Novel Technique for Implantation of a Cardioverter Defibrillator in Children

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An 8-year-old boy with hypertrophic nonobstructive cardiomyopathy with ventricular fibrillation underwent implantation of an implantable cardioverter defibrillator. The lead was inserted through a pursestring suture in the right atrial appendage, and the tip of coil was placed in the right ventricular apex under fluoroscopic guidance. Another defibrillation coil was placed in the back of the left atrium and left ventricle by the transverse sinus. The device wrapped in a monofilament mesh sheet was placed in the intraperitoneal space. This case utilized a new technique for an implantable cardioverter defibrillator implantation in a small child.


An implantable cardioverter defibrillator (ICD) is used to prevent cardiac death due to life-threatening arrhythmia. Rare cases of ICD implantation in childhood have been described, but the technique for ICD implantation in such cases has been not standardized due to the small size of the patient, potential for somatic growth, and high risk of venous obstruction [1]. An ICD implantation requires many complicated leads and may include the risk of cardiac strangulation. Placement of the relatively large generator is associated with cosmetic problems and a risk of device erosion and infection [1]. The conventional ICD implantation method has various problems. We present herein a new method for implantation of an ICD in children with hypertrophic nonobstructive cardiomyopathy (HNCM).

An 8-year-old boy was hospitalized to undergo ICD therapy. He had a history of syncope during karate, and an automated external defibrillator (AED) diagnosed ventricular fibrillation and the defibrillation was performed. Cardiac rhythm had been restored with a single defibrillation. Echocardiography showed the left ventricular posterior wall was 6.7-mm thick and the septal wall was 12.9 mm. Systolic anterior movement was identified, and thus HNCM was diagnosed. The patient experienced seizures after resuscitation, but his consciousness recovered (Glasgow Coma Scale score was 13 at 12 hours after syncope). For these reasons, ICD implantation was indicated and he was referred to our hospital.

His weight and height were 25.2 kg and 125 cm, respectively. Median full sternotomy was performed under general anesthesia. First, the tip of a dual-coil lead (6947M-62, screw-in; Medtronic, Minneapolis, MN) was passed through the transverse sinus and introduced through a purse-string suture in the right atrial appendage, and the tip of the coil (right ventricular [RV] coil) was then screwed in the right ventricle under fluoroscopic guidance. To allow future growth, the lead in the right atrium was loosening, and the lead from the right atrial appendage to the other coil (transverse sinus coil [TS coil]) was left 1 loop at the front of the right atrium. The TS coil was secured to the pericardium near the superior vena cava using 5-0 Prolene (Ethicon, Somerville, NJ). The TS coil was introduced into the back of the left atrium and left ventricle, avoiding the left anterior descending coronary artery (Fig 1A;B;C). The atrial pacing lead (4968-35, drug-eluting Medtronic) was secured to the right atrium. Next, a horizontal incision was made in the left upper abdominal area and a laparotomy was performed. The device (Protecta XT D354DRM; Medtronic) was wrapped in BARD mesh (BARD, Davol, Warwick, RI) like a pouch. All leads through the diaphragm were connected to the device in the intraperitoneal space, and the mesh pouch was then secured to the intraperitoneal abdominal wall using 4-0 Prolene (Fig 2).

Testing of the device showed the ventricular lead R wave at 28.1 mV, impedance at 632 Ω, and a pacing threshold of 0.5 V at 0.6 ms. Ventricular fibrillation was able to be induced with shocks on the T wave, and defibrillation was successful with 15 J by coil-to-coil shock.

The patient reported nausea on postoperative day 2, but showed no ileus. Postoperative echocardiography showed no tricuspid regurgitation. He was discharged home on postoperative day 10.

Comment

Some methods of transvenous implantation for an ICD in a small child have been reported [2, 3]. These methods carry a risk of venous obstruction [1]. Kantoch and colleagues [3] reported a method of ICD implantation by the right atrial appendage with the lead tip positioned in the right ventricular apex under direct visualization with cardiopulmonary bypass. In our patient, the RV coil was inserted through a pursestring suture in the right atrial appendage on the beating heart; the TS coil was placed in the back of the heart by the TS with no cardiopulmonary bypass. Tain-Yen and colleagues [4] reported the pericardial placement of an ICD coil under fluoroscopic guidance through the TS. Our technique also is relatively easy and certain.

The method with epicardial defibrillation patches includes complicated lead distributions. Health Canada is
advising health care professionals and the public of a rare potential risk of cardiac strangulation for children implanted with epicardial leads. With the growth of the child, the leads can compress the heart, which in turn can result in cardiac strangulation. Because our technique required no sensing ventricular lead, we need fewer leads than the conventional epicardial method. The risk of cardiac strangulation may be reduced. Our technique also increases a variety of shock combinations available, such as the RV coil to the TS coil, the RV coil to the device, and the TS coil to the device. We achieved good defibrillation thresholds (DFTs) with coil-to-coil shock. The endocardial implantation system obtains favorable DFTs compared with an extracardiac implantation system or subcutaneous system [5]. As our endocardial system put the heart between the RV coil and the TS coil, the DFTs in our approach may be more successful.

The device was implanted into the intraperitoneal space. Implantation of the relatively large device in the pericardium, posterior rectus sheath, or thoracic cavity has previously been reported. However, a large device is associated with cosmetic problems and risks of skin erosion [1], mediastinitis, and tamponade [6]. Placement in the intraperitoneal space had low risks of these problems. There is great reward in the use of this technique for the ICD implantation. Moreover, because the monofilament pouch became covered in tissue postoperatively, wrapping the device in a pouch of monofilament mesh allowed easier exchange of the battery as with the conventional method.

In conclusion, this new technique for implantation of an ICD may be easy, safe, and effective in small children. Successful defibrillation at low energy, various combinations of shock, and low risk of problems with implantation of the large device are possible compared with the conventional technique. Follow-up is required to ensure that cardiac strangulation, tricuspid valve insufficiency, and ileus do not develop.

References
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