Practical Techniques to Manage Dysfunctional and Infected Leads: Lead Exchange Using a Retained Wire and Externalized Pacemakers with Active Fixation Leads

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ABSTRACT. As the number of patients implanted with heart rhythm devices has steadily increased over the years, a growing number of device-related infections, system malfunction, and other particular clinical scenarios which require extraction or removal of leads and generators are being seen. The difficulties with lead removal and reliable temporary stimulation of pacer-dependent patients demand the use of safe and effective techniques to manage these complex cases. This paper describes two simple and reliable methods to manage these patients: lead exchange using a retained wire and externalized pacemakers using an active fixation lead. Both methods are supported by case reports and series demonstrating their utility and effectiveness in clinical practice.

KEYWORDS. cardiac pacemakers, implanted electrodes, programmed cardiac stimulation.

Introduction

The number of patients undergoing implantation of heart rhythm devices (pacemakers and defibrillators) has seen an exponential growth in the last decade. Electrophysiologists today are being confronted with an increasing number of patients presenting with device malfunction (generator and/or leads) and pacing/defibrillator system infections during follow up. To successfully manage these cases, which are often complex in nature, techniques have been developed to safely and effectively perform lead removal (if the lead is <12 months old) or extraction (for leads older than a year) using an array of novel technologies and a multidisciplinary approach. Many of such patients requiring removal of their cardiac rhythm device are pacer dependent due to complete or advanced atrioventricular (AV) block and require temporary stimulation while awaiting correction of coagulopathy, treatment of systemic infections, or hemodynamic stabilization until a permanent pacing or defibrillator system can be safely implanted. This article describes two techniques which are simple, safe and useful in the management of some of these patients: Lead exchange using a retained wire and externalized pacemakers using an active fixation lead.

Lead exchange using a retained wire

Patients with documented pacemaker or implanted cardioverter-defibrillator (ICD) lead malfunction or infection and those with generator pocket infection traditionally have been considered candidates for device and lead extraction and/or removal. The 2009 Heart Rhythm Society (HRS) consensus on transvenous lead
management has expanded the indications for removal or extraction procedures to include patients with bacteremia of unclear source with non-contaminant microorganisms, non-functional abandoned leads, venous obstruction or occlusion, chronic pain unresponsive to conventional analgesia, requirements for chest radiation therapy and magnetic resonance imaging scanning among others. It is well known that multiple leads through the tricuspid valve can lead to valvular complications over time. Central venous access in patients with prior lead placement is often limited by the presence of stenosis or occlusion with collateralization of one or several vascular segments; therefore, as part of the removal or extraction procedure, a venogram is required to document vein patency and guide a new axillary or subclavian venipuncture to obtain access for the new lead to be placed. Venous access and venoplasty techniques using dilators and/or angioplasty balloons can have serious complications such as pneumothorax, hemothorax, chylothorax and vascular damage.

The retained wire technique described in this article is particularly useful for lead removal procedures, that is, leads which have been recently implanted (<12 months), as lead fibrosis to the adjacent tissue is minimal and intravascular manipulation of the lead is feasible. In contrast, older implanted pacing and ICD leads (>12 months) can have significant fibrosis at crucial attachment areas (shocking coils for ICD leads and distal electrode tip for pacing leads) which will limit their intravascular manipulation. For such cases, lead extraction is undertaken using advanced techniques and equipment, including locking stylets, cutting and laser sheaths, surgical backup, general anesthesia and echocardiographic monitoring among others.

Materials and technique
For lead exchange with a retained wire there are two similar techniques described in the literature. A stepwise approach is described.

Step 1: lead preparation
Once the device pocket is open, the sutures anchoring the lead sleeve to the fascia are cut. Using blunt dissection, the lead is also freed from adherences at the subclavian insertion site (Figure 1). Finally, the active fixation mechanism that attaches the lead to the endocardium is retracted under fluoroscopy. This allows for the lead tip to be pulled back to the superior vena cava or innominate vein (Figure 2a).

Step 2: insertion of guidewire into the electrode insulation
This next step is achieved by fixing the body of the lead with one hand while the other hand is used to puncture the lead insulation (Figure 3a). Breaking and lifting the lead insulation can be done with a micropuncture needle or a vein pick. The site of access should be a few centimeters behind the lead insertion site into the vasculature. Once the insulation is raised from the electrode conductor, the flexible tip of a guidewire (0.038 inches in case of a vein pick approach or a Nitinol microwire in case of a micropuncture needle approach) is advanced 4 or 5 mm between the insulation and the conductor (Figure 3b). The objective is for both the lead and wire to be advanced as a single unit, allowing for the guidewire to be introduced into the vascular space.

Step 3: placement of the guidewire into the vascular space
At this point both lead and wire are advanced as a unit until the tip of the wire is seen at the level of the superior
vena cava under fluoroscopy (Figure 2b). Next, one hand fixes the wire while the electrode is gently advanced a few millimeters until the tip of the wire is freed from the lead insulation; this is confirmed by observing the guidewire moving freely in the intravascular space under fluoroscopy. Finally, the pierced lead is removed and the guidewire is retained to secure access for a new lead placement (Figure 2c). If the microwire technique is used, a 4 or 5-Fr introducer is placed, then a J wire is advanced and the introducer is exchanged for a peel-away introducer to allow lead placement.

One important point to be made is that the lead that is used to retain access, whether is successfully extracted or not, cannot be further used for stimulation or defibrillation therapy as the integrity of the lead insulation is now compromised. If the lead cannot be fully extracted, it should be left abandoned, capped and sutured to the pectoralis fascia.

Externalized pacemakers with active fixation leads

Not infrequently, patients with confirmed or suspected infected cardiac rhythm devices are pacer dependent and removal of their pacing system creates a complex management scenario. Traditionally, these patients are kept monitored in an intensive care unit (ICU), receiving cardiac stimulation through a transvenous temporary pacing system while undergoing antibiotic therapy to control the systemic infection and prevent seeding of the future implanted system. The risk of lead dislodgment from a transvenous passive temporary wire is substantial, which precludes their management outside an intensive care unit setting and increases hospital costs and potential risks to a pacer dependent patient. Another clinically relevant scenario includes patients who develop transient complete or high grade AV block which is potentially reversible (after open heart valve surgery, during acute myocarditis or drug intoxication) and may require cardiac stimulation for periods longer than 48 or 72 hours. For some of these patients, after temporary pacing is instituted, the decision to withhold placement of a permanent pacemaker system beyond a few days may be difficult, even if the possibility of AV conduction recovery is still reasonable, with a less than reliable temporary pacing system. A safer, reliable method to achieve temporary pacing which allows for management of such patients outside the ICU environment, thus reducing costs and minimizing risks to the patient is to take advantage of the reliable pacing capabilities of an active fixation lead combined with an externalized generator to provide cardiac stimulation.6–8

Materials and techniques

The two key elements of this temporary pacing system are the active fixation lead and a resterilized pacemaker generator. The active fixation lead provides reliable pacing minimizing the risk of lead dislodgement and failure to capture. A resterilized pacemaker generator can be obtained from patients who are not actively infected and have undergone device upgrades (from pacemakers to ICDs or cardiac resynchronization generators) or even from elective system replacements, as the low battery voltage generators can still provide reliable pacing for a few weeks. The pacing system as a unit is inexpensive, as the cost of the active fixation lead, resterilization of the generator and supplies required for implantation together with the cost of the electrophysiology laboratory use are easily offset by the elevated costs of prolonged ICU stays.

It is important to understand that the technique for placement of an externalized pacemaker system should follow the same rules of sterility as for a permanent device implantation. This reduces the potential risk of local infection and bacteremia which could hinder future placement of a permanent device if needed. The implantation technique is described below.

Step 1: vascular access

The first step is to choose a central venous access site that allows placement of the temporary system (lead and generator) without affecting future placement of a permanent pacing device and that is comfortable and safe for the patient, even allowing for ambulation. The preferred sites are the internal jugular or subclavian veins contralateral to an infected site, and not the site chosen for a future permanent pacemaker placement. In some cases, due to limited vascular access secondary to unfavorable venous anatomy (stenosis, obstruction), local infection or trauma from prior central line placement, one has to choose a femoral vein to implant the system. In these cases there is a higher risk of short term infection and a limitation to patients mobility.
Step 2: placement of active fixation lead
Once central access is obtained, a peel away introducer is placed and an active fixation lead is advanced under fluoroscopy to the desired pacing site (usually the right ventricle). Once the active fixation mechanism is deployed and adequate pacing and sensing parameters are obtained, the peel away introducer is removed, leaving the lead protruding from the skin access site. Using a plastic lead sleeve, the lead is anchored to the cervical skin using non-absorbable suture (Figure 4).

Step 3: connecting the resterilized generator, fixing, and covering the system
After the lead is fixed to the patient’s skin, the resterilized pacemaker is connected, the redundant electrode is tucked behind the generator and the generator is anchored to the cervical skin using non-absorbable suture. Finally, both generator and lead are covered with a sterile bio-occlusive dressing in order to maintain sterility (Figure 5).

Several points should be emphasized. The first one is to assure fixing both lead and generator to the same anatomic site in the skin. This is particularly relevant when placing the system via internal jugular access, as fixing the lead to the neck and the generator to the thorax may cause lead dislodgement with neck movements (Figure 4b). The second point refers to the method used to externalize the lead. In some centers, a venous introducer is left in place, anchoring both the introducer and the lead to the skin. Some of these

Figure 4: Illustration of an externalized pacemaker system using an internal jugular approach. (a) Adequate anchoring of the lead and generator to the skin neck area. This allows covering of the system with a sterile dressing and free neck mobility. (b) Example of inadequate fixation of the externalized pacing system. The lead is anchored in the neck while the generator is affixed to the infraclavicular skin, requiring a larger sterile area to be maintained and risking dislodgment with neck movements.

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Figure 5: Externalized pacemaker implanted via right internal jugular access in a patient with complete atrioventricular block and sepsis. An active fixation lead and resterilized generator are covered under sterile conditions using a bio-occlusive dressing. This patient was transferred from the intensive care unit to a telemetry unit for 10 days of antibiotic therapy prior to permanent pacemaker implantation.

Figure 6: Externalized pacing system 2 weeks after implantation. The sterile dressing is uncovered showing the lead and generator anchored to the neck area. Note the skin erythema surrounding the lead insertion site (circle). At this point the system must be removed and, if necessary, a permanent pacemaker implanted or a new temporary system placed in a different site.
introducers allow sterile manipulation of the protruding lead by using an external sleeve (such as the introducers used for Swan Ganz catheter placement).9 In our experience, this practice may favor manipulation of the lead by nursing and medical staff untrained to handle these electrodes and lead to system dysfunction. Additionally, these introducer covers are bulky and uncomfortable to the patient when placed in the neck area. We find covering the generator and lead as a unit with a sterile, transparent bio-occlusive dressing a much simpler and comfortable approach. Finally, the duration of externalized pacing is dependent on the patient’s pacing needs but should not be carried out beyond several weeks as an increased risk of local infection and potential bacteremia is greater over time (Figure 6). In cases where externalized pacing is maintained beyond 5–7 days, we perform weekly sterile wound care following the same sterile principles applied during implantation. If externalized pacing is required beyond this point, removal of the system and placing a new one at an alternative site should be considered.

Conclusions

The lead removal techniques and temporary pacing solutions described in this manuscript, together with current advanced lead extraction techniques provide practical and safe solutions to manage patients with pacemaker and defibrillator malfunction, infections and other situations where system removal is advisable; and those with advanced potentially transient AV block or symptomatic bradycardia who require temporary pacing or those pacer dependent patients who require removal of their pacing system and cannot be immediately implanted with a new one. The case series and reports presented in the literature for both techniques have demonstrated their safety and effectiveness. Incorporating these procedures into routine practice can help reduce complications and decrease costs related to the management of these complex cases.

References