

# Lead management in setting of limited venous accesses: A case report and review of literature



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## Introduction

Given increasing patient longevity and technological advances, including a greater availability of devices such as those used for cardiac resynchronization therapies, the number of patients needing device upgrades has been steadily rising. However, venous occlusion encountered at the time of new lead placement can impede lead access to the myocardium.<sup>1</sup> Various techniques have been developed to overcome this problem, including full epicardial system, thoracoscopic or video-assisted implantation of leads, serial dilation, tunneled access, venoplasty, venous access proximal to the site of venous occlusion, and lead extraction.<sup>2</sup> Tunneling of the leads during a system upgrade or replacement of a nonfunctioning lead is a valuable technique that is less commonly used in this setting. Lead tunneling commonly involves passing a lead or catheter from one location to a location that is separated from it by tissue. Here, we describe a complex case of insertion of new right atrial and right ventricular (RV) defibrillation leads via the right internal jugular vein in a patient with complete heart block and bilateral subclavian vein occlusion. The complex decision-making associated with managing patients in need of a device but with poor venous accesses is discussed.

## Case report

An 80-year-old man with severe nonischemic cardiomyopathy and a complicated device history presented with *Staphylococcus epidermidis* endocarditis necessitating cardiac implantable electronic device system extraction. Twelve years earlier, he had had a dual-chamber pacemaker placed

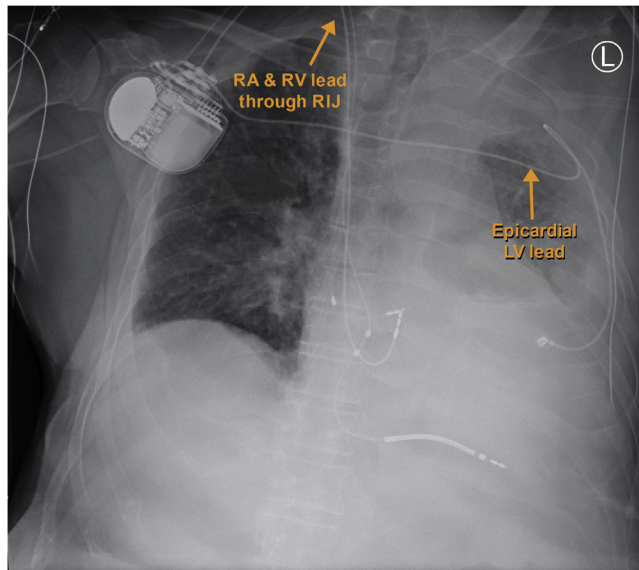
## KEY TEACHING POINTS

- Lead tunneling is a viable option during device upgrade for patients with limited venous access. It commonly involves passing a lead from one location to another with tissue in between. It can be done ipsilaterally if another vein on the same side is used or contralaterally if an opposite vein is utilized.
- Lead tunneling should be considered in patients who are unable to tolerate more invasive options such as lead extraction and venoplasty.
- Various lead tunneling techniques are described in the literature, and their outcomes are discussed in this case report.

with a subsequent atrioventricular junction ablation. Two years later, it was upgraded to a biventricular implantable cardioverter-defibrillator (BiV ICD) system secondary to RV pacing-induced cardiomyopathy. The RV pacing lead was removed at that time. Six years later, he was noted to have a right atrial lead fracture. The left subclavian vein was occluded, so a right atrial lead was placed from the right subclavian vein and subsequently tunneled across to the left side. Eight years later, the patient's BiV ICD was moved to the right side and his left lead system was capped elsewhere. An endocardial coronary sinus lead could not be placed at that time, so an epicardial lead was placed and tunneled from left to right. The patient later presented to an outside hospital with fever and shortness of breath with blood cultures positive for *Staphylococcus epidermidis*. A transesophageal echocardiogram revealed multiple vegetations on the intracardiac device leads. He underwent laser-assisted transvenous extraction of the 6 permanent pacemaker and defibrillator leads that had been placed over the previous several years, initially for a pacemaker and later for the upgrade of the pacing system. During extraction of the atrial

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**Figure 1** Chest radiograph showing right atrial (RA) and right ventricular (RV) leads inserted via right internal jugular vein (RIJ) and tunneled over the clavicle to the infraclavicular device pocket. Previously placed epicardial left ventricular (LV) lead connected to the biventricular implantable cardioverter-defibrillator generator.

lead with the laser sheath, the lead snapped off at the tip and an atrial lead remnant was left embedded in the atrial appendage. The left-sided device and the lead system were extracted. The right device pocket showed no signs of infection. Given the underlying complete heart block, the epicardial left ventricular (LV) pacing lead that was implanted in 2018 was connected to a single-chamber generator and placed in the right-sided device pocket. The patient was discharged to a long-term care facility with a wearable cardioverter-defibrillator because of a severely reduced LV ejection fraction (20%–25%).

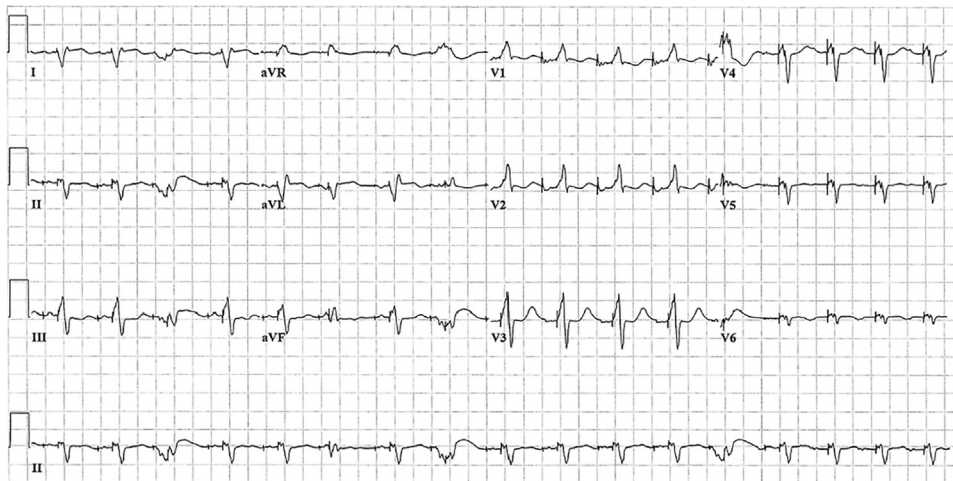
He presented 2 months later with worsening heart failure secondary to AV dissociation with VVI pacing and multiple false alarms from the wearable cardioverter-defibrillator for ventricular tachycardia, misdiagnosed owing to electronic noise and oversensing of unipolar LV pacemaker lead signals. The patient was considered for implantation of a cardioverter-defibrillator with a biventricular pacing system from the right side after complete resolution of bacteremia and recovery from endocarditis.

At the time of implantation, the right upper-extremity venogram revealed occlusion of the right subclavian venous system with previously known left subclavian vein occlusion. Given advanced age and deconditioning from recent prolonged hospitalizations for endocarditis and congestive heart failure, and after discussion among the clinical team members and the patient, it was determined that the patient was not a surgical candidate for an epicardial ICD system via full thoracotomy or minithoracotomy. Given bilateral subclavian vein obstruction and a patent right internal jugular

vein, we proceeded with the placement of the right atrial and RV defibrillator leads via the right internal jugular vein, with tunneling of the leads to the pre-existing right infraclavicular generator device pocket.

Vascular ultrasound was used to visualize and access the right internal jugular vein, and 2 venous accesses were obtained. An RV pacing defibrillator lead was placed into the RV apical septum, and a right atrial lead was placed in the right atrial appendage. Appropriate pacing, impedance, and sensing were confirmed on both leads. The lead collars were secured in the pre-muscular fascia by nonabsorbable sutures in the right internal jugular vascular access site. Attention was then paid to the pre-existing infraclavicular horizontal scar from the previous pacemaker implantation in the right infraclavicular area. An incision was made over the pre-existing scar site, and the single-chamber pacemaker was exposed. A limited blunt dissection between the fascia and subcutaneous tissue was performed to delineate the appropriate tunneling plane. A Boston Scientific tunneling tool (Natick, MA) was advanced cranially from the pre-existing permanent pacemaker pocket site toward the pre-existing incision, which had been made close to the access site at the right internal jugular vein. Care was taken to ensure the tunneling tool remained above the clavicle to avoid injuring the brachial plexus or causing a pneumothorax. Once the tunneling tool was visualized in the neck area pocket site, the dilator inside the peel-away was retracted. A peel-away sheath remained in place, and the atrial lead was threaded over it into the pre-existing pacemaker site. The same technique was attempted for the RV defibrillator lead; however, this tunneling tool could not be used because of the larger diameter of the defibrillator lead. A conventional tunneling tool was then advanced from the right pectoral pacemaker site to the right neck area at the venous access site. The IS-4 connector of the RV defibrillator lead was secured with a nonabsorbable suture and then was pulled back into the pectoral pacemaker pocket.

A new BiV ICD generator was connected to the right atrial and RV leads. The pre-existing LV epicardial lead was connected to the LV port of this BiV ICD ([Figure 1](#), [Supplemental Video 1](#)). During the case, the original pacemaker was kept inside the pacemaker pocket to ensure backup pacing, as the LV epicardial pacing lead was unipolar. The neck incision was closed with 2 layers of nonabsorbable sutures. The ICD pocket was closed in 3 layers by nonabsorbable sutures. During the case, after achieving AV and VV synchrony, the patient's hemodynamics and blood pressure improved from a baseline of 88/60 mm Hg to 120/80 mm Hg. The electrocardiogram showed biventricular paced rhythm ([Figure 2](#)). The patient was taken off the milrinone drip post-procedure, which had been started at index hospitalization for congestive heart failure exacerbation. He made a complete, uneventful recovery and was discharged home in stable condition, and has done well.



**Figure 2** Electrocardiogram showing biventricular paced rhythm.

## Discussion

Management of patients with limited venous accesses at the time of device upgrade or, as in this case, after lead extraction for endocarditis must involve a heart team approach including surgeons and electrophysiologists in order to minimize the number of interventions and ensure the best available options are chosen. Different options are available, and each must be tailored accordingly based on patient comorbidities, local surgical expertise, and clinical situation.

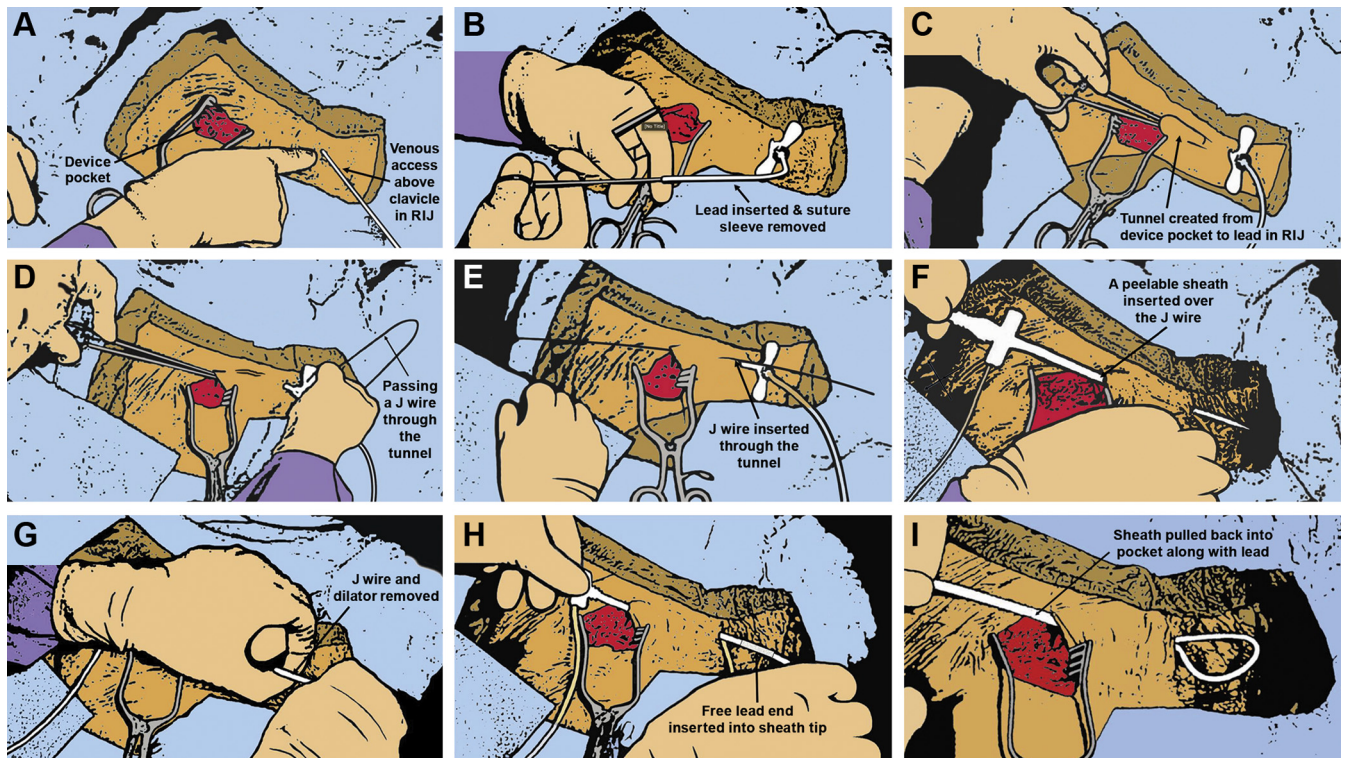
Our case describes lead tunneling as one of the options available to treat these patients. Lead tunneling is performed when ipsilateral venous access is occluded and either contralateral venous access is obtained for lead placement or different venous access is utilized on the ipsilateral side.<sup>3,4</sup> It may also be considered when the device generator needs to be moved from the original location (eg, during malignancy treatment if the device is situated in the path of planned radiation beam therapy) and leads are followed to the new location. Tunneling of leads is also utilized in cases of epicardial pacemaker or defibrillator leads that need to be channeled from the epicardial site to the pectoral pocket. Numerous tunneling techniques are described in the literature.<sup>5</sup> These include the use of commercial tunneling tools (eg, a central line kit that is shaped like a knitting needle). The simplest technique is to use a Kelly clamp to dissect the subcutaneous tissue from receiving to satellite wound. A temporary cap can be secured on the lead tip, and then the cap is grabbed instead of a connector pin to bring the lead into the pocket to avoid damage to the connector pins. As we were familiar with using a tunneling tool during subcutaneous ICD implantation, we utilized the tunneling tool for tunneling the lead over the clavicle.

Other approaches in patients with limited vascular access are discussed in the literature. In a study by Kowalski and colleagues<sup>6</sup> that looked at 8 patients with limited vascular access, a subcutaneous array was tunneled posteriorly in all patients and an epicardial rate-sensing lead was implanted

by left lateral minithoracotomy in 3 patients. All patients were successfully defibrillated. Other methods include surgical placement of the ICD lead or defibrillation coils directly on the pericardium with separate ventricular pacing leads or placing the transvenous lead directly through the atrium via sternotomy.<sup>7</sup>

In a study by Bhakta and colleagues<sup>8</sup> that looked at 6 patients with compromised venous and RV access, 5 patients had an epicardial ICD lead with the distal lead tip fixed to the anterior epicardium of the RV outflow tract that formed a sling by looping the lead under and around the ventricles. All patients had traditional placement of epicardial sensing/pacing leads. No postprocedure complications were noted, and the defibrillation threshold was achieved. Video-assisted thoracoscopic surgery was used in 2 patients, and open median sternotomy was used in 4 patients.

The right internal jugular vein is considered a safe approach for lead placement in situations in which bilateral subclavian venous accesses are occluded.<sup>9</sup> It offers direct access to the right-sided chambers. It is essential to have adequate subcutaneous tissue over the clavicle to avoid lead erosion through the tissue. The lead is usually tunneled over the clavicle rather than under to prevent injury to the brachial plexus or other vascular complications. The placement of a coronary sinus lead via the right internal jugular vein has been described. Pires and colleagues<sup>10</sup> described placing a coronary sinus lead via the right internal jugular vein in 10 patients referred for placement of biventricular devices. In that study, a coronary sinus lead was tunneled subcutaneously over the clavicle using a blunt instrument. Shaped like a long needle holder, the instrument is directed upward from within the pectoral pocket toward the wound in the neck. The lead's end is gently grabbed and pulled down into the pocket and, along with other leads, attached to the device. The leads are secured at the venipuncture entry point in the neck and in the pocket using sutures.



**Figure 3** A step-wise approach to placing the lead through the right internal jugular vein (RIJ). **A:** Device pocket in the infraclavicular area and venous access obtained through RIJ. **B:** Lead placed, and suture sleeve removed. **C:** Using Kelly forceps, tunnel created from the device pocket to location close to internal jugular access going above the clavicle. **D:** Passing a J wire through the tunnel with the tip grabbed by Kelly forceps. **E:** A 0.018 J wire inserted through the tunnel. **F:** Peel-away sheath inserted over the J wire. **G:** The wire and dilator are removed. **H:** The free end of the lead inserted at the sheath tip. **I:** Sheath pulled into the device pocket through the tunnel along with the lead. Image adapted with permission from a video from Katz MG and Huang DT. Internal Jugular Venous Access and Lead Implantation for Cardiac Implantable Electronic Devices. How-to Manual for Pacemaker and ICD Devices: Procedures and Programming. Ed. Amin Al-Ahmad et al. Wiley Blackwell, 2018. 23-26.

A stepwise approach to lead tunneling from the internal jugular vein to the right-sided device pocket is illustrated in Figure 3.

Long-term patient outcomes with contralateral lead placement with presteral tunneling were studied in 1 retrospective study.<sup>11</sup> Eighteen patients were identified over 15 years, and electrical parameters were stable in 95% of the patients. In 1 patient, ventricular oversensing that required replacement was noted 10 months after lead tunneling. Discomfort related to a tunneled lead was reported in 1 patient.

## Conclusion

Lead placement via the internal jugular vein in cases of bilateral subclavian vein occlusion is a viable option. Although long-term data regarding tunneled leads are limited, we suggest consideration of this option in patients who are poor candidates for more invasive surgical options.

## Appendix

### Supplementary data

Supplementary data associated with this article can be found in the online version at <https://doi.org/10.1016/j.hrcr.2021.04.014>.

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