Procedural and clinical outcomes after catheter ablation of unstable ventricular tachycardia supported by a percutaneous left ventricular assist device

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BACKGROUND Hemodynamic support using percutaneous left ventricular assist devices (pLVADs) during catheter mapping and ablation of unstable ventricular tachycardia (VT) can provide effective end-organ perfusion. However, its effect on procedural and clinical outcomes remains unclear.

OBJECTIVE To retrospectively evaluate the procedural and clinical outcomes after the catheter ablation of unstable VT with and without pLVAD support.

METHODS Sixty-eight consecutive unstable, scar-mediated endocardial and/or epicardial VT ablation procedures performed in 63 patients were evaluated. During VT mapping and ablation, hemodynamic support was provided by intravenous inotropes with a pLVAD (n = 34) or without a pLVAD (control; n = 34).

RESULTS Baseline patient characteristics were similar. VT was sustained longer with a pLVAD (27.4 ± 18.7 minutes) than without a pLVAD (5.3 ± 3.6 minutes) ($P < .001$). A higher number of VTs were terminated during ablation with a pLVAD (1.2 ± 0.9 per procedure) than without a pLVAD (0.4 ± 0.6 per procedure) ($P < .001$). Total radiofrequency ablation time was shorter with a pLVAD (53 ± 30 minutes) than without a pLVAD (68 ± 33 minutes) ($P = .022$), but with similar procedural success rates (71% for both pLVAD and control groups; $P = 1.000$). Although during 19 ± 12 months of follow-up VT recurrence did not differ between pLVAD (26%) and control (41%) groups ($P = .305$), the composite end point of 30-day rehospitalization, redo-VT ablation, recurrent implantable cardioverter-defibrillator therapies, and 3-month mortality was lower with a pLVAD (12%) than without a pLVAD (35%) ($P = .043$).

CONCLUSION In this nonrandomized retrospective study, catheter ablation of unstable VT supported by a pLVAD was associated with shorter ablation times and reduced hospital length of stay. While pLVAD support did not affect VT recurrence, it was associated with a lower composite end point of 30-day rehospitalization, redo-VT ablation, recurrent implantable cardioverter-defibrillator therapies, and 3-month mortality.

KEYWORDS Catheter ablation; Hospital length of stay; Ischemic cardiomyopathy; Non–ischemic cardiomyopathy; Percutaneous left ventricular assist device; Ventricular tachycardia

ABBREVIATIONS **EMI** = electromagnetic interference; **IABP** = intra-aortic balloon pump; **ICD** = implantable cardioverter-defibrillator; **ICM** = ischemic cardiomyopathy; **LOS** = length of stay; **non-ICM** = non–ischemic cardiomyopathy; **pLVAD** = percutaneous left ventricular assist device; **$SctO_2$** = cerebral tissue oxygen saturation; **VT** = ventricular tachycardia

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Introduction

Scar-mediated ventricular tachycardias (VTs) are often hemodynamically unstable,[1] limiting detailed entrainment and activation mapping to guide catheter ablation.[2] Instead, substrate-based modification is commonly used, which involves targeting the arrhythmogenic substrates in sinus rhythm.[3–5] Yet in some patients, particularly in those with non–ischemic cardiomyopathy (non-ICM), mapping of low-voltage areas does not always exhibit fractionated and/or late potentials, such that a clear substrate cannot be identified.[6]

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Under these circumstances, mapping during tachycardia seems more attractive but can often only be performed given sufficient hemodynamic support. In addition, in those with significant left ventricular (LV) dysfunction, prolonged episodes of sustained VT can sometimes lead to exacerbation of heart and/or renal failure even in the setting of a hemodynamically tolerated arrhythmia, affecting patient morbidity and clinical outcomes.[7] Hence, it is conceivable that such patients may benefit from hemodynamic support during catheter mapping and ablation of VT.

While vasoactive drugs and intra-aortic balloon pumps (IABPs) are most commonly used for hemodynamic stabilization, frequently in the setting of unstable VT they provide insufficient support. Specifically, low systolic blood pressure and tachycardia can significantly impair IABP performance.[8] In contrast, percutaneous left ventricular assist devices (pLVADs) are less susceptible to such variables and generally capable of providing greater hemodynamic stability and end-organ perfusion in the setting of unstable VT.[9] Theoretically, LV unloading by pLVADs may also minimize periprocedural heart failure. However, it remains unclear whether pLVAD support during VT mapping and ablation can significantly affect the short- and long-term clinical outcomes.

Here, we report a retrospective, nonrandomized analysis of the procedural and clinical outcomes after catheter ablation of unstable, scar-mediated VT with/without hemodynamic support provided by an impeller-driven axial flow pump (pLVAD) as compared with a standard-of-care control group.

Methods

Study population

We retrospectively evaluated a total of 68 consecutive catheter ablation procedures performed for the treatment of scar-mediated hemodynamically unstable VT (defined as a mean arterial blood pressure of $\leq$50 mm Hg and/or requiring internal/external defibrillation) in 63 patients with structural heart disease by using an endocardial/epicardial approach. The procedures were performed by 2 operators at a single center (Mercy General Hospital, Sacramento, CA) with/without a pLVAD, whenever available. Data were obtained from reviewing medical/hospital records.

Data analysis

Five groups/subgroups of patients were analyzed: (1) the entire patient cohort (n = 68); (2) patients who underwent mapping and ablation with and without pLVAD (control); (3) patients with ischemic cardiomyopathy (ICM; n = 36) and non-ICM (n = 32); (4) patients with ICM in the pLVAD group (ICM-pLVAD group; n = 18), patients with ICM in the control group (ICM-control group; n = 18), patients with non-ICM in the pLVAD group (non-ICM-pLVAD group; n = 16), and patients with non-ICM in the control group (non-ICM-control group; n = 16); and (5) patients who underwent mapping and ablation with IABP (n = 12) vs control. The primary end point was defined as VT recurrence during follow-up. The secondary composite end point consisted of 30-day rehospitalization, redo-VT ablation, recurrent implantable cardioverter-defibrillator (ICD) therapies (both shocks and antitachycardia pacing), and 3-month mortality. These end points were not predefined but were ascribed after data collection. All patients had a preexisting ICD or a cardiac resynchronization therapy-defibrillator at the time of ablation. VT recurrence and ICD therapies were examined throughout follow-up through serial ICD/cardiac resynchronization therapy-defibrillator interrogations.

Procedural details

All procedures were performed under general anesthesia. During VT mapping/ablation, all patients received inotropic support with intravenous dobutamine or dopamine (2–20 μg/(kg · min)) and repeated boluses of phenylephrine (100 μg) with/without a pLVAD. Although not considered standard practice, we prefer the use of inotropic agents to provide hemodynamic support under general anesthesia during VT mapping. In addition to the conventional markers of hemodynamic stability, cerebral oximetry (ie, cerebral tissue oxygen saturation [$SctO_2$]) was monitored (Figure 1) using a cerebral oximeter (INVOS, Covidien, Mansfield, MA), as described previously.[10] $SctO_2$ has been shown to represent a sensitive indicator of cerebral hypoxia and end-organ perfusion.[11] $SctO_2$ was measured at baseline and throughout the procedure on 100% fraction of inspired oxygen. During VT, a lower limit of 20%–25% of the preanesthesia induction value was allowed.[11]

Cardiac assist devices

A 12/13-F pLVAD (Impella 2.5/Impella CP, ABIOMED, Inc, Danvers, MA) was inserted after systemic anticoagulation (target activated clotting time $\geq$250 seconds). The pLVAD was positioned inside the LV in a retrograde transaortic fashion via a 13/14-F introducer sheath through the femoral artery. A maximum performance level of 9 (50,000 rpm, up to 2.5 L/min [Impella 2.5] or 3.8 L/min [Impella CP]) was maintained throughout the procedure unless electromagnetic interference (EMI) necessitated temporary adjustments. As previously described by Miller et al,[10] this may occur with the use of a magnetic-based mapping system. The severity of EMI depends on the Impella performance level and the mapping catheter distance from the motor.[10] To overcome this, the pLVAD performance was reduced to P2 (usually required only when mapping within the outflow tract endocardially or at the base of the heart epicardially[10]). The Impella CP seems to be associated with a smaller degree of EMI, possibly owing to improved insulation of the motor. All venous/arterial sheaths and pLVADs were inserted electively at the onset of the procedure and weaned/removed before discharge from the electrophysiology laboratory by the cardiac electrophysiologist operator. For closure of the pLVAD arteriotomy site, the preclose technique (using 2 Perclose ProGlide devices, Abbott Laboratories, Abbott Park, IL) was used.[12]