Electrical storm and catheter ablation of ventricular tachycardia days after left ventricular assist device implantation

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Abstract

Ventricular arrhythmias are common complication associated with left ventricular assist devices (LVAD). We present a challenging case of a 57-year-old male LVAD recipient who developed ventricular tachycardia refractory to antiarrhythmic drugs and device therapy in the early postoperative period and was eventually successfully treated with radiofrequency catheter ablation. Ventricular arrhythmias were successfully mapped, eliminated with ablation, and remained non-inducible. This case demonstrates that ventricular arrhythmia catheter ablation can be feasible, effective, and safe in LVAD recipients with a scar-related electrical storm even days after LVAD implantation. Although optimal treatment strategy in this patient population still needs to be defined, catheter ablation should be considered in LVAD recipients with ventricular arrhythmias refractory to antiarrhythmic drugs and device therapy representing a treatment of last resort.

Key words: ventricular arrhythmias, catheter ablation, ventricular assist devices, mechanical circulatory support, advanced heart failure

Sažetak

Električna oluja i kateterska ablacija ventrikulske tahikardije danima nakon ugradnje uređaja za mehaničku cirkulacijsku potporu lijevoj klijetci

Ventrikulske aritmije česta su komplikacija povezana s uređajima za mehaničku cirkulacijsku potporu lijevoj klijetci (LVAD). Predstavljamo izazovan slučaj 57-godišnjeg bolesnika, nosioca LVAD-a, koji je razvio ventrikulsku tahikardiju otpornu na antiaritmike i terapiju defibrilacijskim uređajem u ranom poslijeoperativnom razdoblju te je u konačnici uspješno liječen radiofrekventnom kateterskom ablacijom. Ventrikulske aritmije bile su uspješno mapirane, eliminirane ablacijom te neinducibilne na kraju procedure. Ovaj slučaj pokazuje da kateterska ablacija ventrikulskih aritmija može biti izvediva, učinkovita i sigurna u nosioca LVAD-a s električnom olujom čak i nekoliko dana nakon ugradnje. Iako optimalna strategija liječenja ove populacije još nije potpuno određena, katetersku ablaciju valja razmotriti kao krajnje rješenje kod nosioca LVAD-a s ventrikulskim aritmijama otpornim na antiaritmike i na terapiju defibrilacijskim uređajem.

Ključne riječi: ventrikulske aritmije, kateterska ablacija, uređaj za mehaničku cirkulacijsku potporu lijevoj klijetci, uznapredovalo srčano popuštanje

Introduction

The continuous-flow left ventricular assist device (LVAD) is an established treatment option for patients with advanced heart failure (HF) with a steep implantation rate increase over the past decade.[1] Ventricular arrhythmias (VA) are common complication associated with this therapeutic modality and the VA burden might rise after an LVAD implantation, increasing the risk of adverse outcomes.[2-4] A noticeable fraction of these patients experience incessant VAs or electrical storm (ES) refractory to antiarrhythmic drugs (AAD)[5]. Therefore, they are eligible for radiofrequency (RF) catheter ablation. In this report, we present a challenging case of an HF patient with AAD-refractory ES soon after LVAD implantation. According to available data, this is the first case of an RF catheter ablation of VA in an LVAD recipient in our country.

Case presentation

A 57-year-old male patient with advanced HF due to ischaemic cardiomyopathy underwent HeartMate III LVAD (Abbott Laboratories, Chicago, IL, USA) implantation in April 2021. He developed incessant ventricular tachycardia (VT) in the early postoperative period with multiple shocks delivered by cardiac resynchronization therapy defibrillator device (CRT-D). His previous history included acute ST-elevation myocardial infarction three years before LVAD implantation, paroxysmal atrial fibrillation, type 2 diabetes, and chronic kidney disease. He was an elective candidate for heart transplantation (HTx), but his status was upgraded to urgent after three frequent hospital admissions due to HF worsening. During the last HF hospitalization, the patient required inotropic and vasoactive support due to hemodynamic instability and suffered from sustained VTs that were terminated by frequent antitachycardia pacing (ATPs). The right heart catheterization findings prohibited heart transplantation and the patient eventually received LVAD.

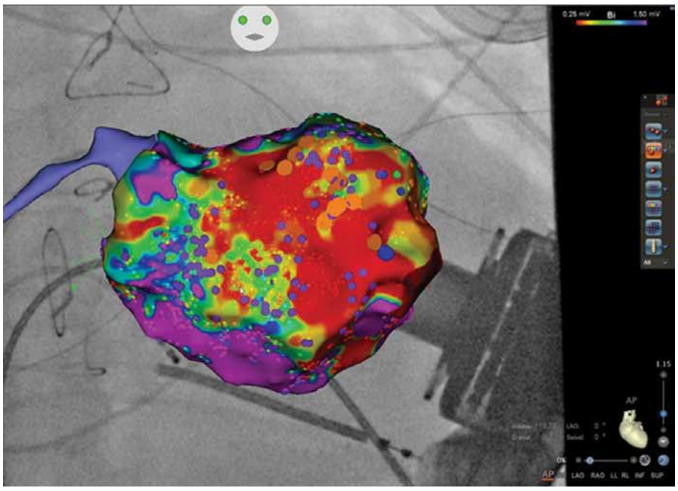

Figure 1: Electroanatomical map in the anteroposterior projection depicting an extensive dense scar (in red), mid-diastolic potentials (purple dots), and late mid-diastolic potentials (orange balls)

On the sixth postoperative day, the patient developed repetitive VTs with CRT-D shocks and was initially stabilized with amiodarone. However, VT recurred and required additional AADs administration (magnesium, propranolol, lidocaine, and mexiletine), but without a favorable treatment response. LVAD parameters were optimized. Nevertheless, VT became persistent and the patient was referred for an electrophysiological study and catheter ablation.

The procedure was performed on uninterrupted warfarin (INR 2.57) and under conscious sedation with diazepam. Vascular access was obtained via femoral veins. Intracardiac echocardiography was used for transseptal puncture guidance. High-density electroanatomical map of the left ventricle was recorded using a 3-D mapping system (CARTO3®, Biosense Webster, Inc., Diamond Bar, CA, United States) and a multipolar mapping catheter (PentaRay® Biosense Webster, Inc., Diamond Bar, CA, United States) with emphasis on diastolic potentials (Figure 1). Moderate electromagnetic interference due to LVAD was present on surface ECG, but not on endocardial electrograms. During mapping, at least five different VT morphologies with similar cycle lengths of around 380 ms were observed (Figure 2), originating from an extensive scar in the antero-septo-apical region which also exhibited a lot of diastolic potentials. Potential VT isthmuses were identified and ablation lines were designed to eliminate them. During ablation VT morphology changed twice and only after ablation near the LVAD inflow cannula, a conversion to paced rhythm was achieved (Figure 3). Michigan VT provocation protocol was conducted, but clinical VT could no longer be provoked. Extremely fast VT was provoked only on very aggressive ventricular stimulation. After ATP it degenerated into VF which was hemodynamically tolerated. Finally, external defibrillation had to be performed and the patient was converted to atrial fibrillation with biventricular pacing (underlying complete heart block). There were no complications and antiarrhythmic therapy was reduced to a lower dose of amiodarone and propranolol following the procedure.

Discussion

Large observational retrospective studies have reported the rate of ES in LVAD recipients between 9% and 10.7%. Furthermore, between 35% and 63% of these events occur during the first month after implantation. A history of VAs before LVAD implantation, HF duration > 84 months, AAD therapy and perioperative mechanical circulatory support were identified as an independent risk factors for ES following LVAD implantation.[6,7] These studies also found early ES was associated with lower rate of survival, which is in accordance with previously published data that had reported a three- to six-fold increased risk of death

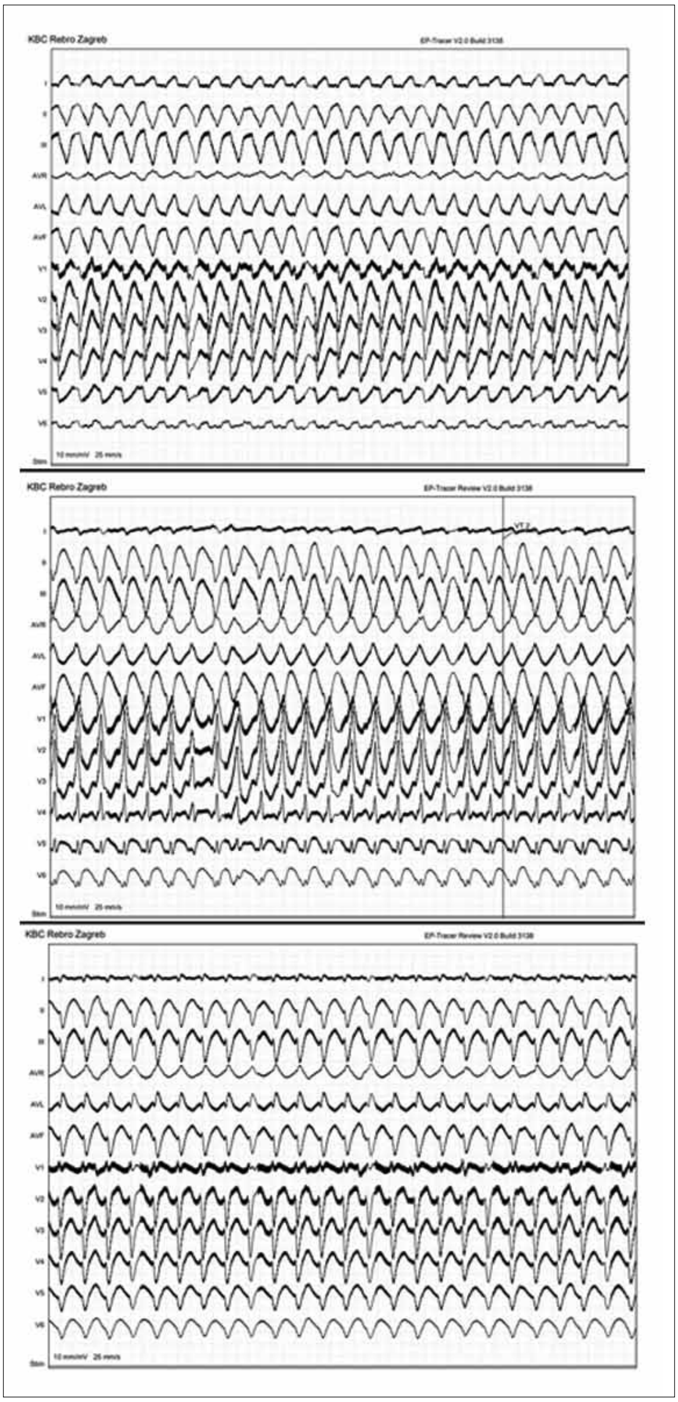

Figure 2: A 12-lead electrocardiograms during the electrophysiology study show different VT morphologies

as well as a negative impact on hospitalization rate and quality of life in LVAD recipients with ES.[8,9]

The potential causes of VAs in these patients include myocardial ischemia (old scars or a scar at the LVAD inflow cannulation site), suction events due to excessive left ventricular unloading, electrolyte disturbances, myocardial depolarization and repolarization abnormalities, and the use of inotropic agents early after implantation.[7,10] Considering the ischemic substrate, it is important to stress that VAs are mostly related to the preexistent cardiomyopathy substrate rather than the cannulation site. VAs are usually hemodynamically well-tolerated in LVAD recipients due to circulatory support provided by the device and are more often than not successfully managed with AADs, cardioversion, ATP, or defibrillation shocks. Catheter ablation, although rarely performed, is an important treatment option for refractory VAs unresponsive to previously mentioned conventional management.

Data on catheter ablation of VAs in patients with novel fully magnetically levitated HeartMate III LVAD, the latest in the evolution of LVADs, are scarce. Bergau et al. reported the results of a single-center observational prospective study that included five patients who underwent catheter ablation of VA in the presence of a HeartMate III LVAD and demonstrated the feasibility, efficacy, and safety of a conventional ablation approach in these conditions.[11] Similar conclusions were drawn in a study by Nof et al. on a cohort of 19 patients.[11] Although some authors hypothesized potential interference between LVAD and electroanatomical mapping systems[11,12], we found no significant interferences during the procedure.

Conclusion

Our case showed that VA catheter ablation can be feasible, effective, and safe in LVAD recipients with a scar-related ES even days after LVAD implantation. In our patient, VAs were successfully mapped, eliminated with ablation, and remained non-inducible. This supports the practice that catheter ablation should be considered in LVAD recipients with AAD-refractory VAs and multiple ICD shocks representing a treatment of last resort.

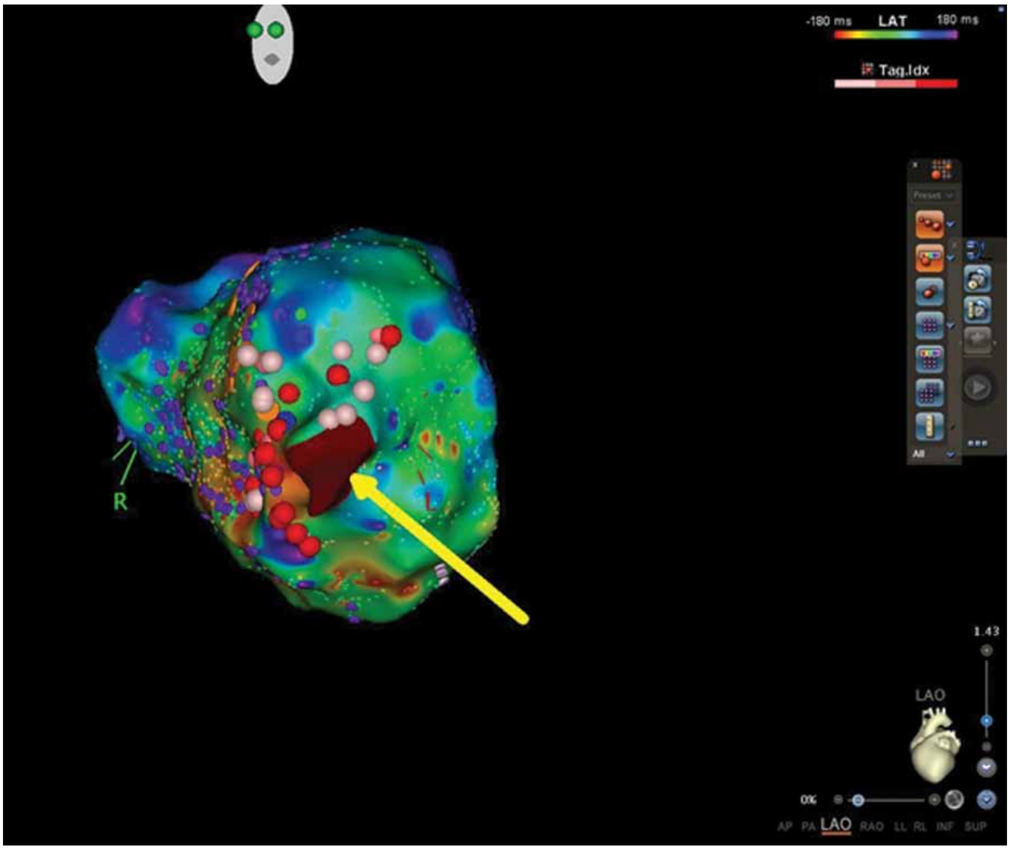

Figure 3: Electroanatomical map depicting the ablation lesions (red balls) near the LVAD inflow cannula (yellow arrow)

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