Implantation of a cardiac resynchronization therapy and defibrillation system using a robotic approach

Sana Amraoui, MD,[*] Louis Labrousse, MD, PhD,[*] Jean-Luc Jansens, MD, PhD,[†] Manav Sohal, MBBS,[‡] Pierre Bordachar, MD, PhD,[*] Philippe Ritter, MD[*]

From the [*]Université de Bordeaux Hôpital Haut-Lévêque, LIRYC, Pessac, France, [†]Free University of Brussels (ULB), Hôpital Erasme, Brussels, Belgium, and [‡]Guy's and St Thomas' NHS Foundation Trust, London, United Kingdom.

Introduction

Device infection is one of the most feared complications in patients implanted with a cardiac device.[1,2] In some cases, conventional transvenous reimplantation cannot be performed, so alternative approaches are needed.[3,4]

Case report

A 67-year-old man with dilated cardiomyopathy (New York Heart Association [NYHA] class III and left bundle branch block) was implanted with a cardiac resynchronization therapy and defibrillation (CRT-D) device and was a good responder (NYHA class I and increase in left ventricular ejection fraction [LVEF] from 30% to 45%).[5] After 2 episodes of device infection and 2 CRT-D extractions, a new device was required. As superior venous access was no longer available (thrombosis on 1 side, recent infection on the other), an epicardial approach was used.[6]

The whole procedure was minimally invasive and robotically guided by the da Vinci Robotic System (Intuitive Surgical Inc, Sunnyvale, CA).[7,8] The patient was tilted to the right side, in order to get more intrathoracic space to facilitate left ventricle (LV) access (Figure 1). The patient was intubated with a double-lumen endotracheal Clarins device for single and right selected lung ventilation (left lung exclusion), mandatory to access the LV epicardium. The left chest was insufflated, allowing the introduction of a binocular camera and instruments via 3 transthoracic ports of 10 mm diameter in the anterior axillary line (the fifth intercostal space for the camera, the third and seventh for instruments). The ports were held by 3 robotic arms remotely controlled by the surgeon. The entire LV free wall was exposed. The leads were introduced through the superior port and the instruments were placed in the intrathoracic space through the 2 dedicated ports. This allowed manipulation and placement of the epicardial leads. The 2 LV leads (custom-made Medtronic 9022 leads; Medtronic Inc, Minneapolis, MN) were placed at the lateral LV wall and fixed at the pericardium without suture (like a button of a shirt), after achieving correct sensing/pacing thresholds (<1.5 V at 0.4 ms) (Figure 2). The leads were consequently outside the pericardial space but the active and steroid-eluding part of the leads was in close contact with the myocardium. It was possible to use more readily available steroid-eluting epicardial leads (Medtronic 4968; Medtronic Inc) with the da Vinci system but sutures are required for lead fixation. A defibrillation coil was sutured onto the pericardium along the lateral LV wall, and another was introduced through a small pericardial incision over the anterior right ventricular wall (Transvene Medtronic leads), into the pericardial space (Figure 3). The atrial lead was placed at the right atrial appendage (again without fixation to the myocardium). All leads were tunneled to an epigastric device pocket and connected to the CRT device. A pleural drain was placed in the left pleural space at the end of the procedure and removed after 4 hours, as no persistent bleeding was present. Hospital discharge was possible after 4 days.

The 20 J defibrillation test was successfully performed 3 months after implantation. At 2 years, the patient was a responder to CRT (NYHA class I, LVEF 45%, brain natriuretic peptide 73 pg/mL), without signs of recurrent infection. Sensing and pacing thresholds were stable (1.25 V/0.4 ms for 1 LV lead and 0.5 V/0.4 ms for the other one, 0.9 mV atrial sensing with 99% ventricular pacing).

Surgical implantation of epicardial LV leads has been shown to be feasible, with good electrical stability.[9] It can be performed by a left thoracotomy. However, with this invasive approach, the area of exposed LV is limited for a CRT-D implant, and even worse with a mini-thoracotomy.[10] Alternatively, sternotomy allows unlimited choice of epicardial pacing site since the entire LV is exposed.

KEYWORDS Cardiac resynchronization therapy and defibrillation; Heart failure; Lead endocarditis; Epicardial lead; Robotic approach

ABBREVIATIONS **CRT-D** = cardiac resynchronization therapy and defibrillation; **LV** = left ventricle; **LVEF** = left ventricular ejection fraction; **NYHA** = New York Heart Association

(Heart Rhythm Case Reports 2015;1:356–359)

The following authors have relationships with the industry: Drs Louis Labrousse and Jean-Luc Jansens have received financial support from Intuitive Surgical. Intuitive Surgical had no input into the case **Address reprint requests and correspondence:** Sana Amraoui, Hôpital Cardiologique du Haut-Lévêque, 33604 Bordeaux-Pessac, France. E-mail address: sana.amraoui@hotmail.com.

http://dx.doi.org/10.1016/j.hrcr.2015.06.008

KEY TEACHING POINTS

- In some cases, conventional transvenous cardiac resynchronization therapy and defibrillation (CRT-D) implantation cannot be performed, so alternative approaches are needed. Thus, surgical epicardial implantation is mandatory.
- We used a minimally invasive procedure for a complete epicardial CRT reimplantation in a patient without superior venous access available. The whole procedure was robotically guided by the da Vinci Robotic System.
- This robotic CRT-D implantation was safe and minimally invasive, with significant advantages in the absence of transvenous access. It offers a new alternative when conventional approaches are not suitable.

However, this is a complicated, invasive approach with a low acceptance for patients and longer hospitalization. In centers with the robotic system, guided LV lead implantation seems to be an alternative allowing epicardial CRT-D implantation with a minimally invasive approach and shorter hospitalization.

Discussion

This robotic CRT-D implantation was safe and minimally invasive, with significant advantages in the absence of transvenous access: no sternotomy, no thoracotomy, no intravascular material, optimal shock vectors, LV implantation not dependent on coronary sinus anatomy, short hospitalization, and lack of any requirement for radiograph fluoroscopy. Furthermore, this technique minimizes the difficulties of possible future cardiac interventions as no material is sutured onto the myocardium: the whole system is placed on the pericardium except for the anterior right ventricular shock electrode (today, this electrode is placed outside the pericardial space in the retrosternal fat). This epicardial device implantation offers a new alternative when conventional approaches are not suitable.

Figure 1 Da Vinci Robotic System for cardiac resynchronization therapy and defibrillation implantation: a minimally invasive approach. **A, B:** The patient was tilted to the right side. The binocular camera and instruments were introduced via 3 transthoracic ports of 10 mm diameter. **C:** Instruments were held by 3 robotic arms. **D:** Robotic arms could be controlled remotely at distance by the surgeon.

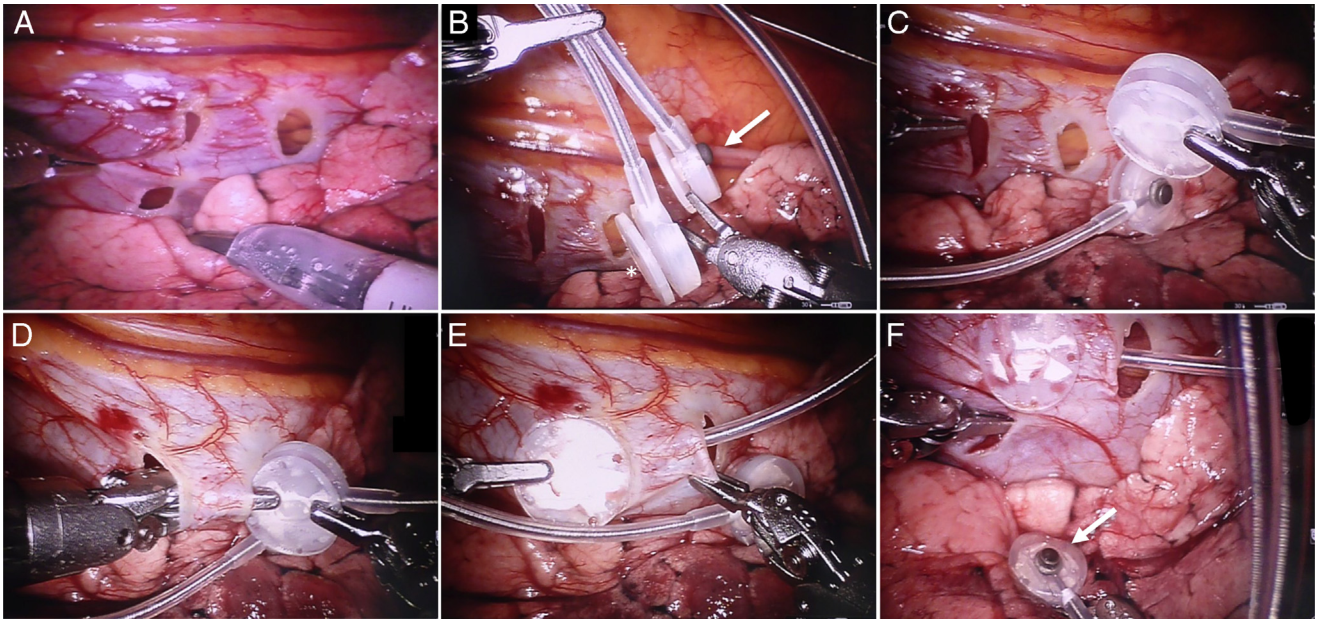

Figure 2 Left ventricular (LV) lead implantation. **A:** Three small pericardial incisions were performed at the left lateral wall with the 2 dedicated instruments to place the first LV lead. **B:** Each bipolar lead (custom-made Medtronic 9022 leads) has 2 circles at the extremity (*asterisks*) carrying an active and steroid-eluting electrode (*arrow*). **C:** Each circle of the lead is held by the instruments. **D:** Each circle of the lead is introduced through 2 pericardial incisions and then fixed at the pericardium without suture (like a button of a shirt). **E:** This method allows good contact of the electrode to the LV myocardium without the use of a needle. **F:** The second circle at the extremity of the lead is also fixed in the same way.

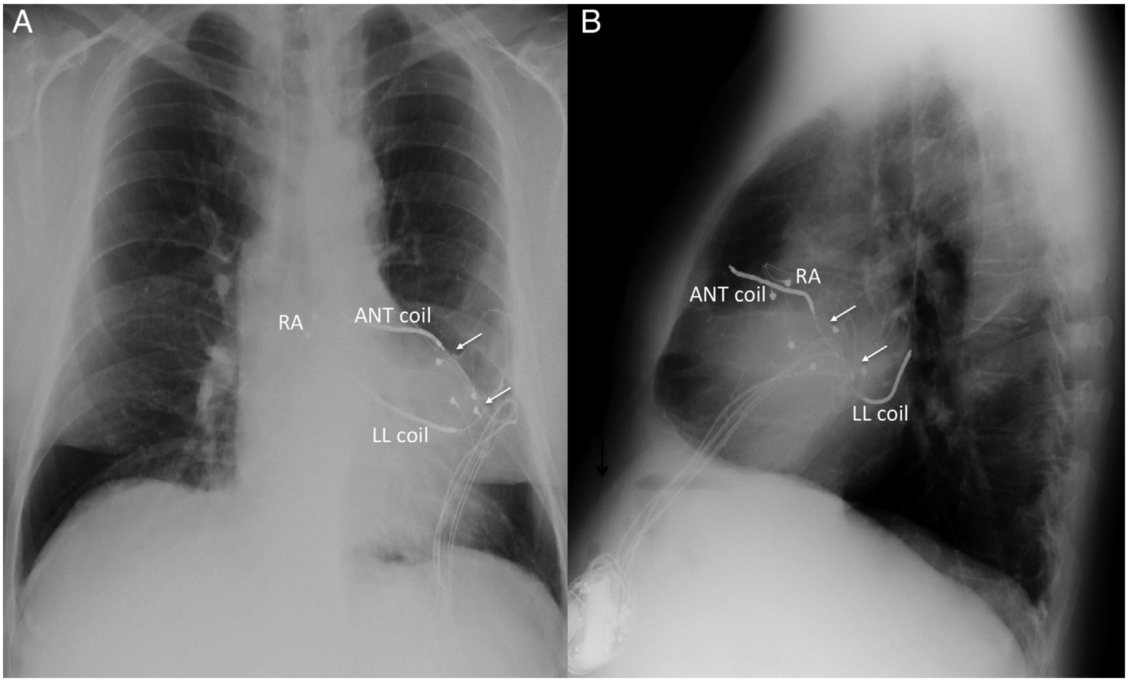

Figure 3 Chest radiograph of the patient with a cardiac resynchronization therapy and defibrillation (CRT-D) device implanted by robotic approach. **A:** Posteroanterior view; **B:** lateral view: 2 epicardial custom-made Medtronic 9022 left ventricular leads (*arrows*) were placed at the lateral wall and tunneled to an epigastric CRT-D device. A right atrial lead and 2 defibrillation coils were tunneled to a CRT-D device localized in the subgastric area. ANT = anterior; LL = left lateral; RA = right atrium.

References

1. Voigt A, Shalaby A, Saba S. Continued rise in rates of cardiovascular implantable electronic device infections in the United States: temporal trends and causative insights. Pacing Clin Electrophysiol 2010;33: 414–419.
2. Greenspon AJ, Patel JD, Lau E, Ochoa JA, Frisch DR, Ho RT, Pavri BB, Kurtz SM. 16-year trends in the infection burden for pacemakers and implantable cardioverter-defibrillators in the United States 1993 to 2008. J Am Coll Cardiol 2011;58: 1001–1006.
3. European Heart Rhythm Association, European Society of Cardiology, Heart Rhythm Society, et al. 2012 EHRA/HRS expert consensus statement on cardiac resynchronization therapy in heart failure: implant and follow-up recommendations and management. Heart Rhythm 2012;9:1524–1576.
4. Brignole M, Auricchio A, Baron-Esquivias G, et al. 2013 ESC Guidelines on cardiac pacing and cardiac resynchronization therapy: the Task Force on cardiac pacing and resynchronization therapy of the European Society of Cardiology (ESC). Developed in collaboration with the European Heart Rhythm Association (EHRA). Eur Heart J 2013;34:2281–2329.
5. Abraham WT, Fisher WG, Smith AL, et al. Cardiac resynchronization in chronic heart failure. N Engl J Med 2002;346:1845–1853.
6. Wilkoff BL, Love CJ, Byrd CL, et al. Transvenous lead extraction: Heart Rhythm Society expert consensus on facilities, training, indications, and patient management: this document was endorsed by the American Heart Association (AHA). Heart Rhythm 2009;6:1085–1104.
7. Jansens J-L, Jottrand M, Preumont N, Stoupel E, de Cannière D. Robotic-enhanced biventricular resynchronization: an alternative to endovenous cardiac resynchronization therapy in chronic heart failure. Ann Thorac Surg 2003;76: 413–417. discussion 417.
8. Kamath GS, Balaram S, Choi A, Kuteyeva O, Garikipati NV, Steinberg JS, Mittal S. Long-term outcome of leads and patients following robotic epicardial left ventricular lead placement for cardiac resynchronization therapy. Pacing Clin Electrophysiol 2011;34:235–240.
9. Burger H, Kempfert J, van Linden A, Szalay Z, Schoenburg M, Walther T, Ziegelhoeffer T. Endurance and performance of two different concepts for left ventricular stimulation with bipolar epicardial leads in long-term follow-up. Thorac Cardiovasc Surg 2012;60:70–77.
10. Navia JL, Atik FA, Grimm RA, Garcia M, Vega PR, Myhre U, Starling RC, Wilkoff BL, Martin D, Houghtaling PL, Blackstone EH, Cosgrove DM. Minimally invasive left ventricular epicardial lead placement: surgical techniques for heart failure resynchronization therapy. Ann Thorac Surg 2005;79: 1536–1544. discussion 1536–1544.