Use of an automatic internal defibrillator to induce and maintain ventricular fibrillation during left ventricular assist device pump exchange

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As the number of patients with left ventricular assist devices (LVADs) increases,[1,2] so will the number of surgical interventions for device failure. In a recent review, 6.4% of patients with a HeartMate II (Thoratec Corporation, Pleasanton, Calif) required LVAD replacements for various reasons.[3] We report a case of LVAD replacement during which the patient's automatic implantable cardioverter defibrillator (AICD) was used to induce, maintain, and eventually terminate ventricular fibrillation (VF) to facilitate LVAD exchange.

CASE REPORT

Written permission for publication was obtained from the patient. A 77-year-old man with a history of ischemic cardiomyopathy, St Jude Medical AICD (St Jude Medical Inc, Austin, Tex) placement in 2007, and HeartMate II implantation in 2011 presented for LVAD pump replacement as a result of an internal fracture of the power supply cable, causing a short circuit.

General anesthesia was induced and maintained in a standard fashion. Cardiopulmonary bypass (CPB) was instituted via right axillary arterial and venous, as well as femoral venous cannulation. A minimally invasive left subcostal incision was chosen to avoid the morbidity of reoperative sternotomy. Because the patient had mild aortic regurgitation, disarticulation and connection of the LVAD could result in a bloody operative field and risk of air ejection once the new device was connected. Before surgery, the patient was in a normal paced rhythm. On institution of CPB, the LVAD flow was reduced. Through the subcostal incision, the inflow and outflow limbs of the ventricular assist device were isolated, the outflow graft was clamped, and the LVAD flow was discontinued. Antitachycardia therapy for the AICD was disabled and VF was induced with a series of three 20-second bursts of rapid right ventricle stimulation with a pacing cycle length of 60 milliseconds. The LVAD pump was then disarticulated from the inflow and outflow limbs. Subsequently, the patient remained in sustained VF and we replaced the LVAD pump. The pump was deaired through a needle in the outflow graft, just distal to its connection to the pump in the subcostal incision. On confirmation of adequate deairing via transesophageal echocardiography, defibrillation was attempted with externally placed defibrillator pads, but was unsuccessful. Antitachycardia therapy was reenabled on the device, selecting a single VF zone at a low rate and low number of intervals with all shocks set to maximum outputs. The AICD successfully terminated VF, and the patient resumed and maintained a stable paced rhythm. The patient was in VF for a total of 21 minutes. The patient was weaned off CPB uneventfully with the new LVAD pump in situ. The remainder of the procedure and hospital stay was uneventful and the patient was discharged home after 11 days. Analysis of the explanted pump confirmed internal driveline fracture.

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DISCUSSION

There are significant risks associated with resternotomy and LVAD exchange. For isolated pump exchange, the subcostal route may be preferable in selected patients. One concern with this approach, however, has been difficulty in deairing and systemic air ejection during pump exchange. As the ascending aorta cannot be accessed, there is no means of capturing air ejected into the aorta. To address this problem, Woo and Acker[4] have described placement of a venting pigtail catheter via the femoral artery into the aortic root to capture any air that is ejected. Typically, the procedure is done with the heart beating, such that the left ventricle can eject any residual air into the aorta immediately after the device is connected (as this closes off the apical route for ejection). VF may allow more controlled management of air, as it allows passive deairing of the ventricle via a needle in the outflow graft, such that the heart does not eject until deairing is accomplished. However, most cases can likely be reasonably deaired without fibrillation of the heart because maneuvers such as connection of cardiotomy suction to the outflow cannula, steep Trendelenburg positioning, carbon dioxide insufflation, and needling of outflow graft should eliminate most air. However, air entrainment can occasionally be troublesome and fibrillation may afford an additional layer of protection and allow more effective deairing in some cases. Additional benefits from fibrillating the heart during pump exchange are reduced blood loss from the apical inflow site during pump exchange and decreased risk of blood contact contamination of the operating team from an ejecting left ventricle. Because most patients with an LVAD also have an AICD in situ, we suggest that the method described here is a simple means to induce, maintain, and reverse fibrillation. Although dissecting out the base of the right ventricle to attach a fibrillator lead is also possible, this adds another layer of complexity to the surgery with increased risk of bleeding and injury to the heart, and risks unanticipated cardiac ejection if wires are displaced and the heart beats spontaneously. By using the AICD to fibrillate, we were able to keep the procedure almost entirely within the LVAD pocket, making it truly minimally invasive. Furthermore, as seen in our case, defibrillation by external pads may be difficult.

The potential applications of this approach are not limited to LVAD device exchange, but could be extended to other minimal access cardiac surgical procedures in patients who have AICDs. The approach may be useful in such procedures, particularly where access to the heart is limited, or where there is a desire to avoid aortic clamping, such as mitral valve repair via thoracotomy in a patient with previous coronary bypass grafts and depressed ventricular function.

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Cardiac hemangioma at the apex of the right ventricle: A case report and literature review

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Primary tumors and cysts of the heart and pericardium are rare, and only 2.8% of these tumors are cardiac hemangiomas.[1] Ventricular hemangiomas are extremely uncommon. We report one of these unusual cases and discuss others in the literature.

CLINICAL SUMMARY

A 49-year-old man without symptoms was admitted to our hospital. A mass between the right ventricle (RV) and the pericardium was demonstrated on his chest computed tomography (Figure 1, *A*). Transthoracic echocardiography showed the mass to be located at the apex of the RV, and there was no hemodynamic abnormality or RV outflow tract obstruction.

The mass adjacent to the RV had a clear border with the normal myocardium (Figure 1, *B*). It was totally excised under cardiopulmonary bypass. A patch of autologous pericardium covered with Dacron polyester fabric was used for the reconstruction of the RV (Figure 1, *C*). This patient recovered uneventfully, with no evidence of recurrence after 6 months of follow-up. The size of the mass was 6.8 × 5.0 × 2.6 cm (Figure 1, *D*). Histologic diagnosis was hemangioma (Figure 1, *E*).

DISCUSSION

Primary tumors and cysts of the heart and pericardium are rare, and only 2.8% of these tumors are cardiac hemangiomas.[1] Hemangiomas of the heart affect all ages and may occur anywhere within the heart,[2] but ventricular hemangiomas are extremely uncommon. In 45 reviewed cases of cardiac hemangioma, only 11 were located in the RV.[3] Cardiac hemangiomas are vascular tumors composed of capillaries or cavernous vascular channels, and most are benign.[4] Surgery is the first choice of therapy in all patients with cardiac tumors.[5]

To date, 30 cases of hemangiomas located in the RV (including that reported here) have been reported in the literature. Table 1 shows the summary of preoperative data and lists the surgical procedures in these cases. The

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