the atrial level. Only under abnormal physiologic conditions, such as with a left ventricular assist device (LVAD), when right atrial pressure (RAP) exceeds left atrial pressure (LAP) the PFO may cause hypoxemia due to a right-to-left shunt. We report the closure of a PFO using a transcatheter approach in a patient on LVAD support. doi: 10.1111/j.1540-8191.2012.01476.x *(J Card Surg 2012;27:528-529)*

The overall incidence of patent foramen ovale (PFO) in the general population is about 27%.[1,2] In the vast majority of cases, the PFO remains clinically benign.[1,2]

Under abnormal physiological conditions where right-to-left shunting occurs, the PFO may cause hypoxemia or may exacerbate a preexisting hypoxemic state. Left ventricular assist devices (LVADs) unload the left ventricle and decrease left atrial pressure (LAP). This hemodynamic change may result in a right-to-left atrial shunt if a PFO exists after LVAD implantation.[3-5]

This report describes successful closure of a PFO using the Amplatzer Septal Occluder (AGA-Medical, Golden Valley, MN, USA) in a patient who was being supported on an LVAD.

CASE REPORT

A 59-year-old male patient received a HeartMate II (Thoratec Inc., Pleasanton, CA, USA) LVAD support for treatment of refractory end-stage heart failure due to an idiopathic dilative cardiomyopathy.

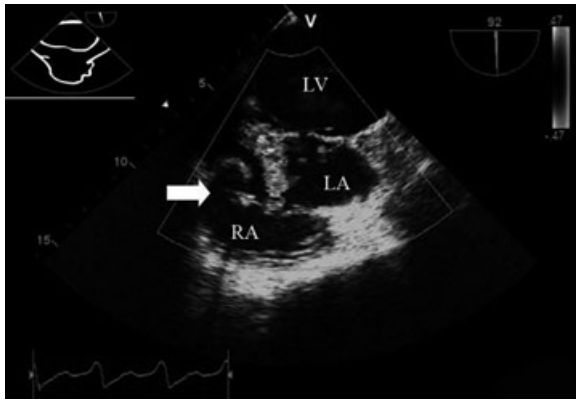

Figure 1. *Echocardiographic diagnosis of the patent foramen ovale (PFO). An arrow points to the atrial shunt. LA = left atrium; LV = left ventricle; RA = right atrium.*

Preoperatively, Interagency Registry for Mechanically Assisted Circulatory Support (INTERMACS) level was 3, mean pulmonary arterial pressure was 36, transpulmonary gradient was 12, and right ventricle function was judged good according to the Berlin algorithm.[6]

The LVAD was conventionally implanted[6] on cardiopulmonary bypass with the inflow cannula in the left ventricle and the outflow cannula in the ascending aorta. Transesophageal echocardiography (TEE) was obtained before cardiopulmonary bypass and after LVAD activation. A bubble contrast study was performed by injecting 10 mL of agitated Dextrose50 solution (Abbott Lab, Chicago, IL, USA) into the right atrium. Only a few microbubbles were seen passing from the right atrium to the left atrium during each cardiac cycle.

It was thought that this small PFO would not result in hypoxemia since the patient's oxygenation was stable (right radial artery P_{O2} of 120 mmHg on an F_{IO2} of 50%). However, 8 hours after arrival in the intensive care unit (ICU) the patient's oxygenation status worsened. He developed recurrent episodes of hypoxemia (P_{O2} of 50 to 60 mmHg) despite being on an F_{IO2} of 100% and a positive end-expiratory pressure (PEEP) of 10 cm H2O.

TEE now revealed a severe atrial shunt (Fig. 1). During cardiac catheterization, blood samples drawn from the left atrium, pulmonary vein, and right radial artery revealed P_{O2} values of 210, 230, and 85 mmHg, respectively (on an F_{IO2} of 100%). The right radial artery P_{O2} improved to 115 mmHg when the PFO was temporarily occluded with a balloon. A 25-mm Amplatzer Septal Occluder (AGA-Medical) was used to close the PFO (Fig. 2). Fifteen minutes after closure the right radial artery P_{O2} improved dramatically to 140 mmHg on an F_{IO2} of 40%.

The patient was extubated 24 hours after transcatheter PFO closure and the patient's hemodynamics rapidly stabilized. He is discharged home awaiting heart transplantation.

Conflict of interest: No funding sources and relevant disclosures to declare.

This report was carried out within Dr. Loforte's Ph.D. program in "Transplantation" awarded by Rome Tor Vergata University, Italy, in cooperation with the Deutsches Herzzentrum Berlin, Germany.

Address for correspondence: Antonio Loforte, M.D., Department of Cardiac Surgery and Transplantation, San Camillo Hospital, P.za C. Forlanini n.1, 00151 Rome, Italy. Fax: +39-06-5870-4706; e-mail: antonioloforte@yahoo.it

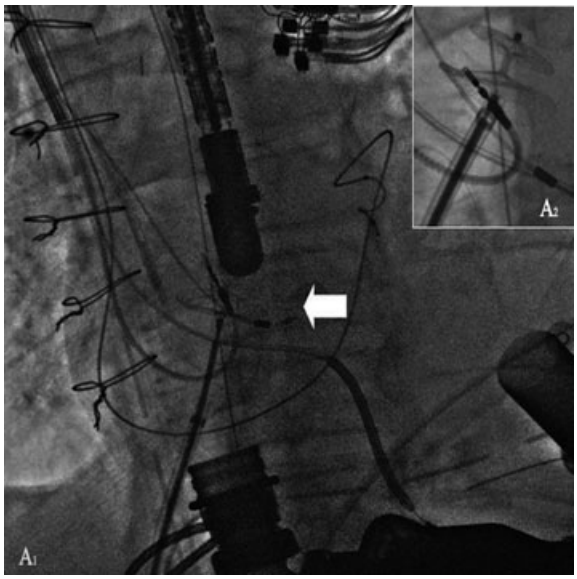

Figure 2. *Transcatheter closure of the patent foramen ovale (PFO) by an Amplatzer Septal Occluder (AGA-Medical) during a HeartMate II (Thoratec Inc.) left ventricular assist device (LVAD) support. A_1 = occluder device delivery (white arrow); A_2 = occluder device deployment.*

COMMENT

The diagnosis of a PFO is a dynamic process. Under abnormal physiologic conditions when right atrial pressure (RAP) exceeds LAP, as during LVAD installation, the PFO may cause hypoxemia due to a right-to-left shunt at the atrial level.[3-5]

In congestive heart failure the patient's LAP is usually much higher than the RAP and the PFO remains closed. After LVAD implantation, LAP is decreased significantly. RAP may drop secondary to decreased pulmonary vascular resistance and right ventricular afterload, but it still remains much higher than LAP. Based on the literature[3-5] and our experience, the diagnosis of PFO in congestive heart failure patients can be made reliably by TEE only after LVAD implantation when the atrial pressure gradient allows blood to shunt from right to left atrium. The diagnosis cannot be made by prebypass TEE.

In patients with an LVAD, the atrial pressure gradient may vary because of different preload conditions (volume status), and the direction of shunt flow may change because of the different gravity effects of the device when the body is at different positions. This may explain the characteristics of intermittent hypoxemia caused by a PFO in LVAD patients.[3-5]

It is difficult to estimate the extent of the shunt by TEE. The amount of contrast microbubbles crossing the atrial septum does not necessarily correlate with the size of defect or the magnitude of the shunt.[1-5]

Once the PFO is detected as in the reported case, it should be immediately treated during initial LVAD implantation. Thus the heart should be placed on total cardiopulmonary bypass and the PFO should be closed in either a fibrillating or cardioplegic arrested heart.[3-5]

This would avoid a delayed atrial defect closure resulting in hemodynamic instability, even if easily performed by a transcatheter procedure.[3-5]

REFERENCES

1. Nacht A, Kronzon I: Intracardiac shunts. Crit Care Clin 1996;12:295-319.
2. Hagen PT, Scholz DG, Edwards WD: Incidence and size of patent foramen ovale during the first 10 decades of life: An autopsy study of 965 normal hearts. Mayo Clin Proc 1984;59:17-20.
3. Liao KK, Miller L, Toher C, et al: Timing of transesophageal echocardiography in diagnosing patent foramen ovale in patients supported with left ventricular assist device. Ann Thorac Surg 2003;75:1624-1626.
4. Nguyen DQ, Das GS, Grubbs BC, et al: Transcatheter closure of patent foramen ovale for hypoxemia during left ventricular assist device support. J Heart Lung Transplant 1999;18:1021-1026.
5. Baldwin RT, Duncan M, Frazier OH, et al: Patent foramen ovale: A cause of hypoxemia in patients on left ventricular support. Ann Thorac Surg 1991;52:865-867.
6. Potapov EV, Krabatsch T, Ventura HO, et al: Advances in mechanical circulatory support: Year in review. J Heart Lung Transplant 2011;30(5):487-493.

15408191, 2012, 4, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/j.1540-8191.2012.01476.x by Universita Di Torino, Wiley Online Library on [14/04/2023]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License