not yet apparent, and recovery rates based on objective markers are high. We intend to continue follow-up for the next two to five years, while looking to evidence for any long-term sequelae.

The utility of endomyocardial biopsy after smallpox vaccination is uncertain. Given the inherent risks and low diagnostic yield of endomyocardial biopsy (1,4), as well as the high likelihood of full objective recovery after smallpox vaccine-associated myopericarditis (3), we would be remiss to recommend a potentially harmful procedure in all patients with depressed left ventricular function.

Although there has been one case of eosinophilic myocarditis that improved shortly after receiving corticosteroids (5), this one case is insufficient to conclude that corticosteroids will always be beneficial, even when eosinophils are seen on biopsy. However, the possibility that corticosteroids may uniquely benefit patients with eosinophilic myocarditis does warrant continued evaluation. Therefore, although we support endomyocardial biopsy in patients with symptomatic moderate or worse left-ventricular dysfunction, the possibility that corticosteroids may uniquely benefit patients with eosinophilic myocarditis does warrant continued evaluation.

REFERENCES


Pacemaker Complication During Magnetic Resonance Imaging

The article by Martin et al. (1) suggesting that magnetic resonance imaging (MRI) examinations are safe in qualified pacemaker patients should lead to improved care, especially for cancer patients. Encouraged by this article, we have taken two patients into a Signa LX EchoSpeed 1.5-T MRI (GE Medical Systems, Milwaukee, Wisconsin). Our second patient experienced difficulties not previously noted, demonstrating the need for continued caution when performing these exams.

A 48-year-old man with a left-sided, dual-chamber pacemaker placed on August 1, 1997, for neurogenic syncope (Thera DR 7960i, Medtronic Corp., Minneapolis, Minnesota) had metastatic multiple myeloma and significant pain. The MRI was performed to evaluate lower extremity neurologic deficits after attempted intrathecal catheter implantation.

The thoracic and lumbar spine regions were evaluated by sagittal fast spin echo (FSE) T2-weighted pulse sequences with fat saturation and pre/post contrast T1-weighted FSE pulse sequences in the sagittal and axial planes. Compared to previous computed tomography (CT) myelogram, MRI revealed more extensive cord compression at T9–10 from epidural tumor. The MRI demonstrated no epidural hematoma, possibly preventing an unnecessary laminectomy. A CT examination performed one month previously, because of pacemaker contraindication to MRI, demonstrated no epidural involvement.

Pacemaker evaluation immediately before MRI showed adequate battery voltage and impedance (Fig. 1) with DDR pacing (lower rate 60, upper sensor and tracking rates 135 beats/min). M.A.R. (an anesthesiologist “facile in the ways of pacemaker programming”) disabled pacemaker rate responsiveness and monitored the patient with pulse oximetry plethysmography and electrocardiography (Millisena 3155 MVS monitor, In Vivo Research, Orlando, Florida). This monitor has no pacemaker artifact enhancement in the remote (MRI) mode.

Upon entering the MRI room, pacemaker magnet mode was activated (DOO pacing, 85 beats/min) until patient alignment with the MRI tunnel (heart rate returned to 74 beats/min). During MRI, pacing appeared to remain in DDD mode, with heart rates between 68 and 82 beats/min. Occasional pseudofusion beats were noted, but the ECG tracing was unreliable during MRI sequences. PVCs were noted during and between MRI scan cycles. No medication was given, and the patient did not complain of palpitations or chest pain (although he had back pain). He was quickly removed from the MRI upon completion of the 1.5-h exam.

Immediate pacemaker interrogation revealed onset of elective replacement (ERI) with a programming change to VVI pacing at 65 beats/min despite normal battery voltage and impedance (Fig. 2). This change eliminated all pacemaker diagnostic data storage. The “STATUS RESET” function in the programmer returned the pace-
Pacemaker Model: Thera DR 7960i  
Serial Number: PDR  

Battery/Lead Values:  
Collected: 5/10/04 10:51

**Battery Status:** Replace Pacer  
**Estimated Time to Replacement (Average):** Replace Pacer  
**Battery Voltage:** 2.77 V  
**Battery Current:** 9.4 uA  
**Battery Impedance:** 2620 Ohms  

**Lead Status:**  
**Pulse Duration:** 0.39 ms  
**Pulse Amplitude:** 2.79 V  
**Output Energy:** 3.7 J  
**Lead Current:** 3.5 uA  
**Lead Impedance:** 740 Ohms  
**Pacing Configuration:** Bipolar

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**Figure 2.** Battery and lead data obtained immediately after magnetic resonance imaging. Despite acceptable voltage and impedance, the pacemaker shows “replace pacemaker,” rather than “OK,” for battery status. Thus, the pacemaker changed from DDD pacing (lower rate 60, upper tracking rate 135 beats/min) to VVI at 65 beats/min. For this pacemaker, replacement is not needed until battery voltage is less than 2.62 volts with impedance >3,000 ohms.

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maker to dual-chamber function, and no other abnormalities were found. It is unclear why our patient’s pacemaker detected an ERI condition. Medtronic Thera platforms (including Prodigy, Preva, Kappa 400, and Insynch 8040) can be especially sensitive to electromagnetic interference signals entering via the telemetry coil, which might account for our observation in this case. Although no inappropriate ERI was found in the Martin et al. (1) series, which included 12 of these platforms (but only one Thera device), no thoracic spine MRI examinations were performed.

This outcome reminds us that significant pacemaker problems might still occur during MRI, despite the experience of Martin et al. (1). Although their report will likely permit better care of pacemaker patients, the caveat that special care of these patients appears necessary. We believe that recommendations from Martin et al. (1) should be strengthened. Rather than simply available, a physician who is “facile in the ways of pacemaker programming” should be present to monitor the patient, as suggested by Gimbel and Kanal (2). Additionally, the entire team caring for patients in the MRI suite needs to be prepared to quickly and immediately remove the patient from the MRI should a significant problem be discovered.

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**REFERENCES**


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**REPLY**

We thank Dr. Rozner and colleagues for their interest in our work (1). They found that a Medtronic Thera DR 7960i pacemaker demonstrated an elective replacement indicator upon interrogation of the device immediately after magnetic resonance imaging (MRI). This phenomenon is neither unexpected nor alarming. Many pacemakers will respond with this warning after an exposure to intense electromagnetic interference. Examples of this exposure include direct current cardioversion, radiofrequency ablation, electrocautery, and MRI. This response is unrelated to the battery voltage or impedance but rather occurs because of a brief power interruption. Magnetic resonance imaging can cause this behavior when the telemetry coil or leads themselves are driven by the radiofrequency output of the MRI, which can result in a parasitic capacitance for brief instances. The solution, when this occurs, is to reset the pulse generator. Newer pacemakers are more resistant to such interference but also can demonstrate this problem.

With respect to their comments, several observations are relevant. The statement that a “pacemaker-facile physician” be present rather than available is consistent with our practice and our recommendations. During all MRI examinations involving pacemaker and implantable-cardiovertor defibrillator patients at Oklahoma Heart Institute, an electrophysiologist is present and observing all available data from the start of the scan through completion of the post exam interrogation. We concur wholeheartedly that this extra step is mandatory to the performance of these studies.

Since the publication of our article (1), we have had the opportunity to expand our pacemaker/MRI database to include a total of 87 patients with 156 leads. We have continued to observe similar but subtle threshold changes in a portion of leads subjected to the levels of electromagnetic interference found at 1.5-T, but none of these threshold changes have been beyond the safe programming limits of the pulse generators.

We stand by our original conclusions. Performance of MRI in appropriately selected, nonpacemaker-dependent patients can be accomplished with an acceptable safety profile. Precautions must include continuous monitoring of the patient with ECG and intermittent voice contact, resuscitation equipment on standby, adequate personnel to move and resuscitate the patient should the need arise, and the presence of a person facile in pacemaker interrogation and programming.

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**REFERENCES**