Transvenous lead extraction in a patient with persistent left superior vena cava

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Introduction

Transvenous lead extraction is the gold standard for lead removal. Within recent years the number of lead removal procedures has constantly increased secondary to the increasing use of cardiac implantable electronic devices (pacemakers and implantable cardioverter-defibrillators).[1–3] With increasing prevalence, extraction techniques have greatly evolved but have also become increasingly challenging in a progressively elderly patient population with increasingly complex device systems. The chief indication for lead removal remains device infection, a class I indication for complete system extraction.[2] Different lead extraction approaches exist. The standard approach is a stepwise procedure, beginning with simple traction from the venous entry site, followed by the use of nonpowered traction tools, so-called locking stylets and mechanical dilator sheaths (polypropylene or polytetrafluoroethylene) to dissect lead-to-vessel, lead-to-endocardial, and lead-to-lead adhesions. A common third step is the use of powered extraction sheaths that apply some form of energy to forcefully disrupt the aforementioned adhesions. These tools encompass laser sheaths (pulsed ultraviolet laser), electrosurgical sheaths (radiofrequency), and, as the newest alternative, "hand-powered" rotating threaded tip sheaths with rotating sharp blades at the tip of the sheath.[2] The majority of leads can be extracted successfully through the initial venous entry site. In some cases, however, usually after long dwell times, crossover to the right internal jugular vein (Pisa approach) or, more commonly, the femoral vein allows for a better traction angle. Thus, detailed anatomical knowledge, including the awareness of thoracic venous anomalies, is vital for procedural success. We present the rare but classic case of successful mechanical transvenous lead removal in a patient with persistent left superior vena cava. Our objective is to create

KEY TEACHING POINTS

- Overall mortality of patients with device infection is high. Therefore, prompt referral of this patient population to specialized centers with well-trained teams and a certain caseload of extractions is essential.
- Thoracic venous anomalies, like the rare type II persistent left superior vena cava, may not only make conventional de novo implantation of pacing and defibrillator leads challenging, but also hamper nonsurgical transvenous lead extraction from the venous entry or alternative venous access sites.
- Different lead extraction approaches exist. The standard approach is a stepwise procedure, beginning with simple traction from the venous entry site, followed by the use of nonpowered traction tools, so-called mechanical dilator sheaths (polypropylene or polytetrafluoroethylene) to dissect lead-to-vessel, lead-to-lead, and lead-to-endocardial adhesions. A common third step is the use of powered extraction sheaths that apply a form of energy (mechanical or laser) to forcefully disrupt lead-to-vessel, lead-to-lead, or lead-to-endocardial adhesions.

KEYWORDS Cardiac implantable electronic devices; Endocarditis; Persistent left superior vena cava; Transvenous lead extraction; Thoracic venous anomaly

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awareness of thoracic venous anomalies and their implications for transvenous lead removal, a procedure of increasing relevance in modern cardiology.

Case report

A 70-year-old man with dilated cardiomyopathy (left ventricular ejection fraction 29%, sinus rhythm 62 beats per minute) and cardiac resynchronization therapy defibrillator device implanted 11 years ago (right atrial lead: St. Jude Medical Tendril™ SDX 1688Tl; right ventricular lead: St. Jude Medical Riata™ 1582; bipolar coronary sinus lead: QuickSite™ 1056T) via a persistent left superior vena cava (PLSVC) (Figure 1A) was referred to our center for complete device and lead removal because of lead endocarditis with a 16 × 10 mm mobile vegetation attached to one of the leads traversing in the right atrium, and *Staphylococcus capitis*–positive blood cultures, complicated with a lumbar spondylodiscitis and a psoas abscess (Figure 1B). Chest radiography also revealed conductor externalization of the implanted 8F single-coil Riata defibrillator lead (Figure 1A'), a well-known problem of this type of defibrillator lead. The right transjugular (Pisa) approach was initially considered for the presumably difficult extraction of the long-standing and externalized Riata lead in the presence of a PLSVC. Phlebography performed via the right internal jugular venous access showed a type II PLSVC anomaly with complete absence of a right superior vena cava (Figure 1C), thus leaving no reasonable superior alternative to the standard approach from the venous entry site. The procedure was carried out under invasive blood pressure monitoring and conscious sedation. The cardiac resynchronization therapy device pocket was opened, showing signs of chronic pocket infection. After disconnection of the generator, the leads were mobilized up to the venous entry site. The active-fixation mechanism was released and locking stylets were inserted in all 3 leads. The right atrial active-fixation lead was extracted effortlessly using an EZ locking stylet (Spectranetics, Colorado Springs, CO), inserted all the way to the tip of the lead, and a single Byrd telescoping polypropylene dilator sheath (Cook Medical LLC, Bloomington, IN). Mobilization of the left ventricular lead, in which an EZ locking stylet could be advanced almost completely (0.5 cm proximal of the tip), was more difficult owing to strong lead-to-vessel interaction, which was stepwise dissected using several Byrd telescoping polypropylene dilator sheaths. Similarly, the right ventricular Riata defibrillator lead showed extensive lead-to-vessel interaction. A Spectranetics 2 locking stylet (Spectranetics,

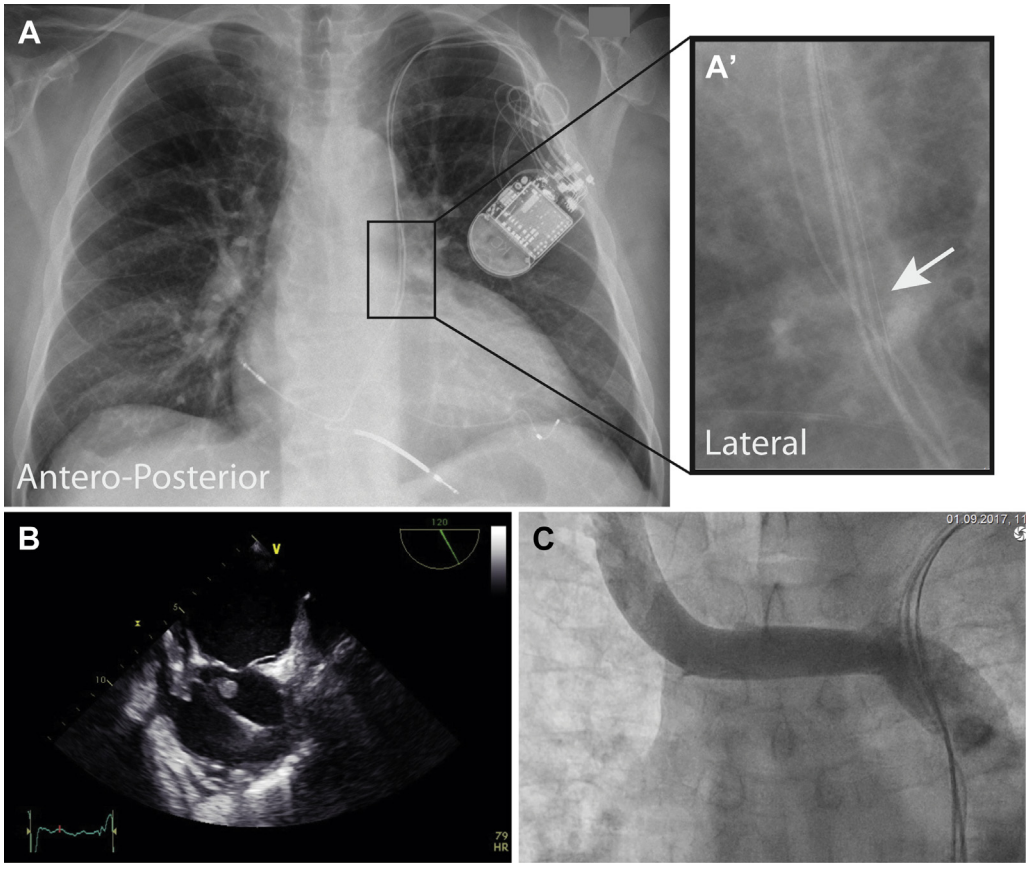

Figure 1 Transvenous lead extraction in a patient with type II persistent left superior vena cava (PLSVC). **A:** Chest radiograph showing the cardiac resynchronization therapy defibrillator device, implanted through the PLSVC. Inset (A'): Lateral chest radiograph excerpt with externalization of the Riata lead (*arrow*). **B:** Transesophageal echocardiogram with a large mobile vegetation 10 × 16 mm on a lead traversing the right atrium. **C:** Phlebography from the right jugular vein, depicting the absence of a right superior vena cava (type II PLSVC).

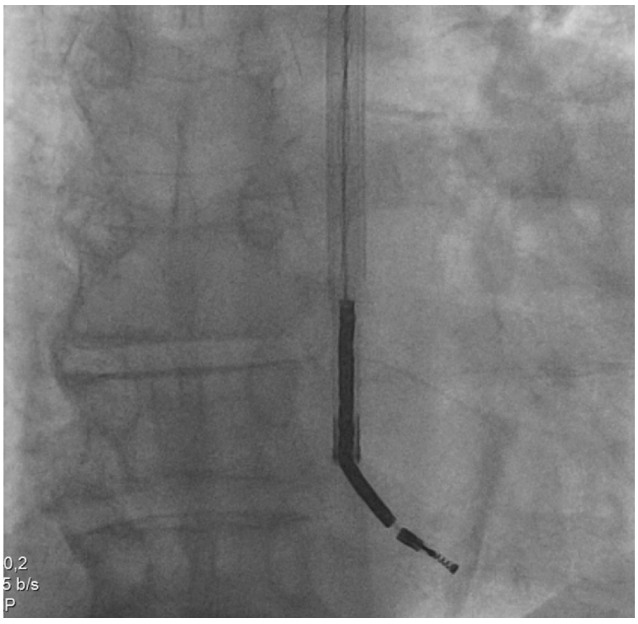

Figure 2 Radiography showing the 13F mechanical dilator sheath during transvenous extraction of the defibrillator lead.

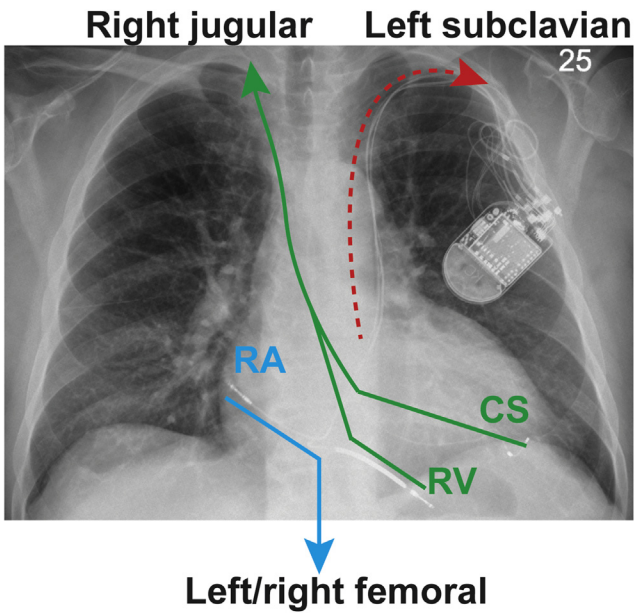

Figure 3 Possible venous access sites for endovascular lead removal; arrows indicating the additional optimal traction force lines for coronary sinus (CS) and right ventricular (RV) removal (*green*) and right atrial (RA) removal (*blue*), in case the initial implantation site access (*dotted red line*) is not successful.

Colorado Springs, CO) was inserted all the way to the tip. During manual adherence dilatation and dissection of the lead using several Byrd telescoping polypropylene dilator sheaths, increasing externalization of the high-voltage conductors occurred, which finally necessitated the use a mechanical 13F Evolution® RL controlled-rotation dilator sheath (Cook Medical LLC, Bloomington, IN) for successful lead extraction (Figure 2 and Supplemental Video). After successful removal of all 3 leads, infected tissue was resected from the pocket, and, along with the lead tips, was sent for cultures. A gentamycin-impregnated collagen sponge and redon drain were left behind in the pocket before wound closure.

Thoracic venous anomalies, like the rare type II PLSVC in our case, may not only make conventional de novo implantation of pacing and defibrillator leads challenging, but also hamper nonsurgical transvenous lead extraction from the venous entry or alternative venous access sites.

Discussion

Although the risk of device implantation has decreased tremendously over time, significant risk remains associated with device extraction, a problem of increasing clinical relevance. Recent outcome data from the ELECTRa registry indicate that overall safety of nonsurgical, transvenous lead extraction is good, indicating an in-hospital major complication rate of 1.7% and a procedure-related mortality rate of 0.5%.[4] Though rare, complications of transvenous lead extraction are frequently catastrophic and require prompt surgical rescue. Operator experience is a major determinant of safety.[5] In rare cases, for example with thoracic venous anomalies, operator experience is of even more importance. In this case, leads were in situ for more than 10 years and strong lead-to-lead and lead-to-vessel interaction, as well as lead-to–myocardial tissue (valves, coronary sinus) interaction, were to be expected. Therefore, surgical and different percutaneous access should be carefully considered preoperatively and perioperatively. The different vascular access sites result in different traction angles and different traction force vectors for lead-tip removal. In case the extraction via the initial venous entry site does not result in successful lead removal, the right jugular approach is often the preferred access site for removal of a coronary sinus or right ventricular lead, whereas a femoral approach could have been helpful for right atrial lead removal (Figure 3). Importantly, lead implantation via a PLSVC does not rule out the presence of a residual right superior vena cava, which is the most common form of PLSVC. Therefore, a combination of several vascular access sites, potentially with the use of snaring tools, had to be considered during optimal preparation of the case.

In summary, overall mortality of patients with device infection, even after complete device removal and adjuvant antibiotic therapy, ranges as high as 18% at 1 year and 28% at 3 years.[6] Thus, prompt referral of this patient population to specialized centers with well-trained teams is essential.[2,5]

Appendix

Supplementary data

Supplementary data associated with this article can be found in the online version at https://doi.org/10.1016/j.hrcr.2020.11.025.

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