Introduction

The number of patients who require removal of intracardiac leads is increasing. This is not simply because the number of patients implanted with cardiovascular implantable electronic devices (CIEDs), such as pacemakers, implantable cardioverter defibrillators (ICDs), or cardiac resynchronization therapy devices (CRT, CRT-D), has increased dramatically, but because the incidence of complications associated with CIEDs has also increased. More sick patients with a variety of morbidities are now indicated for CIED implantations.

Complete removal of the entire CIED system is often required in the patients with complications related to the implanted device, and open-chest and open-heart removal has been the only approach for this purpose. This approach can be invasive for the severely compromised patients. More importantly, even with the open-heart approach, dissection of the leads from the veins is not so easy and occasionally requires systemic deep hypothermia with circulatory arrest to open the veins for the dissection and removal of the leads.

Recently, various tools and techniques have emerged for the transvenous removal of CIED leads. This manuscript describes the indications, techniques and tools for transvenous lead removal.

Indications for lead extractions

A lead extraction is defined as a lead removal procedure requiring more complex procedures than simple traction. The indications for lead extractions are categorized into infection, chronic pain, thrombosis or venous stenosis, functional leads, and nonfunctional leads. The indication in each category has been discussed determined on the basis of the evidence, and published as an Expert Consensus.

Infection is the major indication for CIED removal and the complete removal of the entire system is required for the elimination of the infection. The CIED infection can present with local signs of infection, such as pocket pain, an abscess, or skin erosion (Figure 1), and with critical systemic conditions, such as bacteremia, sepsis, intracardiac or intravenous vegetation, pulmonary emboli, and others. Conservative treatments, including antibiotics and debridement, are usually not effective in most situations. In the patients with an occult infection, which is defined as continuous positive cultures without any clinical evidence of an infection, a lead extraction is strongly recommended.

Many patients require a CIED re-implantation for bradycardia, ventricular tachyarrhythmias, or heart failure. The question then is raised as to when we can re-implant a new CIED safely in the patients who have undergone a removal of an infected device and the leads. Although there has been little data to provide a firm consensus, a relatively early (3 days later) transvenous re-implantation can be safely performed in the patients without any evidence of a systemic infection. In the patients who need an earlier re-implantation, an epicardial lead implantation or wearable defibrillator is considered.

Lead extraction in patients without any signs of infection or other complications is controversial. Since it is rare for a patient with a failed or no longer required lead to exhibit any symptoms or to be at risk of death, it is crucial to balance the risk of the lead extraction with the risk of leaving the lead implanted. In the patients with severe chronic pain related to the CIED and not manageable by other therapies, the lead extraction may be indicated.

In patients with symptoms related to a venous thrombosis or stenosis, or with restrictions for the application of the CIEDs or other therapies caused by a venous occlusion, a lead extraction is recommended. It is not recommended to place a stent in
the stenotic vein, because the lead will be clamped against the vein wall, making the future lead extraction difficult and dangerous.

There are several conditions of functional and non-functional leads recommended for extraction. The conditions include life-threatening arrhythmias associated with the implanted leads, leads with potential risk of fracture and following cardiovascular damage, interference with the normal detection of arrhythmias by the CIEDs, or restriction restrictions indicated for other therapies or examinations, such as radiation, surgery, and magnetic resonance imaging scanning. Lead removal is reasonable in the patients already with multiple leads and an implantation of a CIED will result in more than 4 leads on one side or more than 5 leads through the SVC.

Various techniques and tools for lead removal

Simple traction using standard stylets and fixation screw retraction clips may be effective in removing leads with shorter periods of implantation. Specialized traction devices, such as locking stylet, snares, sutures, grasping devices or other types are effective in engaging or entrapping the leads. The locking stylets are designed to hold onto the inside of the lead along its length and are effective in delivering the traction force to the entire length of the lead and preventing elongation of the lead body by the traction.

Various types of sheaths have been developed to dissect the adhesion between the lead and inside wall of the vein. Mechanical sheaths are made of metal, Teflon, polypropylene or other materials, and are used to disrupt the fibrotic attachments around the lead by the manual advancement of the sheath over the lead.

A laser sheath delivers a ring of ultraviolet light at a wavelength of 308 nm generated by an excimer laser system and vaporizes the scar tissue around the circumference of the lead to free the leads from the veins. The laser energy delivery is confined to 50 microns in depth to decrease the risk of penetration. The success rate of the lead extraction has been reported to be as high as 94% with a short extraction time of about 4 min.

Electrosurgical dissection sheaths use radiofrequency energy emitted between bipolar tungsten electrodes at the sheath tip to locally dissect the binding tissue that surrounds and anchors transvenous leads. A rotating threaded tip sheath has a threaded barrel at its distal tip and the ergonomic trigger handle drives sheath rotation and tip advancement to bore through and disrupt fibrotic attachments without any electrical energy supplied.3

A telescoping sheaths technique uses two sheaths to take advantage of the flexibility of the inner sheath, such as a laser or rotating threaded tip, and the stiffness of the outer sheath, usually mechanical, to prevent kinking and to improve the effectiveness of the advancement over the lead without over-stressing the lead.

Training and risk management

Because the lead removal is a procedure for complications of CIEDs, it is difficult to standardize the procedure. Every patient has a different indica-

Figure 1 Infected device and skin erosion
The patient presented with bacteremia and a skin erosion around the implanted CRTD. The blood culture was positive for Staphylococcus aureus and a vegetation was exhibited in the right atrium. The complete removal of the generator and intravenous leads was indicated.
tion for lead extraction. The preoperative evaluation is extremely important and the therapeutic strategy should be planned individually (Figure 2). Further, the procedure has a certain risk of cardiovascular injury and other additional complications, potentially leading to mortality. For these reasons, training and the risk management of the operators and team are crucial.

References