

# Superior vena cava reconstruction and implantation of a leadless pacemaker for management of pacemaker-induced superior vena cava syndrome



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## Introduction

Superior vena cava (SVC) syndrome is a rare complication of transvenous pacemaker implantation. Treatment strategies include endovascular stenting and open SVC reconstruction. In either case, the need for implantation of new pacing leads can present clinical challenges. Here we present the first reported use of a surgically placed leadless pacemaker for the treatment of pacemaker-induced SVC syndrome.

## Case report

Our patient is a 61-year-old woman, who had been treated for paroxysmal complete atrioventricular block with a dual-chamber transvenous pacemaker (device: A2DR01 Advisa DR MRI [Medtronic, Minneapolis, MN]; leads: Medtronic 5076 CapSureFix Novus) inserted via the left axillary vein. Three years after implantation, the patient presented with facial plethora, swelling, and headache. Venography and computed tomography demonstrated isolated focal stenosis at the junction of the innominate vein and SVC with numerous venous collaterals (Figure 1). Balloon angioplasty led to transient relief of her symptoms, which recurred approximately 6 months after treatment.

After heart team discussion, a treatment strategy was designed to consist of surgical lead extraction, SVC reconstruction, and direct implantation of a Micra leadless pacemaker (MDT MC1VR01 Micra VR TCP; Medtronic).<sup>1</sup> Open surgical repair was chosen over percutaneous device extraction and SVC stenting because of the large size of this vessel relative to available stents. In addition, the stenosis was localized at the confluence of the vessels and made

## KEY TEACHING POINTS

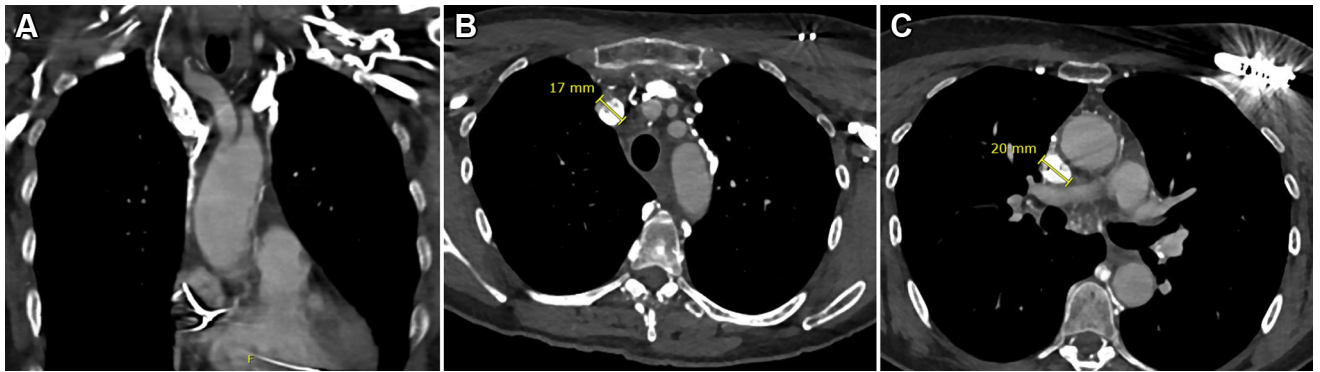
- Patients with pacemaker-induced superior vena cava (SVC) syndrome often require a multidisciplinary approach to achieve venous patency and adequate pacing.
- Surgical SVC reconstruction and pacemaker implantation is a useful strategy for patients with anatomy that is unsuitable for endovascular management of pacemaker-induced SVC syndrome.
- Factors to consider when deciding on a pacing strategy following SVC reconstruction include reliability of the pacing system, need for atrioventricular synchrony, need for cardiac resynchronization therapy, and need for defibrillation therapy.
- A leadless pacemaker is an attractive option for patients with permanent atrial fibrillation or low predicted pacing burden.

stenting more challenging. We selected a single-chamber leadless pacemaker to minimize the risk of future vascular compromise and because the patient consistently paced less than 0.1% with her dual-chamber device. Because the need for pacing was rare and the device was intended only as a backup pacer, evaluation of ventriculoatrial retrograde conduction was not performed. The patient had not had prior cardiac surgery and was deemed to be of acceptable operative risk.

The patient was taken to the operating room and standard monitoring lines were placed. A median sternotomy and standard aortic and bicaval cannulation were performed. Cardiopulmonary bypass was initiated without aortic cross-clamping or cardioplegic arrest. Inspection of the SVC demonstrated a discrete stenosis, extending from the level

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**Figure 1** Representative images from preoperative computed tomography. **A:** Focal stenosis of the superior vena cava (SVC) at the junction of the left brachiocephalic vein. **B, C:** Normal SVC superior (**B**) and inferior (**C**) to the lesion.

of innominate-SVC junction to the azygos vein. This was incised longitudinally and the pacemaker leads were removed. The pacemaker itself was removed via an incision over the left prepectoral pocket. The SVC was reconstructed with an augmenting patch angioplasty using autologous pericardium and running 5-0 polypropylene suture ([Video 1](#)).

Following SVC reconstruction, the electrophysiology team joined the case. A 23F Medtronic Micra delivery catheter was advanced across the tricuspid valve under direct vision. The surgeon held the distal part of the delivery system without introducer and positioned the device against the right ventricular mid-septum. The catheter controls were employed to extrude the Micra device, forcing the nitinol tines into the septum. Visual inspection confirmed that all 4 tines had engaged the myocardium. The heart was filled with blood and the device was interrogated. After initial testing, the pacing threshold was unacceptably high ( $>2$  V at 0.24 ms), so the device was recaptured under direct vision and repositioned. Retesting demonstrated acceptable impedance and pacing threshold (1.6 V at 0.24 ms; 0.68 V at 0.24 ms at the end of surgery). On postoperative day 3, device interrogation demonstrated impedance of 750  $\Omega$ , pacing threshold of 1.13 V at 0.24 ms, and sensing threshold of 3.9 mV. The postoperative course was uncomplicated, and

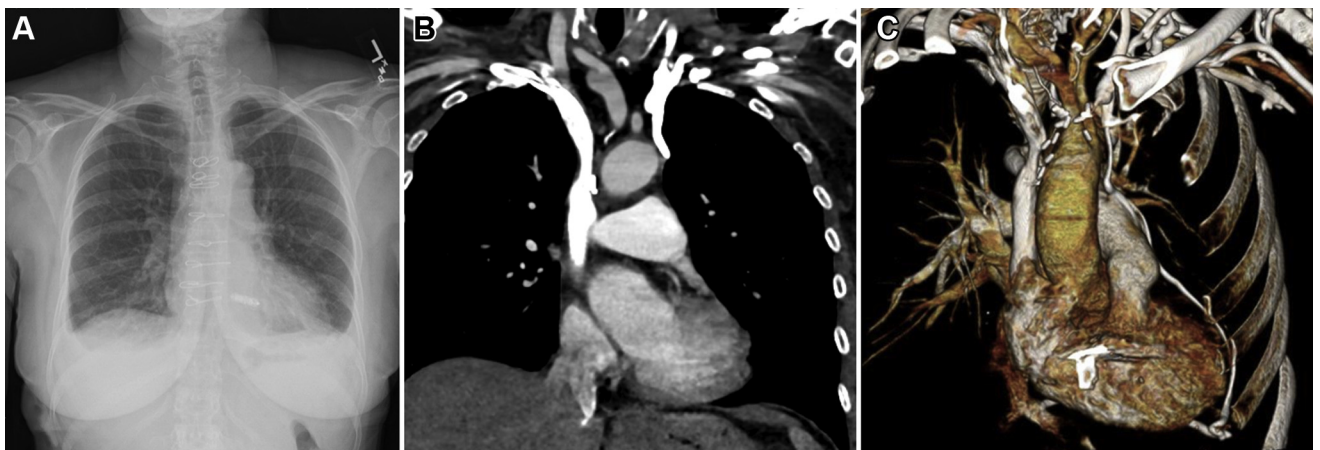
the patient experienced relief of facial swelling and plethora. Standard postoperative chest radiograph showed expected findings, with well-positioned pacemaker ([Figure 2A](#)).

At 3-month follow-up impedance was 540  $\Omega$ , pacing threshold was 0.75 V at 0.24 ms, and sensing threshold was 6.0 mV; measured R wave was 6.0 mV. The patient remained asymptomatic with regard to her SVC syndrome and her pacemaker has been functioning without issue. Computed tomography angiography demonstrated a widely patent SVC and resolution of venous collaterals ([Figure 2B and C](#)).

## Discussion

Pacemaker-induced SVC syndrome is thought to occur in approximately 0.5% of cases.<sup>2</sup> The risk is increased with upgrade of pacemaker devices, more than 1 pacemaker lead, device and/or lead infection, and severed pacemaker leads.<sup>3</sup> Nonsurgical treatment options include balloon venoplasty and stenting.<sup>4,5</sup> Surgical SVC reconstruction has the advantage of concurrent lead extraction and the possibility of epicardial pacing lead placement post reconstruction.

Factors to consider when deciding on a pacing strategy following SVC reconstruction include reliability of the pacing system, need for atrioventricular synchrony, need for



**Figure 2** **A:** Postoperative chest radiograph demonstrated appropriate positioning of the leadless pacemaker. **B, C:** Computed tomography at 3 months demonstrated a widely patent superior vena cava on 2-dimensional imaging (**B**) and 3-dimensional reconstruction (**C**).

cardiac resynchronization therapy, and need for defibrillation therapy. Epicardial pacing leads have the advantage of being completely extravascular, but studies in adults have shown that these leads can have higher thresholds and have a higher failure rate than transvenous leads.<sup>6</sup> In patients requiring dual-chamber pacing, a permanent epicardial pacing system would likely be the treatment of choice. However, in patients with permanent atrial fibrillation or those with a low predicted pacing burden, leadless pacing is emerging as an alternative. Postapproval registry data have suggested that leadless pacing is equivalent to transvenous leads in terms of durability and reliability.<sup>1,7</sup>

There has been 1 case report of surgical implantation of a leadless pacemaker at the time of mitral and tricuspid valve surgery and another of repositioning of a leadless pacemaker device during cardiac surgery.<sup>8,9</sup> For patients with pacemaker-induced SVC syndrome, surgical implantation of a leadless pacemaker has several potential advantages. These include avoiding the potential for an inflammatory reaction in the iliofemoral veins or inferior vena cava and avoiding trauma to the newly reconstructed SVC from the stiff guidewire or sheath introducer.

Several unique features of surgical implantation warrant discussion. During transvenous implantation of the Micra device, fixation is judged with cine fluoroscopy to ensure that at least 2 of the 4 tissue fixation tines move with gentle traction. In our case it was determined by consensus that fluoroscopic confirmation of device stability was not necessary, as visual inspection of the device revealed that all 4 of the tissue engagement tines were engaged in the right ventricular septum. Additionally, impedance and pacing threshold measurements may be suboptimal at the time of initial implantation and improve with closure of the heart and weaning from cardiopulmonary bypass. This is a phenomenon that we have observed with epicardial leads, as well.

Direct implantation of a leadless pacemaker is a viable alternative to epicardial pacemaker leads for patients with pacemaker-induced SVC syndrome. This approach may be especially attractive for patients with permanent atrial fibrillation or low predicted pacing burden, who do not require dual-chamber pacing.

## Appendix

### Supplementary data

Supplementary data associated with this article can be found in the online version at <https://doi.org/10.1016/j.hrcr.2019.08.005>.

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