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CASE REPORT
Heart failure

A case report about successful treatment of refractory ventricular tachycardia with ablation under prolonged haemodynamic support with extracorporeal membrane oxygenation

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Background In patients with severe left ventricular dysfunction, recurrent ventricular tachycardia (VT) non-responsive to antiarrhythmic therapies may cause further deterioration of cardiac function and haemodynamic instability. The use of extracorporeal membrane oxygenation (ECMO) in the setting of haemodynamically unstable VT may allow rhythm stabilization and can be effective in providing haemodynamic stability during VT ablation procedures.

Case summary We describe the clinical course of a patient with ischaemic cardiomyopathy and recurrent VTs in the early post-myocardial infarction (MI) period. Nineteen days after MI, the patient started to experience recurrent attacks of VT, which became more frequent and non-responsive to medical treatment including amiodarone and lidocaine. The patient developed cardiogenic shock and a decision was made to institute ECMO. The patient was supported with ECMO for 32 days because of heart failure, refractory VT, and recurrent infections. An electrophysiological study was performed 4 days after ECMO initiation, which revealed a large scar area in the left ventricle. Radiofrequency energy was applied 69 times, rendering the VT non-inducible. Subsequently, VT attacks disappeared and the patient was weaned from ECMO after 32 days. The patient received a left ventricular assist device 5 days post-ECMO weaning and was then transplanted.

Discussion There is still no evidence or guidelines regarding patients with refractory VT; however, ECMO support has been successfully used during VT ablation procedures. In this case report, VT ablation had a crucial role in treating the culprit arrhythmia while the implementation of ECMO allowed a complex ablation procedure to be completed safely.

Keywords Case report • Heart failure • Ventricular tachycardia • VT ablation • Catheter ablation • Extracorporeal membrane oxygenation

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Learning points

- Ventricular tachycardia (VT) ablation is a useful procedure in controlling recurrent post-myocardial infarction VTs.
- The implementation of extracorporeal membrane oxygenation in a haemodynamically unstable patient may allow a complex ablation procedure to be completed safely.

Introduction

Ventricular tachycardia (VT) caused by scar-related re-entry represents the most common mechanism of VTs in patients with ischaemic cardiomyopathy.[1,2] Catheter ablation is an effective treatment for VT in patients with structural heart disease, preventing long-term arrhythmia, and potentially reduce hospitalization and improve survival.[3] The use of extracorporeal membrane oxygenation (ECMO) in the setting of haemodynamically unstable VT is attractive but the evidence is still limited and no consensus on the best mechanical circulatory support strategy has been reached.[4–8]

We describe the clinical course of a patient with ischaemic cardiomyopathy and recurrent VTs in the early post-myocardial infarction (MI) period, who was successfully treated with ECMO and catheter ablation under ECMO support.

Timeline

Days	Event
0	Abdominal pain which started during the night, symptoms were interpreted as gastritis. He was discharged.
0	He returned to the emergency department the same day with increased abdominal pain, right bundle branch block, and high troponin and N-terminal prohormone of brain natriuretic peptide levels (3060 and 4370 ng/L, respectively).
1	Ejection fraction of 15–20%, coronary angiography showed proximal occlusion of the left anterior descending and chronic total occlusion of the right coronary artery. The patient was treated with percutaneous coronary intervention.
2–18	Medications for heart failure with reduced ejection fraction were initiated and Levosimendan was used 15 days post-myocardial infarction.
19	Recurrent attacks of ventricular tachycardia (VT) refractory to pharmacological treatment, overdrive pacing, and electrical cardioversion.
20	The patient underwent peripheral extracorporeal membrane oxygenation (ECMO) cannulation due to cardiogenic shock and refractory VT.
24	Ventricular tachycardia ablation procedure was successfully performed during ECMO support.
53	ECMO weaning.
58	The patient received a left ventricular assist device. He was subsequently transplanted.

Case presentation

A 49-year-old male with a history of gastric ulcer presented to the emergency department early in the morning with abdominal pain which started during the night. He was assessed by a surgeon and the symptoms were interpreted as gastritis (electrocardiogram showing Q-wave inferiorly and poor R-wave progression but troponin levels were not measured) and the surgeon discharged the patient. He returned to the emergency department the same day with increased abdominal pain, right bundle branch block (RBBB), and high troponin and N-terminal prohormone of brain natriuretic peptide (NT-proBNP) levels (3060 and 4370 ng/L, respectively). Echocardiographic examination revealed a severely reduced ejection fraction of 15–20% and ventricular akinesia/hypokinesia corresponding to the left anterior descending (LAD) coronary artery. Coronary angiography showed proximal occlusion of the LAD and chronic total occlusion of the right coronary artery. The patient was treated with percutaneous coronary intervention with stent implantation in the LAD and initiated on medications for heart failure with reduced ejection fraction including angiotensin-converting enzyme inhibitor, beta-blockers, and mineralocorticoid antagonist. The patient was kept in hospital post-MI because of hypotension and severe heart failure. Treatment with the intravenous inotropic agent levosimendan was used 15 days post-MI. Nineteen days after the MI, the patient started to experience recurrent attacks of VT, which were initially responsive to administration of amiodarone, beta-blockers, magnesium, and electrical cardioversion. Subsequently, the VT attacks became more frequent and non-responsive to medical treatment including lidocaine. The patient developed cardiogenic shock with pulmonary oedema (Troponin and NT-proBNP levels were 863 and 5530 ng/L, respectively) and a decision was made to institute veno-arterial extracorporeal membrane oxygenation (VA-ECMO).

The patient underwent peripheral ECMO cannulation (femoral vein, common femoral artery, and distal perfusion catheter) 20 days post-MI. The ECMO circuit included the Cardiohelp system (Maquet, Germany). Continuous monitoring of invasive arterial pressure, pulse oximetry, electrocardiography, urine output, and central venous pressure was performed. The patient was supported with ECMO for 32 days because of heart failure, refractory VT, and recurrent infections. Refractory VT continued after placing the patient on ECMO. A temporary pacemaker was used for overdrive pacing with 100 b.p.m. Amiodarone infusion with a total dose of 6.6 g over 7 days was used together with ECMO and temporary pacemaker, to no avail.

An electrophysiological study was performed 24 days post-MI and 4 days after ECMO initiation. A diagnostic catheter was applied to the coronary sinus/right ventricle through the right femoral vein. A PentaRay diagnostic catheter and a 3.5 mm open irrigated tip Thermocool ablation catheter (Biosense Webster, Inc., Diamond Bar, CA, USA) was used for the mapping and ablation of the left

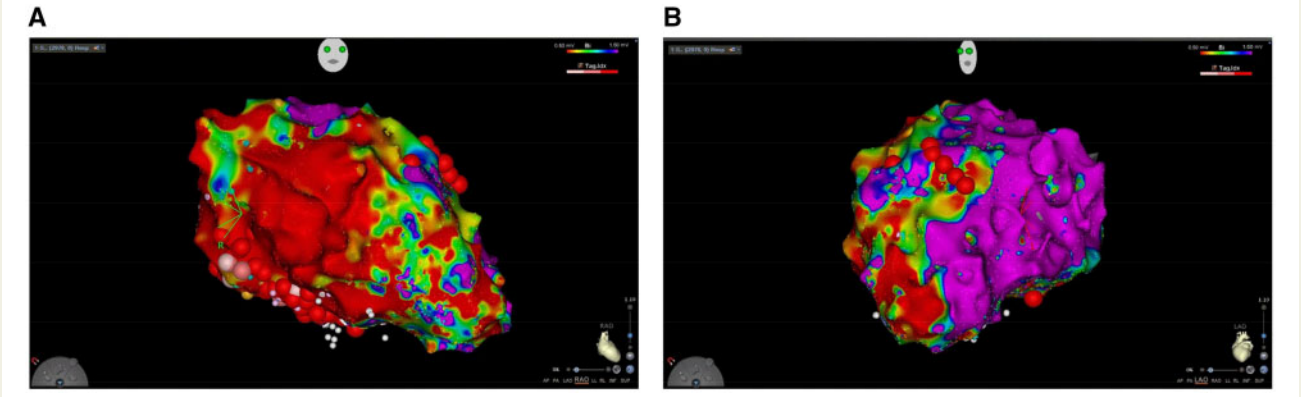


Figure 1 High-density electro-anatomical carto map of left ventricle in (*A*) right anterior oblique and (*B*) left anterior oblique projections created with a diagnostic PentaRay catheter (Biosense). The different colours represent scar tissue (red, <0.50 mV), healthy tissue (purple, >1.5 mV), and borderline tissue (orange to blue, 0.5–1.5 mV). Red and pink dots indicate ablation lesions.

ventricle by trans-septal puncture. High-density electro-anatomical mapping with the CARTO 3 (Biosense Webster, Inc., Diamond Bar, CA, USA) was performed (*Figure 1*). Simultaneous bipolar and unipolar maps were acquired to define areas of low voltage (respectively, <1.5 and <8.3 mV) or scar (<0.5 and <5.0 mV). Electrophysiological study revealed a large scar area anteriorly and inferiorly near septum in the left ventricle. Ventricular tachycardia with RBBB morphology and a frequency of 160 b.p.m. was induced (*Figure 2*). Exit of this VT was identified using Paso mapping (Carto, Biosense Webster, Diamond Bar, CA, USA) and was located at the mid-ventricular infero-lateral scar boarder. Radiofrequency energy (40 W at ~60 s per ablation site, irrigation 30 mL/min) was applied 69 times inferiorly and near septum with a total ablation time of 3440 s, rendering the VT non-inducible. We did not experience any interference with the catheter visualization in carto due to the haemodynamic support with ECMO.

Two days after ablation, the patient suffered from 10 VT attacks that were responsive to electrical cardioversions, amiodarone and lidocaine infusion. Repeat ablation was considered too high risk due to large scar area and was not performed. However, subsequently, VT attacks disappeared and the patient was weaned from ECMO after 32 days.

The patient received a left ventricular assist device (LVAD; Heartmate 3, Abbott, Lake Bluff, IL, USA) 58 days post-MI and 5 days post-ECMO weaning as a bridge to decision and subsequently, an implantable cardioverter-defibrillator few weeks later. No VT attacks were detected during the waiting time for heart transplantation. The patient underwent heart transplantation 1 year after LVAD implantation.

Discussion

This case report addresses the issue of VT ablation in a haemodynamically unstable patient supported by ECMO in the early post-MI period. It also highlights the potential benefits of prolonged ECMO support to allow rhythm stabilization and implementation of advanced heart failure treatments.

There is still no evidence or guidelines regarding patients with ventricular arrhythmias refractory to defibrillation and antiarrhythmic agents; however, ECMO support has been successfully used during VT ablation procedures.[9,10] Moreover, ECMO has been suggested to improve survival rate in refractory VT in children and adults[8,11,12] but the mortality rate increased among patients with more than 1 day of ECMO support.[13] Generally, prolonged VA-ECMO therapy >1–2 weeks is associated with high risk of complications and death; however, survival in VA-ECMO varies with treatment duration, indication for treatment, and other patient factors.[14,15]

Radiofrequency ablation of post-MI VT is often complex because of the necessity for repeated induction attempts and prolonged VT mapping; however, clinical studies have previously demonstrated the usefulness and feasibility of catheter ablation in controlling recurrent post-MI VTs.[16–18]

In this case report, VT ablation had a crucial role in treating the culprit arrhythmia considering the large and complex substrate that was found during carto mapping of left ventricle. Additionally, the implementation of ECMO in a haemodynamically unstable patient allowed a complex ablation procedure to be completed safely. There is also evidence that ECMO support may help to terminate catecholamine driven electrical storms while restoring systemic circulation in cardiogenic shock related to acute MI, myocarditis, and hypoxaemia.[5,19]

Conclusions

Ablation of haemodynamically unstable VTs can be safely supported by ECMO in the early post-MI period, allowing rhythm stabilization and bridging decompensated patient to LVAD or heart transplantation.

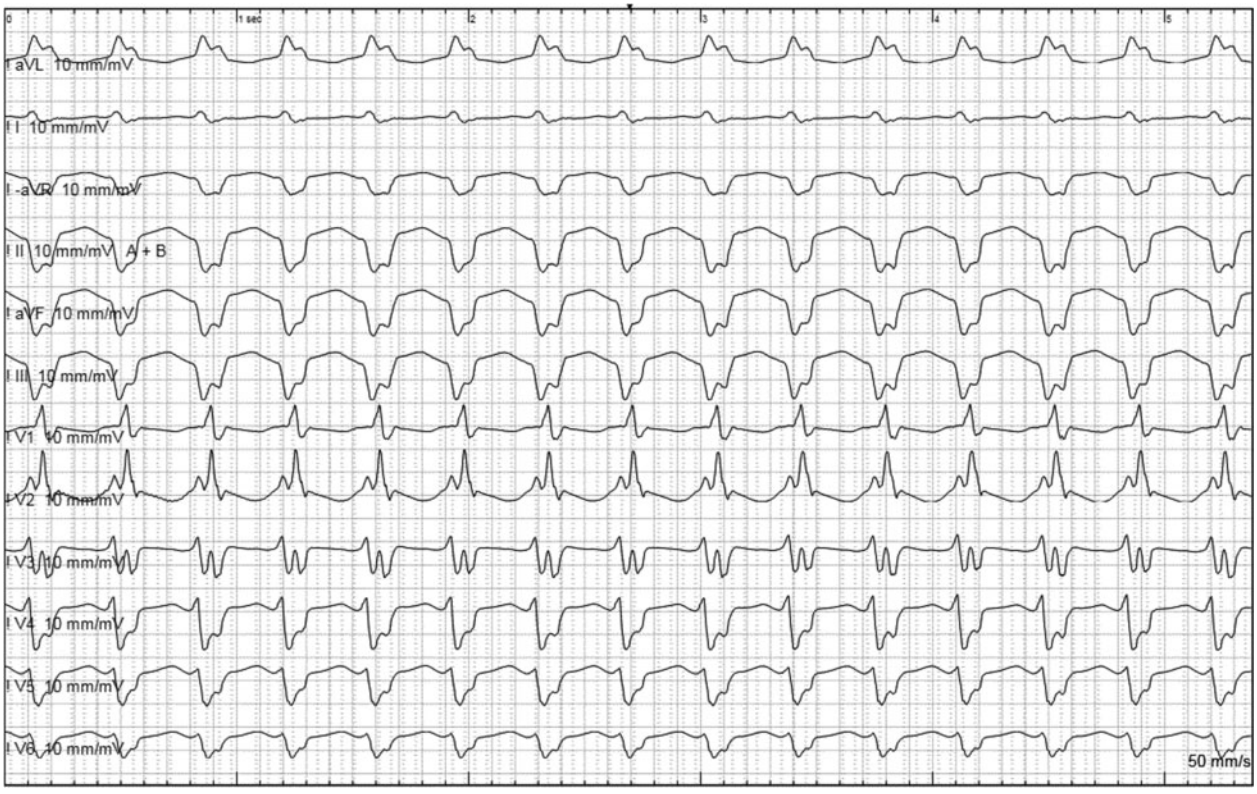
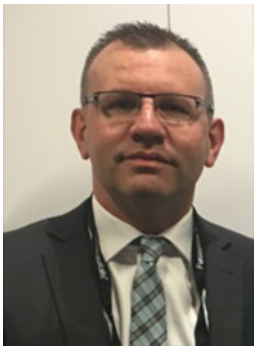


Figure 2 Twelve-lead electrocardiogram (Cabrera format, 50 mm/s) of ventricular tachycardia induced by programmed ventricular stimulation during the electrophysiological study which was identical to the previously observed clinical ventricular tachycardia.

Lead author biography



Emil Najjar has been specialist in Internal Medicine and Cardiology since 2012 and 2014, respectively; and has been working at the Karolinska University Hospital in Stockholm, Sweden since 2010 where he finished my residency in Internal Medicine and Cardiology. Emil also successfully completed his PhD degree at the Karolinska Institutet in 2020. He has been working with advanced heart failure patients since 2015 and has been the medical director for the ventricular assist device programme since 2018.

Supplementary material

Supplementary material is available at *European Heart Journal - Case Reports* online.

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Slide sets: A fully edited slide set detailing this case and suitable for local presentation is available online as Supplementary data.

Consent: The authors confirm that written consent for submission and publication of this case report including images and associated context has been obtained from the patient in line with COPE guidance.

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