An 8 year-old boy had been treated for 2 years for exercise-cardioverter-defibrillator (Heart Rhythm Case Reports 2015;1:159-162) complicating lead implantation with potential for serious morbidity and mortality. We present a case of subacute ICD lead perforation in a boy who presented with hiccups.

Case report
An 8 year-old boy had been treated for 2 years for exercise-related “seizures” unresponsive to phenobarbital and levetiracetam. He presented to an outside hospital after an episode of loss of consciousness while playing laser tag. The episode was thought to be a seizure but lasted 45 minutes, so Emergency Medical Services was called. When Emergency Medical Services arrived, he was in ventricular fibrillation and was successfully defibrillated. He was transported to the local hospital, where he experienced multiple episodes of ventricular arrhythmia in the emergency department. Ventricular tachycardia that degenerated into ventricular fibrillation occurred during IV placement. Defibrillation was again successful, but polymorphic ventricular tachycardia recurred and became incessant after administration of epinephrine and amiodarone. The patient was transported to a regional tertiary pediatric hospital for further treatment. A diagnosis of catecholaminergic polymorphic ventricular tachycardia was suspected based on a normal baseline electrocardiogram (ECG), bidirectional ectopy, and ventricular tachycardia that had worsened with epinephrine. Later genetic testing confirmed an RYR2 mutation. He was treated acutely with intravenous esmolol, and the epinephrine and amiodarone were discontinued.

The patient recovered from the cardiac arrest and had near-normal mentation and normal ventricular function. Five days after admission, he underwent single-chamber ICD placement with a St. Jude Durata 7122Q (St. Jude Medical, St. Paul, MN) lead. The implant procedure was notable for poor ventricular sensing in apiical and septal lead positions (<3.0-mV R waves), so the final lead placement was presumably placed in the subinfundibular aspect of the right ventricle, where 7.5-mV R-wave electrograms were recorded (Figure 1A). The ICD implantation was uncomplicated, and the patient was discharged home the next day. On the day of discharge, the echocardiogram showed normal left ventricular function and no effusion. However, upon retrospective review, the discharge chest X-ray film was suspicious for lead protrusion into the pericardial space (Figure 1B).

One month after ICD placement, the patient complained of intermittent hiccups. ICD interrogation showed appropriate R-wave sensing with no tachyarrhythmia. Routine ICD interrogation 2 months after implant showed stable lead impedances in both pacing and high-voltage circuits and 7.4-mV R waves, with no ventricular capture. Diaphragmatic pacing was confirmed as the source of the “hiccups,” which occurred at outputs >4.0 V at a pulse width of 0.4 ms. A subsequent chest X-ray film showed the right ventricular lead tip outside the right heart border (Figure 2). The patient was admitted to the hospital for observation. Chest computed tomography confirmed the right ventricular lead tip outside the heart border by 1 cm with suspicion for extrusion into the lung parenchyma (Figure 2). An echocardiogram showed normal biventricular function and normal atrioventricular and semilunar valve function with no pericardial effusion. Serial chest X-ray film and echocardiogram comparison indicated that the cardiac chambers had remodeled from top-normal to low-normal size.

Surgical lead removal was performed 2 days later. Upon direct visual inspection, the ICD lead tip was found to have perforated the right ventricular myocardium near the left anterior descending artery. The pericardium was tented and dimpled but intact. The lead was contained within the pericardium, and there was no penetration to the lung parenchyma. After the endocardial lead was removed, an epicardial ICD lead system was implanted that included a single coil in the inferior pericardium (Figure 3). The inferior pericardial coil location was chosen to provide an acceptable shock vector with an active can in a typical left pectoral position and to allow adequate lead slack in anticipation of the patient’s future somatic growth. The patient’s recovery

**Keywords**: Implantable cardioverter-defibrillator; Perforation; Durata; Catecholaminergic polymorphic ventricular tachycardia

**Abbreviations**: ECG = electrocardiography; ICD = implantable cardioverter-defibrillator (Heart Rhythm Case Reports 2015;1:159-162)

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was uneventful, and he was discharged home 3 days after epicardial ICD implantation.

**KEY TEACHING POINTS**

- Inherited arrhythmia syndromes may present as “seizure disorders,” and a resting electrocardiogram may be normal.
- Hiccups should be taken seriously in any patient with a cardiac pacing device.
- Pacing and sensing thresholds may be preserved despite myocardial perforation of implantable cardioverter-defibrillator and pacemaker leads.

**Discussion**

Misdiagnosis of a seizure disorder is common in pediatric patients with life-threatening ventricular arrhythmias, especially in cases such as catecholaminergic polymorphic ventricular tachycardia in which the baseline ECG is normal. Exercise-related seizures unresponsive to medications and in the setting of normal test results should raise the index of suspicion for an underlying arrhythmia. Perforation of the myocardium with an endocardial lead is a known but rare complication of ICD implantation. Patient risk factors for perforation are older age, female sex, left bundle branch block, worsened heart failure class, higher left ventricular ejection fraction, and non–single-chamber ICD implant. To date, pediatric patient size has not been reported as a risk factor, but knowledge about this population is limited. Subacute perforations occur more commonly with active

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**Figure 1**

A: Portable chest X-ray films (anteroposterior views) immediately before and after implantable cardioverter-defibrillator (ICD) implantation. B: Anteroposterior (left) and lateral (right) chest X-ray films 1 day after endocardial ICD implantation. Upon review there is concern for possible lead myocardial perforation.
fixation leads and those with small diameters, particularly leads in the Riata (St. Jude Medical) family. To date there has been only 1 report of cardiac perforation due to a Durata lead. Indeed, the curved design of the Durata is meant to offset the risk of cardiac perforation due to small lead diameter. The long-term risk of cardiac perforation for the Durata lead compared to other ICD leads with larger diameters remains to be determined.

Epicardial ICD implantation is a viable alternative for patients at risk for sudden cardiac death who are unsuitable for an endocardial approach. The failure rate for epicardial leads is higher than for endocardial leads, but the use of pericardial and subcutaneous coils as an alternative to epicardial patches has mitigated the risk.

Hiccups after cardiac pacemaker or ICD placement should raise concern for diaphragmatic pacing and lead perforation. This is an unusual case of a subacute Durata ICD lead perforation due to cardiac remodeling after ICD implantation in an 8-year-old boy who presented with hiccups as the consequence of myocardial perforation.

Figure 2  Anteroposterior (top left) and lateral (top right) chest X-ray films and chest computed tomography (bottom) 2 months after implantable cardioverter-defibrillator (ICD) implantation showing right ventricular ICD lead perforation.
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Figure 3  Anteroposterior (left) and lateral (right) chest X-ray films after epicardial implantable cardioverter-defibrillator implantation.