Pacemaker and Internal Cardioverter Defibrillator Lead Extraction: A Safe and Effective Surgical Approach

John M. Kratz, MD, and John M. Toole, MD

Division of Cardiothoracic Surgery, Department of Surgery, Medical University of South Carolina, Charleston, South Carolina

Background. **Need for pacemaker or internal cardioverter defibrillator lead removal is increasing. Removal can be dangerous, difficult, or unsuccessful.**

Methods. **We retrospectively reviewed our results and the techniques we used in 365 patients from 1992 through 2009 for successful complete removal of leads and complications. Various techniques of extraction were analyzed for effectiveness and complications. The eras before (1992 to 1999) and after the availability of laser sheath extraction (2000 to 2009) are compared.**

Results. **Of 365 patients who underwent transvenous lead extraction, of which 235 were infected, and 130 had lead removal for noninfectious indication. *Staphylococcus aureus* was the infecting organism in 40%, and coagulase-negative *Staphylococcus* occurred in 33%. One-half of the organisms were methicillin resistant. Preimplant risk factors for infection included more than one device implant procedure in 105 (47%), preimplant Coumadin therapy (Bristol-Myers Squibb, Princeton, NJ) in 74 (31%), and hemodialysis in 9 (4%). Laser extraction became available in 2000. The era with the availability of laser extraction was associated with a better complete extraction rate (93% vs 89.55%) a lower bleeding rate (1.9% vs 3.1%), and complete extraction without the additional use of femoral workstation extraction tools. Mortality was 1.1%. No death was due to device removal. All deaths were the result of severe preoperative and continuing postextraction sepsis.**

Conclusions. **A lead extraction protocol that included procedures done in an operating room environment allowing rapid, open intervention for bleeding, a varied choice of extraction tools, arterial line monitoring, transesophageal echocardiography, general anesthesia, and an experienced team yielded complete extraction in more than 90% of patients, with a low complication rate and no procedurally related deaths.**

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Many factors have resulted in an increasing number of patients presenting with infections or other complications of pacemaker or internal cardioverter defibrillator systems (ICD). Owing to expanding indications, more patients are undergoing device implant. The aging population presents a higher percentage of patients requiring device implant. The population of patients surviving to require reimplantation for battery depletion is growing, as is the need to implant devices in anticoagulated or otherwise increasingly complicated patients. Pacemaker or ICD lead extraction can be fatal or complicated. Even the lay press has reported the possible hazards of lead extraction [1].

Although patients requiring explantation of pacing systems have become more numerous and complicated, techniques for complete and safe removal of pacing leads have also become more diverse and available. We review the experience of a single center with principally 1 surgeon's experience in the management of complicated pacemakers or ICDs requiring revision or removal from 1979 through 2009.

Material and Methods

The Institutional review board of the Medical University of South Carolina approved this study and waived requirement for patient consent for review of records for this study.

Between 1992 and 2009, 365 patients were referred for pacemaker or ICD lead extraction (Table 1). We retrospectively reviewed these patient's records for techniques used, complete lead removal, complications, possible causes of infection, causative organism, and methods used to prevent and minimize complications.

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Address correspondence to Dr Kratz, Division of Cardiothoracic Surgery, Medical University of South Carolina, 25 Courtenay St, Charleston, SC 29424; e-mail: kratzj@musc.edu.

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Table 1. Demographics of Patients With Lead Extraction

Variable	All Patients	Infectious	Noninfectious
Total No.	365	235	130
Sex			
Male, %	65	69	57
Female, %	35	31	43
Age, median (range), y	62 (3–103)	66 (3–95)	55 (5–103)
ICD, %	25 (91/365)[a]	76 (69/91)[b]	24 (22/91)[c]
Pacemaker, %	75 (274/365)[a]	61 (166/274)[d]	39 (108/274)[e]
Coumadin, %	22 (80/365)[a]	31 (74/235)[f]	5 (6/130)[g]
Dialysis, %	3 (10/365)[a]	4 (9/235)[f]	0.8 (1/130)[g]
Multiple implants, %	36 (131/365)[a]	47 (105/235)[f]	20 (26/130)[g]

[a] Percentage of total patients. [b] Percentage of ICD patients infected. [c] Percentage of ICD patients not infected. [d] Percentage of pacemaker patients infected. [e] Percentage of pacemaker patients not infected. [f] Percentage of infected patients. [g] Percentage of not infected patients.

ICD = internal cardioverter defibrillator.

Statistical Analysis

Demographics and results are presented as counts. Percentages are reported when appropriate. Outcomes were compared with the Fisher exact one-sided test using NCSS 2001 software (Number Cruncher Statistical Systems, Kaysville, UT).

Surgical Procedures

All patients with infection received intravenous vancomycin until an organism and its antibiotic sensitivity could be identified. Cultures were obtained from the pocket before the operation whenever possible. Cultures were preformed on tissue from the pocket and lead tips upon extraction. Antibiotics were given for 1 week after extraction, except in instances of possible or certain endocarditis, in which case 6 weeks of antibiotics were given.

All procedures were performed in the operating room under general anesthesia with arterial catheter monitoring. Patients were prepared and draped to allow immediate access for cervical, subclavian, femoral, and median sternotomy incisions. In recent years, monitoring with transesophageal echocardiography has provided earlier and better detection of pericardial effusion and possible previously undetected endocarditis.

Pacemaker-dependent patients were managed in the following order. Sick sinus syndrome patients or heart block patients with a stable escape rhythm and a satisfactory heart rate were managed with backup cutaneous pacing and observation in the intensive care unit for a few days to allow treatment with antibiotics before placing a new pacing system.

Patients with a pocket infection only or noninfected patients were frequently managed by placement of a new pacing system transvenously from the opposite shoulder or using epicardial leads by way of a subxiphoid incision before lead extraction. In patients with more aggressive infection and an unsatisfactory heart rate due to heart block, a permanent transvenous pacing lead with an active fixation screw was placed as a temporary lead through a separate cutaneous venous entry. This lead was securely sutured to the skin and attached to an exteriorized permanent pacemaker.

Antibiotics are given for 3 to 4 days to clear any remaining infection before placement of a new pacing system. We prefer, when possible, to treat the infectious process for a few days with appropriate intravenous antibiotics before a new system is implanted.

A subxiphoid approach for epicardial lead removal was used in patients where active endocarditis was present or the risk of recurring exposure to blood-borne organisms was present, such as in dialysis patients.

Our goal in patients with an infectious process was to remove all elements of the pacing system, including currently used or old retained leads. In patients with soft indications for removal, such as lead malfunction or system upgrade, the planned extraction was used cautiously, recognizing the ever-present risk of a major bleeding complication.

Various lead removal techniques were used. The distribution of techniques used is reported in Table 2. The least invasive number of techniques that would result in a complete removal of all lead material was used; that is, if traction alone or traction with a stylet could affect complete removal, sheaths were not used. Excessive traction without a locking stylet in place may cause damage to the stylet channel, however; and therefore, a low threshold for use of a locking stylet was indicated if minimal traction would not easily dislodge the lead.

Traction-only has been used since 1989 and continues to be successful in some cases. It was initially the only transvenous method available. This method was occasionally enhanced with the use of a cord tied to the lead and then run over a pulley to a hanging 1-pound weight to provide constant controlled traction to a recalcitrant lead. This method was rarely currently used except in the case of a recently implanted lead.

Traction with locking stylets became available to us in 1993. We have used locking stylets consistently as part of our lead extraction technique, except in the case of a recently implanted lead that may be easily removed with traction alone. We initially used the Wilkoff stylet (Cook

Table 2. Techniques Used

Technique	No.
Traction	32
Traction, stylet	47
Traction, stylet, sheath	50
Traction, stylet, sheath, femoral	12
Traction, stylet, sheath, femoral, jugular forceps	1
Traction, stylet, laser	202
Traction, stylet, laser, femoral	19
Traction, stylet, laser, femoral, jugular	1
Femoral only	1
Open	8