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Characterization of Ventricular Tachycardia After Left Ventricular Assist Device Implantation as Destination Therapy

A Single-Center Ablation Experience

Joshua D. Moss, MD,[a] Erin E. Flatley, RN, MSN, ANP-BC,[b] Andrew D. Beaser, MD,[b] John H. Shin, MD,[c] Hemal M. Nayak, MD,[b] Gaurav A. Upadhyay, MD,[b] Martin C. Burke, DO,[d] Valluvan Jeevanandam, MD,[b] Nir Uriel, MD,[b] Roderick Tung, MD[b]

ABSTRACT

OBJECTIVES This study sought to report mechanisms of ventricular tachycardia (VT) and outcomes of VT ablation in patients with a left ventricular assist device (LVAD) as destination therapy.

BACKGROUND Continuous flow LVAD implantation plays a growing role in the management of end-stage heart failure, and VT is common. There are limited reports of VT ablation in patients with a destination LVAD.

METHODS Patients with a continuous-flow LVAD referred for VT ablation from 2010 to 2016 were analyzed retrospectively. Baseline patient characteristics, procedural data, and clinical follow-up were evaluated. Arrhythmia-free survival was assessed.

RESULTS Twenty-one patients (90% male, 62 ± 10 years) underwent catheter ablation of VT at a median of 191 days (interquartile range: 55, 403 days) after LVAD implantation (15 HeartMate II, 6 HeartWare HVAD). Five patients (24%) had termination (n = 4) or slowing (n = 1) of VT with ablation near the apical inflow cannula, and 3 (14%) had bundle-branch re-entry. Freedom from recurrent VT among surviving patients was 64% at 1 year, with overall survival 67% at 1 year for patients without arrhythmia recurrence and 29% for patients with recurrence (p = 0.049). One patient had suspected pump thrombosis within 30 days of the ablation procedure, with no other major acute complications.

CONCLUSIONS In this relatively large, single-center experience of VT ablation in destination LVAD, freedom from recurrent VT and implantable cardioverter-defibrillator shocks was associated with improved 1-year survival. Bundle branch re-entry was more prevalent than anticipated, and cannula-adjacent VT was less common. This challenging population remains at risk for late pump thrombosis and mortality. (J Am Coll Cardiol EP 2017;■:■–■)

Left ventricular assist device (LVAD) therapy is increasingly used for treatment of advanced heart failure, having been shown to improve survival after eventual cardiac transplantation (1,2) as well as survival and quality of life as destination therapy in patients ineligible for transplantation (3,4). Earlier pulsatile-flow devices have largely given way to smaller and more durable continuous-flow devices, with improved outcomes (4–6).

Ventricular arrhythmias (VA) are common in patients with continuous-flow LVAD—particularly in those patients with a history of VA prior to LVAD

From the [a]Section of Cardiac Electrophysiology, Division of Cardiology, University of California-San Francisco, San Francisco, California; [b]Heart and Vascular Center, University of Chicago Medicine, Chicago, Illinois; [c]Mid-Atlantic Permanente Medical Group, Rockville, Maryland; and the [d]CorVita Science Foundation, Chicago, Illinois. Dr. Moss has served as a consultant for St. Jude Medical. Dr. Nayak has received speaker's honoraria from Biosense Webster. Dr. Upadhyay has received research support from Medtronic and Biotronik. Dr. Jeevanandam has served as a consultant for and scientific advisor to Thoratec; and as a scientific advisor to ReliantHeart and HeartWare. Dr. Uriel has received grant support from and has served as a consultant for Abbott and Medtronic. All other authors have reported that they have no relationships relevant to the contents of this paper to disclose.

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ABBREVIATIONS AND ACRONYMS

BBRT = bundle-branch re-entrant ventricular tachycardia

EF = ejection fraction

ICD = implantable cardioverter-defibrillator

INR = international normalized ratio

IQR = interquartile range

LVAD = left ventricular assist device

RF = radiofrequency

RV = right ventricular

VA = ventricular arrhythmia

VT = ventricular tachycardia

implantation—and are associated with increased morbidity (7) and mortality (8,9). The benefits of catheter ablation for VA have been demonstrated across a wide spectrum of patients (10,11). Favorable outcomes of VA ablation in patients with continuous-flow LVAD have been published in several cohorts, including a single-center experience across the temporal spectrum of device technologies (12), a multicenter experience with the HeartMate II device (Thoratec, Pleasanton, California) (13), and several smaller cohorts (14-16).

We sought to describe the mechanisms, timing, and ablation outcomes in a relatively large single-center VA ablation experience in patients with a continuous-flow LVAD prescribed as destination therapy.

METHODS

All patients with a continuous-flow LVAD who underwent an electrophysiology study and ablation procedure for VA at the University of Chicago Medicine were included. All relevant clinical and procedural data were collected retrospectively from the medical chart, procedure report, electrophysiology recording system, 3-dimensional mapping system, and implantable cardioverter-defibrillator (ICD) interrogations. Early VA was defined as sustained monomorphic ventricular tachycardia (VT) or ventricular fibrillation that occurred either within 30 days of LVAD implantation or during the same hospitalization as LVAD implantation. Retrospective analysis of the data was approved by the institutional review board.

PATIENT SELECTION. The decision to proceed with VT ablation was made on a case-by-case basis at the discretion of the Heart Failure/Mechanical Circulatory Support team and the consulting electrophysiologist. None of the patients in this cohort were deemed eligible for cardiac transplantation. Ablation was most often considered for recurrent sustained VA requiring ICD therapy more than 1 month after LVAD implantation despite a trial of antiarrhythmic drug therapy. A smaller number of patients were also referred for VT storm, or concern for exacerbation of right ventricular (RV) failure in the setting of recurrent VT, occurring within 2 weeks after LVAD implantation. Suction events, with irritation of ventricular myocardium pulled into contact with the inflow cannula, could often be identified by stereotypical nonsustained and polymorphic bursts of VA, frequently correlating with transient changes in logged pump parameters. Whenever suspected, these were first treated with adjustment of diuretic dosing and/or LVAD pump speed, either empirically or guided by hemodynamic ramp testing (17), prior to consideration of ablative therapy.

ELECTROPHYSIOLOGY STUDY AND ABLATION. All procedures were performed at the University of Chicago Medical Center. Procedures were performed under conscious sedation or general endotracheal anesthesia per operator discretion. Anticoagulation with warfarin with target international normalized ratio (INR) 2 to 3 was continued uninterrupted or periprocedural anticoagulation was maintained with therapeutic heparin as needed. Heparin was also administered during all procedures to achieve and maintain a goal activated clotting time >300 s prior to any left-sided instrumentation. Catheters were advanced via femoral venous and/or arterial access, and LVAD controller parameters were continuously monitored. Temporary adjustments of LVAD pump speed were made as needed to facilitate retrograde aortic and/or transseptal access. Percutaneous epicardial access was not attempted in any of the cases.

Three-dimensional electroanatomic endocardial voltage maps were created using commercially available mapping systems (CARTO 3, Biosense Webster, Diamond Bar, California [n = 16]; Velocity, St. Jude Medical, Minneapolis, Minnesota [n = 4]; or Rhythmia, Boston Scientific, Natick, Massachusetts [n = 1]) and used to delineate areas of scar with standard low-voltage settings (<1.5 mV) (18) and abnormal electrical activation. Intracardiac echocardiography was to guide transseptal access when chosen, monitor catheter position and lesion formation, and visualize the LVAD inflow cannula. Cannula-adjacent VT was defined when targeted within 2 cm of the inflow cannula, and non-cannula-associated VT was defined when targeted within or near regions of scar that were remote and distinct from the inflow cannula.

Whenever clinically feasible, VA were induced with programmed stimulation to facilitate activation and/or entrainment mapping as appropriate. An isthmus was defined as a site that demonstrated concealed fusion with a post-pacing interval within 30 ms of the VT cycle length and a stimulus-to-QRS interval equal to electrogram-QRS (19). Pace-mapping was also used in the majority of procedures to help localize ablation in regions where matches with the targeted VT were seen, particularly at sites with longer stimulus-QRS latency (20). Regions of late activation or local conduction delay as evidenced by split, fractionated, or isolated late potentials were also tagged and targeted for ablation