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DEVICES

Hybrid transvenous and surgical approach for the extraction of coronary sinus leads: A case series

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Abstract

Background: Transvenous lead extraction is the standard therapy for cardiac device-related infection. In some patients, however, a hybrid surgical and transvenous approach may be necessary.

Methods and Results: We present three cases who underwent transvenous lead extraction for an infected CRT-D system. In all cases the CS lead could not be retrieved transvenously due to extensive fibrosis. The lead was successfully extracted through left minithoracotomy in two patients and midline sternotomy in one patient.

Conclusion: In cases where the coronary sinus lead shows severe fibrosis, a transvenous approach can be used to free the proximal part of the lead, while the distal adhesions can be removed surgically through a limited thoracic incision.

KEYWORDS
cardiac implantable electronic devices, cardiac resynchronization therapy defibrillator, coronary sinus lead, hybrid lead extraction, surgical lead extraction

1 | INTRODUCTION

Over the years, the rates of infection of cardiac implantable electronic devices have increased substantially with the increase in the number of implanted devices, particularly for patients undergoing generator replacement, lead revision or device upgrade.[1] Along with intensive antibiotic therapy, complete system removal with transvenous lead extraction is considered the first-line therapy for these cases.[2] With the ongoing evolution of transvenous extraction tools and expertise over the past years, the success rate of this procedure in referral centers has exceeded 96%, with a major complication rate of approximately 2%.[3]

In some cases, however, lead extraction through the transvenous route is met with extreme difficulty and undue manipulations may pose a threat to the patient's life. In such cases, a surgical approach, preferably with a limited thoracic incision, can provide the solution.

We describe three cases who presented with cardiac resynchronization therapy-defibrillator (CRT-D) device-related infection, who underwent surgical extraction of the coronary sinus lead after unsuccessful transvenous extraction. We highlight the characteristics of the patients, the features of the devices, the technical difficulties, and the outcomes of the procedures.

CRT-D, cardiac resynchronization therapy-defibrillator; CS, coronary sinus; LBBB, left bundle branch block; LLD, lead locking device; SVC, superior vena cava.

2 | CASE 1

The first case is a 64-year-old male with a history of an acute anterior myocardial infarction complicated by left ventricular apical thrombus in 2001, hypertension, type 2 diabetes mellitus, and dyslipidemia. He underwent coronary artery bypass grafting with left ventricular reconstruction in 2011. A CRT-D (VIVA XT, Medtronic Inc, Minneapolis, MN, USA) was implanted in 2011 for primary prevention and symptomatic heart failure with left bundle branch block (LBBB), followed by a generator replacement in 2015. In March 2019, the patient presented with fever. Transoesophageal echocardiography revealed vegetations attached to the right ventricular lead, so we decided to perform transvenous extraction of the system.

The procedure was performed under local anesthesia, with continuous invasive blood pressure monitoring from the left femoral artery. A backup temporary pacemaker lead was inserted to the right ventricle through the left femoral vein, and a long wire (145 cm) was inserted in the right femoral vein and advanced to the superior vena cava (SVC) to provide access to a Bridge occlusion balloon (Spectranetics Corporation, Colorado Springs, CO, USA), if needed. Contrast venography (routinely performed before lead extraction in our center) showed subtotal occlusion of the left subclavian vein with marked collateral venous circulation. The right atrial (CapSure Z Novus, Model 5554 Medtronic Inc., Minneapolis, MN, USA) and the dual-coil right ventricular (Sprint Quattro, Model 6935 Medtronic Inc., Minneapolis, MN, USA) active-fixation leads were removed from the right atrial appendage and the right ventricular apex, respectively, by simple manual traction using a regular stylet. The active-fixation coronary sinus lead (Attain StarFix, Model 4195 Medtronic Inc., Minneapolis, MN, USA), positioned in the posterolateral vein, was cannulated with a Liberator stylet (Cook Medical, Bloomington, IN, USA), followed by the introduction of a 7 Fr mechanical polypropylene nonpowered sheath (Cook Medical, Bloomington, IN, USA) that failed to detach the lead from the surrounding adhesions. The procedure was terminated and the patient was referred to the cardiothoracic surgeon. Control venography confirmed the integrity of the SVC and the CS. Transthoracic echocardiography confirmed the absence of pericardial effusion.

Under general anesthesia. Minithoracotomy was performed in the left fourth intercostal space. Pericardial adhesions were removed, the vein was isolated and the distal 7 cm of the lead were freed from fibrosis, this was followed by lead retrieval through the surgical incision (Figure 1, Video S1). A new CRT-D device was implanted from the right subclavian route 1 month after the procedure, after complete resolution of the infection.

3 | CASE 2

The second case was a 60-year-old male. He had a CRT-D (Platinium 4LV SonR, Sorin/MicroPort CRM, Italy) implanted in 2012 for heart failure and LBBB. In 2015 he underwent extraction of the right ventricular lead and reimplantation of a new one due to lead fracture. His past medical history was relevant for ischemic heart disease, percutaneous coronary intervention with 4-stent implantation in 2012, and hypertension. He presented in June 2021 with pocket infection and device erosion through the skin. transthoracic echocardiography revealed a long vegetation attached to the atrial lead. Blood cultures were positive for methicillin-sensitive staphylococcus aureus.

Under local anesthesia, a temporary pacemaker, hemodynamic monitoring sheath and a long wire were positioned as described in the previous case. The right ventricular active-fixation single-coil lead (Vigilia 2CR, Sorin/MicroPort CRM, Italy) was extracted successfully utilizing a Liberator stylet, 10 and 11.5 Fr telescoping mechanical sheaths (Cook Medical, Bloomington, IN, USA), 11 Fr Tightrail rotational mechanical sheath (Spectranetics Corporation, Colorado Springs, CO, USA) and 16 Fr Excimer Glidelight Laser sheath (Spectranetics Corporation, Colorado Springs, CO, USA). For the atrial active-fixation lead (SonRtip PS55D, Sorin/MicroPort CRM, Italy), we used Cook's Liberator stylet, 8.5 and 10 Fr mechanical sheaths and 16 Fr Excimer Glidelight Laser sheath. The lead was successfully retrieved. We attempted to extract the coronary sinus lead (Celerity, Sorin/MicroPort CRM, Italy), positioned in the anterolateral vein, using a Liberator stylet, followed by 7, 8.5, and 10 Fr telescoping mechanical sheaths, a 9 Fr hand-powered Tightrail rotational sheath and a 16 Fr Glidelight Excimer Laser sheath. The lead was extensively fibrosed and could only be retrieved to the proximal part of the vein, approximately 2 cm from the body of the coronary sinus. Considering the high operative risk, the patient was referred for surgical extraction of the CS lead, after confirming hemodynamic stability.

Sternotomy and median longitudinal pericardiotomy were performed under general anesthesia. Proximal occlusion of the culprit vein by a tourniquet was done followed by distal incision, debridement of adhesions, lead mobilization, and subsequent retrieval. A mediastinal drain and a pleural drain were placed. A few days after the procedure, the patient showed signs of inflammation of the sternotomy sutures, followed later on by wound dehiscence and septic discharge with signs of mediastinitis on chest computed tomography. The patient underwent wound revision with mediastinal lavage and closure of the sternum using Robitschek technique, followed by prolonged antibiotic therapy. A new CRT-D device was implanted after the resolution of infection.

4 | CASE 3

The third case is a 74-year-old male who presented in June 2021 with an infected CRT-D system with vegetations on the right ventricular catheter and the tricuspid valve. blood cultures were positive for Streptococcus Mutans. The patient had implanted the CRT-D (Energen P142, Boston Scientific, Marlborough, MA, USA) in 2012 for dilated nonischemic cardiomyopathy with reduced ejection fraction (35%) and LBBB. He had a past medical history of hypertension and left pulmonary embolism in May 2021.

Under local anesthesia, a long wire was placed in the right femoral vein and a sheath for hemodynamic monitoring in the left femoral artery. Incision at the site of the pacemaker pocket was done. The

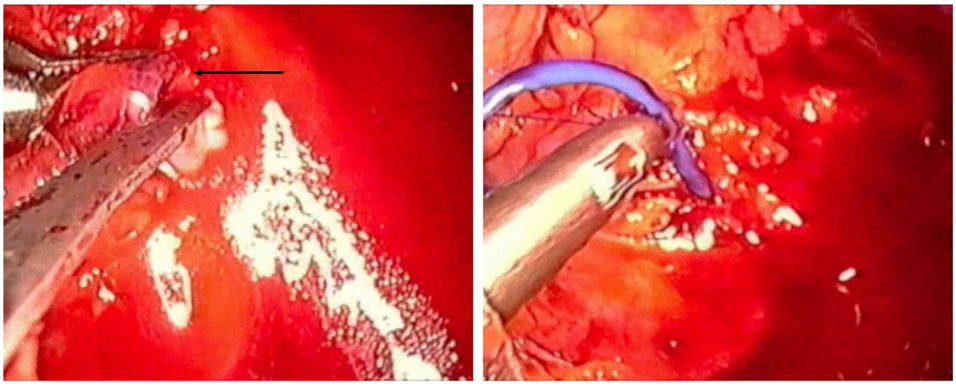

FIGURE 1 Video-assisted mini-thoracotomy during extraction of the CS lead in case 1. The coronary sinus lead is identified (left image, arrow), the branch is ligated, incised and the lead is extracted (right image) [Color figure can be viewed at wileyonlinelibrary.com]

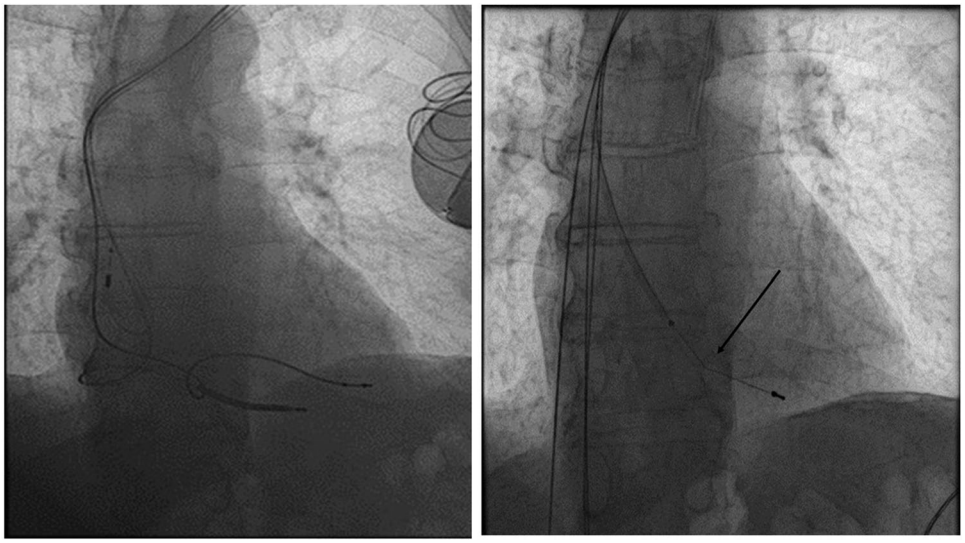

FIGURE 2 Fluoroscopic images of case 3. Left: the position of the leads before the extraction attempt. Right: after the extraction of the right atrial and right ventricular leads, the dilator sheath is seen advancing over the coronary sinus lead till the position depicted by the arrow. Note the increased distance between the lead tip and ring compared to baseline (left) denoting stretching of the lead and impending fragmentation

active-fixation single-coil right ventricular lead (Endotak Reliance 4-site SG 0292, Boston Scientific, Marlborough, MA, USA) positioned in the apical septum was retrieved using a Cook's Liberator stylet, a 10 Fr nonpowered mechanical sheath and a 16 Fr Glidelight Laser sheath. The active-fixation right atrial lead (Flextend 2 4096, Boston Scientific, Marlborough, MA, USA) was also extracted from the right atrial appendage using a Liberator stylet, an 8.5 Fr nonpowered mechanical sheath and a 9 Fr Tightrail rotational mechanical sheath. The CS bipolar lead (Easytrak 2 4542, Boston Scientific, Marlborough, MA, USA) was positioned in the posterolateral vein. First, an LLD-2 locking stylet (Spectranetics Corporation, Colorado Springs, CO, USA) was used, followed by the introduction of 7 and 8.5 Fr mechanical sheaths which ceased to advance 3 cm from the tip of the lead due to tenacious fibrosis (Figure 2). The procedure was terminated due to the risk of coronary sinus tear, and the patient was referred to cardiothoracic surgery.

Left minithoracotomy was performed, the target vein was identified and ligated, the lead was detached from adhesions and retrieved. Antibiotic therapy was continued for approximately 1 month, followed by implantation of a new system after resolution of the infection.

5 | DISCUSSION

We report three cases who underwent successful transvenous extraction of atrial and ventricular CRT-D leads while surgical extraction was needed for the CS lead. All patients had device-related infective endocarditis. In one case the CS lead was extracted though midline

sternotomy while the other two cases underwent left minithoracotomy in order to retrieve the lead. In all cases, the initial attempt at transvenous extraction freed the lead from adhesions up to the coronary sinus body. The surgeon then completed the procedure by dissecting the distal adhesions near the tip of the lead, followed by its retrieval without the need to do a myocardial incision.

The decision to refer these patients to surgery was dictated by the presence of very dense fibrosis in a large portion of the distal CS lead. Given the high risk of vascular tear when trying to advance powered sheaths into the coronary sinus, and the high likelihood that femoral tools would not be successful in the presence of severe fibrosis, the surgical option appeared to be safer and more efficient.

The extraction of coronary sinus leads is reported to be both safe and effective using the standard transvenous methods[4–8] with high success rates, reaching 100% in some case series.[9] Compared to right atrial and right ventricular leads, extraction of CS leads had comparable success and complication rates.[7] Manual traction alone was reported to be sufficient to extract the majority of CS leads that have been implanted up to 4 years.[10,11]

On the other hand, the extraction of active fixation coronary sinus leads, specially the Attain Starfix 4195 lead (Medtronic), is technically more challenging compared to passive leads.[12,13] In a series of 12 extractions, all leads required the use of specialized extraction tools and one lead required surgical removal after failure of transvenous extraction.[14] There were reports of lead fracture,[4,13] cardiac tamponade,[15] tears in the distal coronary sinus, and the obtuse marginal artery[16] as well as the need for modified extraction tools[17] during the extraction of this lead.

Several techniques for surgical lead extraction have been described. In addition to midline sternotomy, a transatrial approach can be used to retrieve leads that have perforated the right atrium, while a subxiphoid approach is useful to extract perforating right ventricular leads as well as epicardial leads. For coronary sinus leads, a left minithoracotomy or thoracoscopy are the techniques of choice. The rarely used ministernotomy can be used to access lead fragments in the innominate veins.[18]

Our case series highlights the use of a surgical approach only to dissect the fibrosis from the distal part of the CS lead, which had already been freed from adhesions through the transvenous approach. This allows the surgical procedure to be less invasive through a minithoracotomy. The use of a hybrid transvenous and surgical lead extraction approach has been previously described by several authors, though different techniques were applied. We previously reported the utilization of a hybrid approach to extract an Attain Starfix lead, where the lead failed to be extracted by the transvenous routes through a superior approach as well as a femoral approach using an ablation catheter and a bioptome, due to fibrotic occlusion of a long segment of the coronary sinus. The procedure was then completed by thoracoscopy which was used to identify and dissect the adhesions, which were more evident at the tip of the lead.[19] Blasi et al. reported the surgical extraction of a Starfix lead in a patient with device-related infective endocarditis, after the transvenous approach failed. The procedure was performed on-pump through a midline sternotomy and with the aid of a tissue stabilizer.[20]

A hybrid approach could be planned beforehand in cases where a difficult procedure is anticipated. Ramirez et al. described a case where a combined transvenous and surgical approach was used to extract three transvenous leads entrapped by a superior vena cava stent, in addition to an epicardial lead.[21] A hybrid approach was also described in a case series of patients undergoing transvenous lead extraction and valve replacement surgery due to infective endocarditis. In this study, however, all leads were removed through the transvenous route.[22] A hybrid approach can also be useful in cases where transvenous lead extraction and the implantation of epicardial pacing leads is needed, as well as cases where extraction of leads implanted from and unusual access (e.g., the jugular vein) is required.[23]

6 | CONCLUSION

A hybrid surgical and transvenous approach can be a necessity to extract leads that cannot be retrieved by the transvenous route alone. Both approaches can be considered complementary, where the transvenous one can be used to free the proximal part of the lead, making it easier for the surgeon to remove the distal adhesions through a limited thoracic incision, thus completing the procedure.

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AUTHOR CONTRIBUTIONS

Antonio Curnis formulated the idea of the case series, was the primary operator during transvenous lead extraction, made the outlines and revised the whole manuscript. Gianmarco Arabia, Luca Bontempi, Manuel Cerini, Francesca Salghetti, Gianfranco Mitacchione, Antonino Milidoni, and Ashraf Ahmed were assistant operators in transvenous lead extraction. Claudio Muneretto was the primary operator in the surgical extraction of the coronary sinus lead. Ashraf Ahmed, Antonino Milidoni, and Gianmarco Arabia performed data collection and analysis. Ashraf Ahmed wrote the abstract, introduction, methods, results, and conclusions.

CONFLICTS OF INTEREST

All authors declare no conflicts of interest.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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