Capping off ventricular assist

Mark R. Helmers, MD, and Pavan Atluri, MD

From the Division of Cardiovascular Surgery, Department of Surgery, University of Pennsylvania, Philadelphia, Pa.

Disclosures: Authors have nothing to disclose with regard to commercial support.

Received for publication Aug 22, 2018; accepted for publication Aug 24, 2018; available ahead of print Sept 27, 2018.

Address for reprints: Pavan Atluri, MD, Division of Cardiovascular Surgery, Hospital of the University of Pennsylvania, 3400 Spruce St, 6 Silverstein Pavilion, Philadelphia, PA (E-mail: Pavan.Atluri@uphs.upenn.edu).

J Thorac Cardiovasc Surg 2019;157:e39-40

0022-5223/\$36.00

Copyright © 2018 by The American Association for Thoracic Surgery

<https://doi.org/10.1016/j.jtcvs.2018.08.046>

Pavan Atluri, MD, and Mark R. Helmers, MD

Central Message

A specialized titanium plug seals the apical fixation ring and simplifies explant of the HeartMate 3 (Abbott, Abbott Park, Ill) in patients who have demonstrated myocardial recovery.

See Article page e35.

Left ventricular pressure and volume unloading with left ventricular assist devices (LVADs) have been shown to induce structural and functional reverse remodeling in a subset of patients with end-stage heart failure.¹ Select LVAD recipients have sufficient improvement in myocardial function with prolonged mechanical unloading to allow for device removal. The first such case of LVAD explant after ventricular recovery was reported in 1996 in a 19-year-old man with idiopathic cardiomyopathy after 183 days of HeartMate (Abbott, Abbott Park, Ill) support, originally intended as a bridge to heart transplant.² Subsequently, several groups have described bridge-to-recovery (BTR) strategies to identify and increase myocardial recovery with varying levels of success.^{3,4}

A wide variety of surgical techniques have been described for LVAD explant. Traditionally, a median sternotomy approach with cardiopulmonary bypass (CPB) without arrest is used to completely remove the pump, fixation ring, outflow graft, and driveline. The apical ventricular defect is then closed primarily or with patch exclusion. On the opposite end of the spectrum, the outflow graft can be divided just distal to the pump and driveline transected underneath the skin, allowing for off-pump, minimally invasive termination of device support. In this approach, the pump and outflow graft are left in situ to thrombose.⁵ Cohn and colleagues⁶ described the use of an intraoperatively fashioned felt plug to facilitate explant of a HeartMate II. Peripheral CPB was used, and, via a subcostal incision, the pump was removed, the outflow graft was oversewn, and the felt plug was inserted and sutured to the sewing ring.⁶ Leaving the sewing ring intact prevents additional ventricular muscle damage, preserves apical geometry, and facilitates LVAD reimplantation should severe heart failure recur.

Since Cohn and colleagues' felt plug, titanium plugs have been developed that custom fit the HeartMate II⁷ and HeartWare HVAD (Framingham, Mass).⁸ These plugs obviate the need for intraoperative felt plug construction and hermetically seal the ventricle preventing pericardial effusion or

ventricular pseudoaneurysm, which may theoretically result from an inadequately sealed felt plug. These plugs are sintered with titanium spheres to promote endothelialization and reduce thrombus formation. As the field of myocardial recovery continues to advance, standardized devices to appropriately facilitate LVAD explant are critical.

In this issue of the *Journal*, Mulzer and colleagues⁹ describe the first clinical use of a novel specialized titanium recovery plug designed for the HeartMate 3. Two explants were performed on CPB in young women who had ventricular recovery after peripartum cardiomyopathy. The third case was performed off-pump in a 55-year-old man. Each patient was anticoagulated for 6 months with a vitamin K antagonist to allow sufficient time for tissue overgrowth of the plug. The plug is innovative and provides promise for ease of explant with the growing interest in LVAD-mediated myocardial recovery.

Although only 1.3% of all LVAD recipients registered in the Interagency Registry for Mechanically Assisted Circulatory Support between 2006 and 2015 underwent device removal or deactivation, this figure was increased approximately 10-fold with an a priori BTR strategy.¹⁰ Preliminary results from the REmission From Stage D Heart Failure study showed an explant rate of 36% with standardized pharmacotherapy and regular low-speed screening echocardiograms.¹¹ There is growing national interest in myocardial recovery, with the best example involving the Phase

II trial of the CTSnet evaluating myocardial regeneration and recovery with mesenchymal stem cell therapy.

As more clinical focus is applied to BTR strategies, the number of explanted LVADs is likely to increase. Certainly the titanium recovery plug pioneered by Mulzer and colleagues⁹ will have an impact in the field. We applaud the authors on their innovative development of the recovery plug. Continued interest and enthusiasm for myocardial recovery on a cellular and clinical basis are warranted and hold promise for the future.

References

1. Levin HR, Oz MC, Chen JM, Packer M, Rose EA, Burkhoff D. Reversal of chronic ventricular dilation in patients with end-stage cardiomyopathy by prolonged mechanical unloading. *Circulation*. 1995;91:2717-20.
2. Levin HR, Oz MC, Catanese KA, Rose EA, Burkhoff D. Transient normalization of systolic and diastolic function after support with a left ventricular assist device in a patient with dilated cardiomyopathy. *J Heart Lung Transplant*. 1996;15:840-2.
3. Birks EJ, Tansley PD, Hardy J, George RS, Bowles CT, Burke M, et al. Left ventricular assist device and drug therapy for the reversal of heart failure. *N Engl J Med*. 2006;355:1873-84.
4. Maybaum S, Mancini D, Xydas S, Starling RC, Aaronson K, Pagani FD, et al. Cardiac improvement during mechanical circulatory support: a prospective multicenter study of the LVAD working group. *Circulation*. 2007;115:2497-505.
5. Selzman CH, Madden JL, Healy AH, McKellar SH, Koliopoulou A, Stehlik J, et al. Bridge to removal: a paradigm shift for left ventricular assist device therapy. *Ann Thorac Surg*. 2015;99:360-7.
6. Cohn WE, Gregoric ID, Radovancevic B, Frazier OH. A felt plug simplifies left ventricular assist device removal after successful bridge to recovery. *J Heart Lung Transplant*. 2007;26:1209-11.
7. Potapov EV, Stepanenko A, Hennig E, Hetzer R, Krabatsch T. A titanium plug simplifies left ventricular assist device removal after myocardial recovery. *J Heart Lung Transplant*. 2010;29:1316-7.
8. Saito T, Potapov E, Dandel M, Hetzer R, Krabatsch T. Reimplantation of left ventricular assist device late after weaning of device using a titanium plug. *J Heart Lung Transplant*. 2014;33:972-4.
9. Mulzer J, Faerber G, Kaufmann F, Potapov E. Recovery plug for HeartMate 3 left ventricular assist device. *J Thorac Cardiovasc Surg*. 2019;157:e35-7.
10. Wever-Pinzon O, Drakos SG, McKellar SH, Horne BD, Caine WT, Kfoury AG, et al. Cardiac recovery during long-term left ventricular assist device support. *J Am Coll Cardiol*. 2016;68:1540-53.
11. Birks EJ, Rame E, Patel SR, Selzman C, Cunningham C, Starling R, et al. Abstract 19838: Remission From Stage D Heart Failure (RESTAGE-HF) interim results and insights from a prospective multi-center non-randomized study of myocardial recovery using LVADs. *Circulation*. 2018;134(suppl_1):19838.