Predictors and clinical relevance of ventricular tachyarrhythmias in ambulatory patients with a continuous flow left ventricular assist device

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BACKGROUND Patients with a left ventricular assist device (LVAD) are at high risk for ventricular tachyarrhythmias (VTAs).

OBJECTIVE We aimed to identify clinical predictors of VTAs and subsequent outcomes after VTA in ambulatory LVAD patients.

METHODS A retrospective study of 149 patients with a continuous flow HeartMate II LVAD who survived to discharge from index hospitalization after LVAD implantation was performed from January 10, 2005, to September 3, 2013. A multivariate Cox model was used to assess clinical predictors of VTAs.

RESULTS During a mean follow-up period of 2.1 ± 1.2 years, 41 patients (28%) experienced VTAs; 30 of these patients (71%) had ventricular tachycardia, and 11 (29%) had ventricular fibrillation. History of VTAs before LVAD (hazard ratio [HR] 3.06; 95% confidence interval [CI] 1.57–5.96; $P = .001$) and history of atrial fibrillation (AF) (HR 3.13; 95% CI 1.60–6.11; $P = .008$) were the most powerful predictors of VTAs after LVAD implantation. There were 19 deaths (46%) among patients with VTAs and 15 deaths (14%) among patients without VTAs ($P < .001$). In multivariate analysis, time-dependent VTAs after LVAD implantation were associated with a significantly higher risk of all-cause mortality when compared with those without VTAs (HR 7.28; 95% CI 3.50–15.15; $P < .001$).

CONCLUSION In ambulatory LVAD patients, history of VTAs before LVAD implantation and history of AF predict VTAs after LVAD implantation. VTAs are associated with an increased risk of mortality. In such patients, aggressive measures to control VTAs and AF should be considered.

KEYWORDS Left ventricular assist device; Implantable cardioverter-defibrillator; Atrial fibrillation; Ventricular tachycardia; Ventricular fibrillation

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Introduction

The increasing number of patients with advanced heart failure presents significant challenges to our health care system.[1] Guideline-directed medical therapies for heart failure are now complemented with device-based therapies, such as implantable cardioverter-defibrillators (ICDs),[2,3] cardiac resynchronization therapy with defibrillators,[4,5] and mechanical circulatory support systems,[6,7] all of which have shown to decrease morbidity and improve survival. Left ventricular assist devices (LVADs) can improve functional status and survival in patients with advanced heart failure and are now being implanted with increasing frequency for both destination therapy and bridge to transplantation therapy.

Although a careful selection of patients for LVAD support can ensure meaningful survival post-LVAD implantation, these patients remain at high risk for complications including ventricular tachyarrhythmias (VTAs).[8–10] With the growing use of mechanical circulatory support, the recognition and management of such cardiac arrhythmias have become of greater significance in this high-risk patient population. Several groups have published outcomes in patients with a concomitant LVAD and ICD,[11,12] and some studies have indicated a reduction in mortality in LVAD patients implanted with an ICD.[13,14] In this analysis, we aimed (1) to identify clinical predictors of VTAs and (2) to assess survival subsequent to VTAs in a cohort of ambulatory patients with a continuous flow LVAD and a concurrent ICD.

Methods

Study design

A retrospective study of all ambulatory patients with a continuous flow HeartMate II (Thoratec, Pleasanton, CA)

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LVAD was performed from January 10, 2005, to September 3, 2013, at the University of Rochester Medical Center, Rochester, NY. The Research Subjects Review Board of the University of Rochester Medical Center approved the study protocol.

Study population

Patients who were discharged from index hospitalization after LVAD implantation were considered "ambulatory" and defined our study population. Our study participants also had an ICD implantation; information on the presence or absence of an ICD at the time of LVAD implantation or subsequently during the study follow-up was collected through chart review. We included patients for only whom we had regular follow-up and reliable device interrogation data. During the study period, 204 patients underwent implantation of a continuous flow HeartMate II LVAD. Of the 204 patients, 24 did not have an ICD implanted, 19 were never discharged from index hospitalization after LVAD implantation, 10 did not have their ICDs monitored at our institution, and 2 patients were transferred to another tertiary care institution and therefore follow-up data were unavailable. The remaining 149 patients constituted our study population.

A detailed chart review was performed to gather information on patient's demographic characteristics and baseline clinical characteristics, including comorbidities and medications. For patients with an ICD in place before LVAD implantation, follow-up began from the LVAD implantation date. For those patients who underwent ICD implantation subsequent to LVAD implantation, follow-up began with ICD implantation date (and not the LVAD date).

Outcomes

The primary outcome was the first occurrence of ventricular tachycardia (VT) or ventricular fibrillation (VF), whichever occurred first, defined as ICD-delivered appropriate shock or antitachycardia pacing. The secondary outcome was all-cause mortality. This outcome was assessed through electronic medical record review. Outcomes occurring during the index hospitalization for LVAD implantation were excluded, given the increased likelihood of such events occurring in this particular setting.[15]

ICD interrogations

Patients in this analysis included those for whom reliable interrogation reports were available. Device therapy history was assessed regularly on a quarterly basis either through remote ICD monitoring systems or during regular clinic visits. For those patients with an ICD implanted at another institution, either device interrogations were recorded during LVAD follow-up visits or findings were communicated to our institution and subsequently entered into the electronic medical record.

Tachycardia detection settings and therapies were programmed according to implanting physician preferences. But in general, devices were programmed to detect VT/VF starting at rates ranging from 170 to 200 beats/min and ICD therapies were set to deliver antitachycardia pacing and shock therapy. Only ventricular arrhythmias resulting in appropriate device therapy were analyzed. Ventricular arrhythmias below the device detection cutoff or nonsustained ventricular arrhythmias were not analyzed. VT and VF were defined based on device programmed rate cutoffs.

LVAD implantation

Implantation of an LVAD has previously been described.[16] Briefly, after a median sternotomy and initiation of cardiopulmonary bypass, LV coring at the LV apex is performed and the LVAD inflow cuff is secured using pledgeted 2-0 Ethibond sutures (Ethicon, Somerville, NJ) and the inflow cannula is inserted and secured. The aortic outflow graft is then tailored to length and sewn end-to-side to the midportion of the ascending aorta. After de-airing, the outflow cannula is connected to the HeartMate II pump and the patient is weaned from cardiopulmonary bypass. The LVAD pump speed is adjusted to obtain adequate filling pressures. Transesophageal echocardiography is used to further adjust LVAD settings to assure that the interventricular septum remains midline and that native LV ejection is intact. LVAD-associated complications include thrombosis, device failure, infection, cerebrovascular accident during LVAD support, and any bleeding event requiring transfusion.

Statistical analysis

Baseline variables were compared between patients with and without post-LVAD VTAs using the Wilcoxon 2-sample test for continuous variables and the χ^2 test for categorical variables. Outcomes and associations with VTAs were evaluated using Kaplan-Meier survival analysis with comparison using the log-rank test and Cox proportional hazards regression models.

The multivariate Cox models were adjusted for clinical covariates selected using stepwise selection that were significantly associated with the specific outcome evaluated using a 2-sided P-value of $<.05$. Analyses were performed with SAS software version 9.4 (SAS Institute Inc, Cary, NC).

Results

A total of 149 patients, 127 (85%) men and 22 (15%) women were included in the study. All implanted LVADs were continuous flow HeartMate II devices, with 65 patients (44%) implanted as a bridge to transplantation therapy and 84 patients (56%) as destination therapy.

Predictors of VTAs in LVAD patients

During a mean follow-up period of 2.1 $\pm$ 1.2 years, 41 patients (28%) experienced post-LVAD VTAs (30 episodes of VT and 11 episodes of VF). Nineteen patients with VTAs (46%) and 15 patients without VTAs (19%) died ($P < .001$). Patient characteristics at the time of LVAD implantation, dichotomized by the presence or absence of post-LVAD VTAs, are presented in Table 1. The 2 groups were similar