

Emergent use of an MRI-conditional external pacemaker in a patient with sinus arrest facilitating diagnosis of a temporal lobe neoplasm



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Introduction

This report describes the case of a 66-year-old previously healthy man admitted to our institution for evaluation of new-onset syncope. The patient had witnessed seizures after admission associated with multiple periods of asystole on telemetry. A temporary pacemaker was emergently placed prior to transfer to the cardiac intensive care unit. An electroencephalogram (EEG) demonstrated a seizure focus at the right temporal lobe but a computed tomography (CT) scan of the brain was unrevealing; magnetic resonance imaging (MRI) was recommended. We describe the use of an active fixation right ventricular lead attached to an external MRI-conditional pacemaker generator prior to MRI scanning, which led to the diagnosis of anaplastic astrocytoma.

Case report

A 66-year-old previously healthy man with a past medical history of hypertension and essential thrombocythemia presented to our institution with recurrent, new-onset syncope. The patient had recently returned to the United States after spending several years living in Venezuela. He reported that 2 days prior to admission he started experiencing episodes of sudden loss of consciousness briefly preceded by nausea and lightheadedness, with each episode lasting 1–2 minutes in duration. Between events he was asymptomatic. Baseline electrocardiogram showed normal sinus rhythm and was remarkable only for an interventricular conduction delay

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without PR segment prolongation or any higher-grade atrioventricular block. An echocardiogram demonstrated normal biventricular function, impaired left ventricular relaxation, and no significant valvular disease. Admission blood work was notable for a mildly elevated white blood cell count at $13.9 \times 10^3/\mu\text{L}$ and a normal hematocrit; platelets were elevated to $616 \times 10^3/\mu\text{L}$, consistent with his prior levels and his diagnosis of essential thrombocythemia. Basic metabolic panel revealed normal electrolytes with the exception of a mildly decreased bicarbonate at 21 mmol/L with a normal creatinine. Lactic acid was elevated at 3.3 mmol/L. Cardiac biomarkers were negative.

He remained hemodynamically stable in the emergency department and was admitted to a telemetry unit for monitoring. Within 24 hours of admission, the patient had multiple syncopal episodes while lying in bed. Review of telemetry tracings from these events clearly demonstrated immediately preceding sinus bradycardia followed by multiple episodes of sinus arrest with asystole lasting 15–20 seconds (Figure 1). Each episode spontaneously resolved. Several hours later the events started to occur approximately every 15–20 minutes. There was P-P prolongation for each event, followed by absence of a P wave with no ventricular escape rhythm. The P-R interval did not prolong. When en route to the electrophysiology laboratory for emergent placement of a “temporary-permanent” pacemaker, the patient had a generalized tonic-clonic seizure requiring intubation, again associated with a prolonged period of asystole. A “temporary-permanent” externalized Medtronic (Adapta) pulse generator was connected to an active fixation right ventricular lead (Medtronic CapSureFix Novus MRI-conditional 5076-58 cm; Medtronic, Minneapolis, MN). Excellent sensing and thresholds were achieved without complications.

A subsequent EEG demonstrated localized ictal discharges from the right temporal region. A brain CT scan with contrast then demonstrated subtle edema in the posterior right frontal lobe but was not considered diagnostic of a specific etiology for this finding. MRI was recommended.

KEY TEACHING POINTS

- Magnetic resonance imaging (MRI) is frequently needed in patients with cardiovascular implantable electronic devices, which historically have been a contraindication to MRI.
- We describe the safe implantation of an external MRI-compatible generator to expedite brain MRI in the urgent workup of suspected intracranial malignancy.
- The use of MR-conditional implantable electronic devices can safely be used to facilitate MRI and is particularly relevant for cases such as ours in which computed tomography is unrevealing.
- Sinus bradycardia and sinus arrest are uncommon manifestations of temporal lobe epilepsy.
- Risk stratification of epileptic patients to determine those at risk of bradyarrhythmias may be clinically useful in preventing sudden unexpected death in epilepsy, although more data are needed.

However, the pacemaker generator implanted initially was not MR conditional, and MRI was institutionally declined.

The patient's externally located generator was exchanged for an MRI-conditional Medtronic Model ADSR01; consultation with technical support indicated that the absent

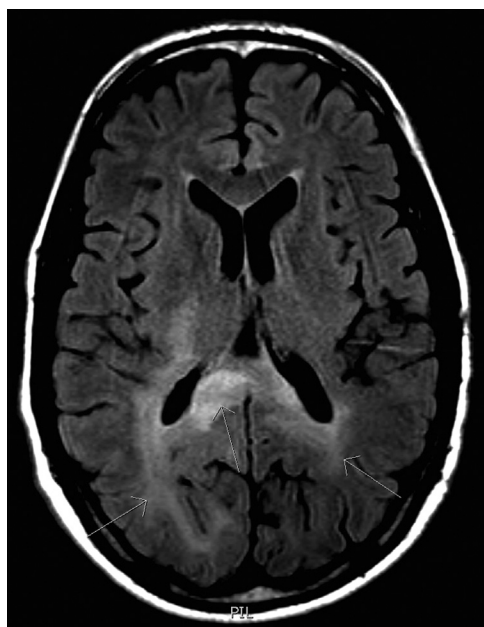


Figure 1 T2-weighted FLAIR sequence from the patient's brain magnetic resonance imaging after external pacemaker placement demonstrates hyperintense signal within the right temporal lobe inclusive of the hippocampus, the right parahippocampal gyrus, and right cortical spinal tract within the right internal capsule posterior limb and right cerebral peduncle, and the bilateral corpus callosum splenium with extension to the bilateral parietal lobes.

atrial port would not be anticipated to result in problems with MRI. The generator was programmed to the VOO mode prior to uneventful brain MRI; post imaging, the generator was programmed back to VVI mode. Appropriate-demand ventricular pacing occurred after MRI, with no further syncopal episodes.

The MRI revealed parenchymal T2-hyperintense signal within the right medial temporal lobe, the right parahippocampal gyrus, the right cortical spinal tract within the right internal capsule posterior limb and right cerebral peduncle, and within the bilateral corpus callosum and splenium right greater than left, primarily affecting white matter. Mild local mass effect, concerning for a diffusely infiltrative mass, was definitively visualized. There was additional ill-defined parenchymal T2-hyperintense signal noted within the bilateral parietal lobes (Figure 2). A subsequent lumbar puncture showed normal opening pressure, and the cerebrospinal fluid demonstrated a mildly increased total protein at 68 mg/dL with negative oligoclonal banding. Extensive bacterial and viral workup was negative. It was anticipated that further bradycardic events were likely, and prior to discharge, a dual-chamber Medtronic MRI-conditional pacemaker was implanted.

A neurosurgical stereotactic brain biopsy of the right temporal lobe lesion showed WHO grade III anaplastic astrocytoma. The etiology of his bradycardia was thought to be sinus arrest secondary to vagal nerve stimulation mediated by temporal lobe epilepsy due to mass effect of the anaplastic astrocytoma. The patient was scheduled to undergo chemotherapy with temozolomide and stereotactic brain radiation with serial-surveillance MRI studies.

Discussion

Over the last 2 decades, MRI has emerged as the imaging modality of choice for diagnosis of various soft tissue and bony abnormalities. MRI is superior to CT for assessment of intracranial neoplasms.^{1,2} Currently more than 2 million Americans have a cardiovascular implantable electronic device (CIED). It is estimated that between 50% and 75% of these patients will have an indication for MRI during their lifetime,³ for more or less compelling indications.

MRI is discouraged in patients with a "non-MRI-conditional" CIED owing to 3 major safety concerns. The first relates to mechanical effects from potential magnetic field-induced force and torque that may result in device or lead movement and dislocation or internal reed switch activation. Second, electromagnetic effects related to the induction of electrical current in the CIED leads in the case of implantable cardioverter-defibrillators may cause over- or undersensing or could even capture the heart at the rate of the radio-frequency coil owing to current induction, which may lead to induction of malignant ventricular arrhythmias. Third, repeated radiofrequency pulses used for signal induction in MRI may lead to the induction of a powerful electrical field amplified at the lead tips, causing intense local heating effect and subsequent tissue damage and edema. This may manifest



Figure 2 Progression from normal sinus rhythm to asystole during a seizure episode lasting for 20 seconds without alteration in electrical intervals or QRS morphology.

as increased pacing thresholds, loss of capture, or triggering of arrhythmias.^{3,4}

Recent innovations by CIED manufacturing companies have led to the creation of “MRI-conditional” devices that obviate all of the above issues. Current labeling of these systems specifies a waiting period of 6–9 weeks after implantation of the CIED, based on the qualifying clinical studies.

Given the clinical necessity of MRI in our patient, it was deemed that the urgent need to establish a diagnosis outweighed the potential risks of performing an MRI 3 days after implantation of the “temporary-permanent” pacemaker. There are institutional policies establishing eligibility for MRI in patients with CIEDs, and many but not all institutions are unwilling to perform MRI in patients with a CIED that is not “MRI-conditional.” For example, Goldsher et al⁵ have previously described successful cervical MRI in a patient several hours after implantation of a permanent Medtronic Sigma 303 DR with Medtronic CapSureFix 5076 leads. Extensive discussions at our institution indicated that MRI would not be considered without the presence of an “MRI-conditional” lead and generator. However, imaging would be considered with a “temporary-permanent” system encompassing MRI-conditional components, even within the initial postimplant window; any deleterious effects on threshold would not be persistent with the temporary RV lead. The Medtronic Advisa generator and Medtronic 5076 lead met these constraints.

Another interesting aspect of our case was the presentation of anaplastic astrocytoma as asystole and syncope. Seizures are a frequent initial manifestation of brain neoplasms; however, presentation with asystole and syncope is less commonly described. Sudden unexpected death in epilepsy (SUDEP) occurs in approximately 1 in every

1000 epileptic patients; although the underlying etiology of SUDEP is poorly understood and thought to be multifactorial, it has been theorized that neurologic mediation of cardiac arrhythmias plays a significant role in the pathophysiology of this syndrome.^{6–8}

Sinus tachycardia is the most common arrhythmia associated with ictal activity, occurring in up to 80% of seizures. Less frequently, bradyarrhythmias have also been described.^{8–12} One recent review of all available case reports and case series of epileptic patients with documented arrhythmias found 162 cases of ictal and postictal arrhythmias in patients undergoing video EEG monitoring.¹³ One hundred and three of these cases were identified as ictal asystole (generally defined as R-R interval >3–4 seconds with correlating seizure activity on video EEG). The overall prevalence of ictal asystole was 0.177% in all patients admitted for routine video EEG monitoring and 0.318% in patients with known refractory epilepsy. The mean duration of ictal asystole was 20 seconds (range, 3–96 seconds). The authors also found 13 documented cases of postictal asystole with mean duration of 30 seconds. Peri-ictal asystole was self-limited in all cases except 1, in which CPR was started after 44 seconds of sinus arrest. Ictal bradycardia without asystole (25 cases) and second- and third-degree atrioventricular conduction block (11 cases) were also rare findings in this review.¹³ Comorbid cardiovascular conditions and medication history were not consistently well documented, making interpretation of this data somewhat difficult.

The exact mechanism of ictal-associated asystole is unknown, but has been hypothesized to be rooted in a vagally mediated response related to stimulation of the insular cortex of the temporal lobe. A small study involving stimulation of the insular cortex of 5 epileptic patients

undergoing temporal lobectomy for refractory seizures demonstrated resultant bradyarrhythmias;¹⁴ the temporal lobe has been documented as a frequent focus of seizures in cases of epilepsy-mediated bradycardia. It is thought that peri-ictal bradycardias promote SUDEP, given concomitant respiratory depression and hypoxemia, which is independently arrhythmogenic.⁷ These findings raise the important question of how to risk-stratify patients with epilepsy-mediated bradycardia who may potentially be at risk for an asystolic event, for consideration of outpatient cardiac monitoring and potential pacemaker implantation.

As far as we know, this is the first case in which MRI was performed in a patient after implantation of a “temporary-permanent MRI-conditional” pacing system. We note that this is an out-of-label use, since the system is approved for permanent implantation and the current labeling and qualifying studies did not include scanning immediately after implantation. The use of an MRI-conditional system in this circumstance, as illustrated in this case report, assuaged concerns about MRI and accordingly facilitated the timely diagnosis of this patient’s underlying malignancy with therapeutic implications. The concerns about MRI with non-MRI-conditional components are almost certainly not institutionally unique. This report highlights the feasibility of an MRI-conditional pacemaker system in patients presenting with sudden unexplained neurological symptoms where MRI is essential for establishing a diagnosis.

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