Percutaneous extraction of stented device leads

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BACKGROUND There are limited published data regarding the percutaneous extraction of device leads jailed by a venous stent.

OBJECTIVE In this study we assessed the feasibility and safety of percutaneous extraction of stented device leads.

METHODS We reviewed our experience percutaneously extracting 7 chronically implanted device leads jailed to the wall of the left innominate and/or subclavian veins by a previously placed stent.

RESULTS All leads were successfully extracted by using a percutaneous approach. Both pacing leads and defibrillator leads were extracted. The oldest pacing lead extracted was 14 years old. The oldest defibrillator lead extracted was 6 years old. Three of the leads were extracted with simple manual traction alone. The 4 remaining leads required a more complex, femoral extraction approach for successful removal.

CONCLUSION In our experience extracting 7 stented device leads, complete percutaneous removal was feasible 100% of the time using a combination of simple manual traction and a femoral approach. No major complications were associated with the extraction procedures.

KEYWORDS Lead extraction; Femoral extraction; Stented lead

ABBREVIATIONS CIED = cardiac implantable electronic device; MSSA = methicillin-sensitive Staphylococcal aureus; RA = right atrium; RV = right ventricular; SVC = superior vena cava

Introduction

Although the volume of device extraction cases continues to grow, there are very little published data regarding the percutaneous extraction of stented device leads. This is related, in part, to the fact that these types of cases are rarely encountered. However, with continued advances in percutaneous intervention, we are likely to face such scenarios more frequently in the future. The paucity of published literature is also related to a perception that stented leads must be extracted surgically. Thus, few operators have attempted percutaneous extraction on stented leads. We present our initial experience regarding the safety and feasibility of percutaneously extracting stented device leads.

Methods

All patients undergoing percutaneous extraction of stented leads at our institution were reviewed. Patients were included regardless of the indication for extraction. Over the past decade, an average of 290 patients and 520 leads were extracted annually in our electrophysiology laboratories. Two patients with a total of 7 stented leads have undergone percutaneous extraction at our institution.

For the purpose of this study, a stented lead was identified as a lead that was impinged or “jailed” to the wall of a vein by the deployment of a stent in a vessel already containing a lead(s). Extraction of leads coursing through the lumen of a stent (leads placed after the stent was deployed) were not counted. Two patients with stented leads were identified, and their histories are briefly described below.

Patient 1

An 86-year-old man with coronary artery disease status post coronary artery bypass surgery, ischemic cardiomyopathy, chronic obstructive pulmonary disease on home oxygen, complete heart block status post pacemaker placement, and end-stage renal disease on hemodialysis via a left upper extremity arteriovenous fistula was referred to our institution for the management of a cardiac implantable electronic device (CIED) infection with methicillin-sensitive Staphylococcal aureus.

The patient initially underwent placement of a left-sided dual-chamber pacemaker for complete heart block in 1997. In 2007, the patient underwent revision of his left-sided pacing system owing to lead malfunction. Two new leads were implanted via the left axillary vein (both right atrium [RA] and right ventricular [RV] leads model 5076; Medtronic, Inc, Minneapolis, MN). A concurrent attempt to manually retract the malfunctioned 4024 and 4524 leads failed, and they were cut, capped, and abandoned.

The patient subsequently developed severe left subclavian vein occlusion, resulting in compromised function of his left upper extremity arteriovenous fistula. In order to salvage the function of the fistula, the patient underwent
venoplasty and stenting (Wallstent, Boston Scientific Corp, Natick, MA) of the left subclavian vein in 2009 at an outside hospital. The 4 left-sided pacing leads were jailed by the stent, resulting in fracture and malfunction of the existing system. The left-sided generator was removed, and all 4 left-sided leads were abandoned. A new cardiac resynchronization pacemaker was implanted from the right axillary vein at that time (5076 leads in the RA and RV, 4196 lead in the coronary sinus, Medtronic, Inc, Minneapolis, MN). The patient’s chest film is presented in Figure 1.

In January 2011, the patient was diagnosed with device-related methicillin-sensitive Staphylococcal aureus bacteremia. He failed to respond to antibiotic therapy. He was turned down for open heart surgery to remove the leads.

A computed tomography scan from an outside facility was reviewed, demonstrating the 4 left-sided leads, jailed between the wall of the left axillary and subclavian veins and the stent. While the 5076 RA lead coursed a relatively straight path alongside the stent, the remaining 3 leads spiraled as they traversed the length of the stent (Figure 2).

He was referred to our institution and underwent successful percutaneous extraction in March 2011.

**Patient 2**

A 63-year-old woman with a history of nonischemic dilated cardiomyopathy underwent placement of a biventricular CIED in 2005 (4076 lead in the RA, 6949 lead in the RV, and 4194 lead in the CS; Medtronic, Inc). The patient did well until the fall of 2009 when she began complaining of facial and neck swelling associated with difficulty sleeping and headaches. Workup at that time with a computed tomography scan showed occlusion of the left innominate vein at the junction of the superior vena cava (SVC) extending into the left subclavian vein. The right internal jugular vein was previously occluded by thrombus. She was diagnosed with SVC syndrome. In November 2009, the patient underwent stenting of the left subclavian and innominate veins with two 10-mm SMART Nitinol stents (Cordis Corporation, Bridgewater, NJ). Her symptoms improved following stenting.

The patient did well until January 2011 when she developed swelling and tenderness at the left device pocket. She was diagnosed with a device-related pocket infection. There was no evidence of lead involvement by transesophageal echocardiogram or blood stream infection. In January 2011, the patient underwent CIED generator extraction and pocket revision at an outside hospital. A large amount of purulent fluid was drained from the prepectoral pocket, and cultures were found positive for coagulase-negative *Staphylococcus*. Lead extraction was not attempted. The leads were cut, and the generator was removed. The wound was left to heal by secondary intention. Unfortunately, despite continued antibiotic therapy, the patient continued to have signs and symptoms of infection of the left prepectoral pocket with poor wound healing. She was referred to our institution and

![Figure 1](image1.png)
**Figure 1** Posterioranterior and lateral chest x-ray radiographs demonstrating 4 abandoned pacemaker leads in the left prepectoral pocket jailed to the wall of the left subclavian vein by a stent. An active biventricular pacemaker with 3 leads is seen in the right prepectoral pocket.

![Figure 2](image2.png)
**Figure 2** Computed tomography scan of 4 left-sided leads jailed to the wall of the left axillary and subclavian veins with the leads spiraling around the stent.
underwent complete percutaneous lead removal in May 2011 (Figure 3).

**Extraction**

Both patients underwent lead extraction in the electrophysiology laboratory under general anesthesia. The typical approach used for extraction has been previously reported. Our approach was modified to help minimize damage or dislodgement of the stent and avoid venous laceration/perforation. Leads were mobilized, and the tie-down sleeves were removed. The helical screws on the leads were retracted, when possible, by counterclockwise rotation of the inner conductor coil. If necessary, straight stylets were advanced down the inner conductor coil to attempt to transmit torque to the helical screw. Not all helical screws could be retracted. An attempt was then made to retract the lead with manual traction alone (with and without the straight stylet in place). If unsuccessful, we proceeded to a femoral extraction approach.

A 16F right femoral workstation (Cook Medical, Inc, Bloomington, IN) was inserted. A snare was advanced through the sheath and was used to firmly grasp the lead. The type of snare used—Needle’s Eye (Cook Medical, Inc), deflecting tip wire (Cook Medical, Inc), or Amplatz Goose Neck (ev3 Inc, Plymouth, MN)—was dependent on the position of the lead. Once the lead was grasped, the 16F femoral workstation sheath was advanced to the lead body. With the lead firmly positioned at the tip of the femoral workstation outer sheath, the sheath was advanced over the lead. This allowed the lead to prolapse into the sheath lumen. The 16F sheath was then advanced up to the level of the SVC as continuous caudal tension was applied to the lead by pulling on the snare. This approach was used to free the lead tip from the RV or RA endocardium first. After the lead tip was freed, continued advancement of the outer sheath to the distal subclavian vein facilitated lysis of adhesions between the lead and the endovascular wall. In circumstances where the sheath would not easily advance over the lead up the SVC, manual rotation of the sheath was used to break up adhesions. The outer sheath was advanced to the distal margin of the stent, but no further. At this point, progressive, and sometimes prolonged, downward manual traction was applied to stretch and pull the lead past the stent. Once the proximal end of the lead was pulled past the stent, the lead was retracted into the femoral workstation sheath and removed.

Thus far we have not required the use of either a laser sheath (Spectranetics, Colorado Springs, CO) or an Evolution extraction device (Cook Medical, Inc) for the extraction of stented leads. These tools, however, may play a role in future cases. Had we not been successful in extracting the leads with a femoral approach described above, our next step would have been to free the leads of adhesions peripheral to stent. To accomplish this, a Bulldog (Cook Medical, Inc) lead extender would be used to secure the proximal (peripheral) margin of the left subclavian vein stent. Once adhesions had been lysed on both sides of the stent, manual traction from either the femoral or the axillary approach would have been used in an attempt to free the lead.

**Results**

All leads were successfully extracted in their entirety by using a percutaneous approach (Table 1). Both pacing leads and defibrillator leads were extracted. The oldest pacing lead extracted was 14 years old. The oldest defibrillator lead extracted was 6 years old. Three of the leads were extracted with simple manual traction alone. The 4 remaining leads were all successfully extracted by using a femoral approach for successful removal. No major complications were associated with the extraction procedures. In both patients there was no evidence of stent thrombus postextraction by either physical examination or venous ultrasound.

**Discussion**

We present our initial experience extracting 7 leads previously stented to the wall of the left innominate and subclavian veins. Of the 7 leads, 3 were extracted with simple manual traction alone. The remaining 4 leads were all successfully extracted by using a femoral approach. After each lead was successfully snared, the outer sheath of the femoral workstation was advanced over it by using traction and countertraction. This freed the lead of adhesions within the RA, SVC, and distal portion of the innominate vein. Once the sheath was advanced to the distal margin of the stent, downward manual traction was applied to the lead to even-

Figure 3  Cine image of leads in patient 2, demonstrating 3 leads jailed to the innominate vein by a stent (arrow) at the innominate/superior vena cava junction.
Venous stenosis following lead placement can occur because of thrombosis or fibrosis around the pacemaker leads. Acute or subacute venous thrombosis is an uncommon event. It typically presents with upper extremity swelling and is managed with a prolonged course (3–6 months or longer) of anticoagulation therapy. Venous stenosis due to fibrosis within the vein is encountered more frequently. It is thought to be a chronic and slowly progressive process that may be clinically silent if adequate concurrent collateralization occurs. Venous stenosis may not be clinically apparent until lead revision is required during a future procedure. Management tends to be conservative as patients are rarely clinically symptomatic owing to adequate collateralization. Symptoms of SVC syndrome developed in one of our patients owing to concurrent, unrelated, right internal jugular vein occlusion.

Lead-related stenosis in the subclavian and/or innominate vein ipsilateral to an upper extremity hemodialysis fistula is more likely to be clinically apparent owing to the higher flow rates in the extremity. In a study by Teruya et al., 14 patients were identified at their institution with hemodialysis access in an upper extremity ipsilateral to an indwelling CIED. Ten of these 14 patients (71%) developed significant upper extremity symptoms related to venous stenosis, including pain, neuropathy, and significant swelling. All 10 patients required ligation of their fistula to achieve symptom resolution. It was postulated that higher venous blood flow, due to an ipsilateral hemodialysis access, may accelerate the development of subclavian vein stenosis.

With advances in percutaneous intervention over the past decade, there has been significant interest in the ability to treat subclavian and innominate vein stenosis percutaneously in order to salvage an ipsilateral fistula. An initial focus on balloon angioplasty of the subclavian vein demonstrated safety and feasibility; however, the primary patency rates were suboptimal. As such, attention shifted to percutaneous intervention using steel or nitinol stents as a first approach.

Stenting subclavian and/or innominate vein stenosis has not consistently demonstrated improved primary, or assisted primary, patency rates compared with angioplasty alone. Multiple additional procedures are typically required to prevent restenosis regardless of the initial approach used, and neither strategy is thought to offer a long-term, durable fix.

Despite a paucity of supporting data, stents are occasionally used in clinical practice as the initial treatment approach to subclavian and/or innominate vein stenosis. Furthermore, in patients with an ipsilateral CIED, stents are frequently placed without prior removal of the device.

### Table 1 Characteristics of percutaneously extracted stented device leads

<table>
<thead>
<tr>
<th>Lead no.</th>
<th>Patient</th>
<th>Lead type</th>
<th>Implant date</th>
<th>Explant date</th>
<th>Fixation</th>
<th>Location</th>
<th>Approach</th>
<th>Stent (date)</th>
<th>Success</th>
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<tr>
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<td>1</td>
<td>Medtronic</td>
<td>1997</td>
<td>2011</td>
<td>Passive</td>
<td>RV</td>
<td>Femoral</td>
<td>Wall (2009)</td>
<td>Yes</td>
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<tr>
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<td>1</td>
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<td>2011</td>
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<td>RA</td>
<td>Superior</td>
<td>Wall (2009)</td>
<td>Yes</td>
</tr>
<tr>
<td>4</td>
<td>1</td>
<td>Medtronic</td>
<td>2007</td>
<td>2011</td>
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<td>RV</td>
<td>Femoral</td>
<td>Wall (2009)</td>
<td>Yes</td>
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<tr>
<td>5</td>
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<td>2005</td>
<td>2011</td>
<td>Active</td>
<td>RA</td>
<td>Femoral</td>
<td>Wall (2009)</td>
<td>Yes</td>
</tr>
<tr>
<td>6</td>
<td>2</td>
<td>Medtronic</td>
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<td>2011</td>
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<td>Nitinol</td>
<td>Yes</td>
</tr>
<tr>
<td>7</td>
<td>2</td>
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<td>2005</td>
<td>2011</td>
<td>Passive</td>
<td>LV</td>
<td>Superior</td>
<td>Nitinol</td>
<td>Yes</td>
</tr>
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</table>

LV = left ventricular; RA = right atrium; RV = right ventricular.
leads. A recent report by Saad et al described a successful stenting of 14 patients with symptomatic, lead-related, subclavian vein stenosis in the setting of an ipsilateral hemodialysis access. During these procedures, the device leads were jailed to the subclavian vein. Although short-term data reported no device-related malfunction, there were no long-term data presented regarding lead function or the feasibility of lead extraction, if required, in the future.

Both stent grafts and CIEDs are known to be associated with infection, and this risk can be significantly higher in patients on dialysis. The indication for extraction in both of our patients was a device-related pocket infection. In both cases, to successfully remove all device hardware, the proximal end of a lead(s) was pulled through the stent and into a femoral sheath. This has a theoretical risk of seeding the stent with an infectious material from the device pocket. To minimize this risk during the procedure, the proximal ends of the leads were trimmed as much as possible and the pocket was copiously irrigated with vancomycin solution prior to extraction. Both patients received a 6-week course of intravenous antibiotic therapy at the time of hospital discharge. After completion of intravenous antibiotic therapy, there was no evidence of stent-related infection in either patient; however, a latent infection remains a concern.

Stenting the lead to the wall of the vein creates a host of concerns, including infectious risks as well as feasibility and safety of future lead removal. The most recent Heart Rhythm Society expert consensus on transvenous lead extraction recommends lead removal prior to any planned stenting procedures owing to the risk of lead entrapment. The National Kidney Foundation’s current clinical practice guidelines advocate the use of stents only in specific situations such as when repeated angioplasty has failed, the patient is a poor surgical candidate for fistula revision or the site of stenosis is surgically inaccessible. The guidelines do not specifically address the issue of placing stents in the presence of device leads. The published literature regarding the safety and feasibility of extracting stented device leads is very limited. In our experience extracting 7 stented leads, complete removal was feasible 100% of the time by using a combination of simple manual traction and a femoral approach. Although percutaneous extraction appears to be feasible, the removal of device leads jailed to the wall of the subclavian vein by a stent significantly increased the complexity of the procedure. Furthermore, the femoral extraction approach required for complete device hardware removal likely exposed our patients to an increased risk of seeding their stents with infectious material from the pocket. Avoiding such scenarios by extracting device leads prior to a planned stenting procedure is highly desirable.

References