Interactive CardioVascular and Thoracic Surgery Advance Access published November 21, 2013

Interactive CardioVascular and Thoracic Surgery (2013) 1–3
doi:10.1093/icvts/ivt488

Explantation of a CircuLite left ventricular assist device without removal of the inflow cannula: how to do it?

Sarah Sainte*, Marc Gewillig, Walter Droogne, Johan Van Cleemput, Johan Vanhaecke, Bart Meyns and Filip Rega

Department of Cardiovascular Diseases, Cardiac Surgery, University Hospitals Leuven, Leuven, Belgium

* Corresponding author: Department of Cardiac Surgery, Gasthuisberg, University Hospitals Leuven, Herestraat 49, 3000 Leuven, Belgium. Tel: +32-16-344260; fax: +32-16-344616; e-mail: sarah.sainte@uzleuven.be (S. Sainte).

Received 27 August 2013; received in revised form 10 October 2013; accepted 16 October 2013

Abstract

As the incidence of heart failure rises and given the shortage of donor organs, left ventricular assist device implantation offers a viable therapy in patients with end-stage heart disease. The CircuLite Synergy™ device is a less invasive support device for Intermacs class 4 heart failure patients. We report the first case of successful weaning from the CircuLite Synergy™ pump and propose our surgical technique to explant the device while leaving the inflow cannula *in situ*.

Keywords: Ventricular assist devices • Heart failure • Weaning

CASE REPORT

A 35-year old woman presented with progressive dyspnoea (NYHA III) and orthopnoea. Exercise tolerance was markedly reduced. An idiopathic dilatated cardiomyopathy was diagnosed with a decline in left ventricular (LV) ejection fraction (EF) to 19% and a LV end diastolic diameter (EDD) of 60 mm. A moderate mitral insufficiency was noted and coronary arteries were normal. Electrocardiogram and chest X-ray showed no abnormalities. NT-pro-BNP was increased (1232 ng/l). Wedge and right atrium pressure was 16 and 9 mmHg, respectively. Cardiac index was 2.49 l/min/m^2. Cyclo-ergospirometry objectivated an importantly reduced exercise capacity with a VO_2 max of 7.6 ml/kg/min. Myocardial biopsy was normal. Cardiac MRI showed no evidence for acute myocarditis. No other family members are similarly affected. Maximum medical heart failure therapy was instituted (diuretics, ACE-inhibitor and β-blocker). Nevertheless, her clinical status deteriorated rapidly. Two weeks after the first admission, a CircuLite left ventricular assist device (LVAD) needed to be implanted as a bridge to transplantation. The surgical technique to implant the CircuLite Synergy™ device was described previously [1]. In short, the inflow cannula (inner diameter: 8 mm; outer diameter: 11 mm) is implanted in the left atrium through a small right-sided thoracotomy and exits the chest via the second intercostal space. The pump itself is positioned in a subclavicular pocket on the same side. An 8-mm PTFE outflow graft is connected to the right subclavian artery. With the pump running at 20K rpm, her cardiac output increased from 3.9 l/min (under inotropic support) up to 6 l/min (±50%). The postoperative course was uneventful. Left ventricular ejection fraction and VO_2 max improved to 35% and 11.1 ml/kg/min, respectively. Three months after the implantation, LVEF increased to 50–55%. VO_2 max increased to 12.4 ml/kg/min and NT-proBNP levels decreased from 1232 ng/l preoperatively to 95 ng/l. Her LV end diastolic diameter came down to 48 mm. Given also the objective improvement of her clinical status, we decided to wean her from the device 5 months after implantation (140 days).

During the explantation in our hybrid operating room, the outflow graft was clamped after opening the pump pocket. The device was turned off. After confirmation of her stable haemodynamics, the outflow graft was cut and sutured. The inflow cannula was left in place after occluding it at both ends. First, a cut 14-Fr valved sheath (outer diameter 16 Fr, inner diameter 14 Fr) was inserted through the inflow cannula to seal the distal end thereby preventing as much leakage as possible and preventing air embolism (Fig. 1). Then, a long sheath (6 Fr) was introduced into the left atrium. Over a guidewire, an Amplatzer Vascular Plug II® was inserted under fluoroscopic guidance (Supplementary Video 1). As shown in Fig. 1, the plug was placed in such way that one blade shielded off the inflow tip of the cannula and that the distal part of the plug stabilized its position in the inflow cannula. We plugged the distal part of the inflow cannula with a silicone cap and checked there was no backflow from the left atrium. No adverse events were reported after explantation and the patient was discharged home 6 days later. At the time of this report, 24 months after removal of the CircuLite Synergy™ system, follow-up echocardiography still showed a sustained improvement of cardiac function with an average EF of 55%. The vascular occlude remains in unchanged position since release; there were no thrombotic events.

DISCUSSION

In an era of a rapidly growing population with congestive heart failure and a marked shortage of donor organs, LVADs offer

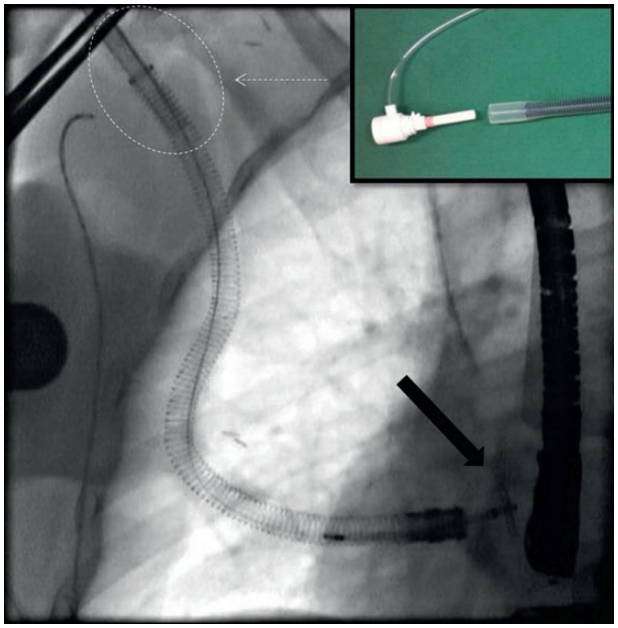
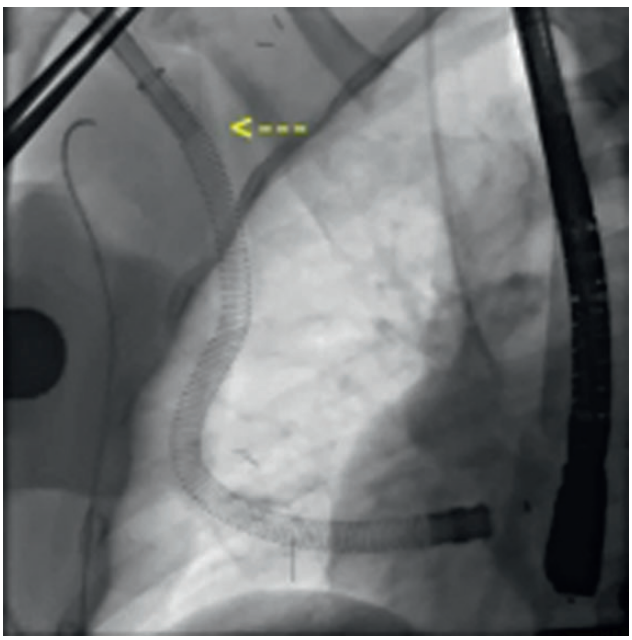


Figure 1: Fluoroscopic image depicting the cut-off 14 Fr valved sheath (circle). The black arrow marks the deployed distal disk of the Amplatzer device (not yet pulled back to seal the cannula tip).



Supplementary Video 1: Deployment and sealing of the Amplatzer device in the proximal tip of the inflow cannula at the entrance of the left atrium. The arrow marks the cut-off 14 Fr valved sheath through which the 6 Fr sheath is placed. We see how the Amplatzer plug is advanced into the left atrium. The yellow circle marks how the distal disk of the plug is pulled back against the cannula tip and how subsequently the deployment of the occluder in the cannula is performed.

a suitable bridge in those patients with end-stage failure unresponsive to optimal medical therapy. Other than full-support devices, CircuLite Synergy™ is a newly developed continuous axial flow pump providing partial support with flows ranging from 1.5 to 4.25 l/min. The device is specifically designed to be implanted in patients who are not sick enough to require full support. A total of 59 patients have been implanted with the CircuLite Synergy™ system to date.

The concept of reverse remodelling induced by mechanical unloading of the failing heart with a full-support pulsatile device (reaching flow rate capacities of 5–10 l/min) was demonstrated already in 1995 by Levin *et al.* [2]. Currently, most patients are supported with continuous flow devices [3].

Our patient was supported with the partial support CircuLite Synergy™ device. The beneficial effect of long-term partial support was studied by Meyns *et al.* [4, 5]. Jacobs *et al.* demonstrated reverse remodelling after partial support [6]. In our patient, reverse remodelling was shown by the reduction in LV end diastolic diameter from 60 to 48 mm after 3 months of support. Myocardial function recovery and subsequent weaning of LVAD is reported several times with full support devices [7]. To our knowledge, this is the first case of myocardial function recovery after partial support with the CircuLite device with subsequent successful weaning off the pump. Hindsight, given the acuity of the clinical course and the complete recovery of cardiac function after several months, we should question the diagnosis of an idiopathic dilatated cardiomyopathy and consider the possibility of a cooled down myocarditis. Nevertheless, myocardial biopsy and cardiac MRI showed no abnormalities. Explantation of the inflow cannula through a thoracotomy or sternotomy was considered to be very invasive. In experimental settings (unpublished data), we tried to plug the cannula close to the pump. Unfortunately, clot formation caused hemiplegia in several animals. This is why we chose for the presented approach. We feel that explantation of a CircuLite device leaving the inflow cannula *in situ* is a safe and feasible procedure requiring a multidisciplinary heart team approach including the interventional cardiologist. No adverse events were reported after the procedure.

In summary, the explantation of a CircuLite LVAD can be accomplished with low morbidity throughout a subclavicular incision, leaving the inflow cannula *in situ*. The inflow cannula was occluded with an Amplatzer Vascular Plug® II. We are now 2 years after the explantation and the patient is doing fine.

SUPPLEMENTARY MATERIAL

Supplementary material is available at *ICVTS* online.

Conflict of interest: Bart Meyns and Filip Rega are consultant to CiruLite, Inc.

REFERENCES

[1] Meyns B, Rega F, Ector J, Droogne W, Vanhaecke J, Van Hemelrijck J *et al*. Partial left ventricular support implanted through minimal access surgery as a bridge to cardiac transplant. J Thorac Cardiovasc Surg 2009; 137:243–5.

[2] Levin HR, Oz MC, Chen JM, Packer M, Rose EA, Burkhoff D *et al*. Reversal of chronic ventricular dilation in patients with end-stage cardiomyopathy by prolonged mechanical unloading. Circulation 1995;91:2717–20.

[3] Kirklin JK, Naftel DC, Kormos RL, Stevenson LW, Pagani FD, Miller MA *et al*. Fifth INTERMACS annual report: risk factor analysis from more than 6,000 mechanical circulatory support patients. J Heart Lung Transplant 2013;32: 141–56.

[4] Meyns B, Klotz S, Simon A, Droogne W, Rega F, Griffith B *et al*. Proof of concept: hemodynamic response to long-term partial ventricular

support with the synergy pocket micro-pump. J Am Coll Cardiol 2009;54: 79–86.
[5] Meyns B, Simon A, Klotz S, Wittwer T, Schlensak C, Rega F *et al*. Clinical benefits of partial circulatory support in New York Heart Association Class IIIB and Early Class IV patients. Eur J Cardiothorac Surg 2011;39:693–8.
[6] Jacobs S, Geens J, Rega F, Burkhoff D, Meyns B. Continuous-flow left ventricular assist devices induce left ventricular reverse remodeling. J Heart Lung Transplant 2013;32:466–8.
[7] Lamarche Y, Kearns M, Josan K, Bashir J, Ignaszewski A, Kaan A *et al*. Successful weaning and explantation of the Heartmate II left ventricular assist device. Can J Cardiol 2001;27:358–62.