Catheter ablation of atrial fibrillation on Impella support in a patient with refractory cardiogenic shock due to tachycardia mediated cardiomyopathy

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Abstract

Background Impella support during Posterior Vein Isolation/Posterior Wall Isolation (PVI/PWI) in the setting of persistent cardiogenic shock due to refractory atrial fibrillation with rapid ventricular response (AF/RVR), to the best of our knowledge, has not been reported in the literature. Case A 61-year-old male trucker was admitted with acute HFrEF with AF/RVR 130 – 150 bpm. EF was 20% with global hypokinesis. He was diuresed and cardioverted to sinus rhythm and a QTc of 532 msec. He reverted to AF/RVR in less than 24 hours and requiring amiodarone drip but was discontinued due to severe intolerance. Subsequently, he developed cardiogenic shock, worsening cardiorenal syndrome, and shock liver requiring continuous renal replacement therapy (CRRT) in the CCU. Inotropes and vasopressors were contraindicated. AV node ablation was refused because he wanted to return to truck driving. Right heart catheterization showed PASP 53, PADP 38, and PCWP 37 with RAP 28mmHg. Coronary angiogram was normal. An Impella device was inserted, with P6 support at 3.4 L/min cardiac output. PVI with cryoablation, PWI, and anterior mitral isthmus ablation was successful with RFA. There was a complete exit block 30 mins after ablation. Normal sinus rhythm was restored after cardioversion. Echocardiography 48 hours later revealed improvement in EF from 10% to 40% in sinus rhythm. Follow up six months in the clinic showed EF recovery to 62%. Conclusion This case report demonstrates that in patients with refractory atrial fibrillation causing cardiogenic shock, PVI/PWI, while on Impella support, could be a good treatment option.

Title Page

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Introduction

There are currently no guideline recommendations regarding pulmonary vein isolation (PVI) and posterior wall isolation (PWI) in the setting of refractory atrial fibrillation with a rapid ventricular response (AF/RVR) and cardiogenic shock. Atrioventricular nodal (AVN) ablation and pacemaker insertion have been the go-to treatment of choice. The fact that AVN ablation is a shorter procedure and does not overbear the already compromised hemodynamics makes it an attractive treatment option. PVI/PWI, though superior to AVN ablation and pacemaker insertion, is rarely performed in the hemodynamically compromised patient (1).

Percutaneous Impella CP (Abiomed, Danvers, MA) support during PVI/PWI in the setting of persistent cardiogenic shock due to pharmacologically and electrically refractory AF/RVR; to the best of our knowledge has not been reported in the literature.

We present a case of PVI/PWI on Impella CP support for persistent cardiogenic shock due to refractory AF/ RVR.

Case

A 61-year-old male truck driver was admitted with acute systolic decompensated congestive heart failure with AF/RVR. His exam was remarkable for irregular tachycardia 130 – 150s, bilateral crackles, and lower extremity edema with cold peripheries. His past medical history is notable for hypertension, and paroxysmal atrial fibrillation diagnosed five months prior. Transthoracic echocardiogram (TTE) showed his LVEF to be 20% with severe LA dilatation. He was diagnosed with tachycardia-induced cardiomyopathy after SPECT myocardial perfusion scan ruled out ischemic cardiomyopathy. He was started on IV diuretic therapy at admission. He underwent transesophageal echocardiography (TEE) and direct current cardioversion (DCCV), receiving 150 J, and then 200 J. Cardioversion was successful at 200 J, and EKG showed QTc of 532. He reverted to AF/RVR in less than 24 hours. He was started on a loading dose of amiodarone 150mg IV bolus and then 1mg/kg/min for 6 hours, and apixaban 5 mg twice daily was started for anticoagulation based on a CHADS VASC of 2. Amiodarone loading was ineffective in reducing ventricular rate or maintaining sinus rhythm. Besides, he developed side effects from the amiodarone, i.e., intense nausea and vomiting and flushing. He could not tolerate both the oral and intravenous formulations of amiodarone. Eventually, amiodarone had to discontinue due to intolerance. Sotalol and Dofetilide were contraindicated due to the prolonged QTc - 532, and Class 1c agents due to cardiomyopathy.

He rapidly decompensated and developed refractory cardiogenic shock with SBPs 80 – 90s compounded by cardiorenal syndrome and ineffective diuresis. AV nodal ablation with a biventricular pacemaker was suggested, but the patient refused on the grounds of being a truck driver. He wanted to get back to his job

as a truck driver when he recovered; therefore, having a device will prohibit that. AF ablation by pulmonary vein isolation and posterior wall isolation (PVI/PWI) was an acceptable treatment option for him despite the elevated risk of hemodynamic decompensation and mortality.

A limited repeat echocardiogram showed his LVEF had worsened to 15% with general hypokinesis and now moderate RV dysfunction.

Right heart catheterization showed he had PASP 53 mmHg, PADP 38 mmHg, PCWP 37 mmHg, RA 28 mmHg. LVEDP 31 mmHg and LVEF was estimated to be 10%. Coronary angiogram showed normal coronary arteries.

An Impella CP was inserted via the left femoral artery under fluoroscopic guidance (Figure 1), and support set to P6 with 3.4 liters/minute of cardiac output. A CT scan of the chest with a reconstruction of the left atrium and pulmonary veins was utilized during the ablation procedure to align the 3D electroanatomic map for additional anatomic correlation. Artic front balloon cryoablation of the right and left pulmonary veins (Figure 1). Entrance and exit blocks were demonstrated more than 30 minutes after the ablation. Voltage mapping post-ablation demonstrated successful radiofrequency ablation of the posterior wall and successful radiofrequency ablation of the anterior mitral isthmus line. Normal sinus rhythm was restored (Figure 2, Panel A, and B).

Toward the end of the procedure, he required more impella support amidst vasodilatory shock. The ECMO team assessed him for additional mechanical circulatory support. However, he recovered reasonably quickly before the ECMO cannulas were placed.

Due to complications of vasodilatory shock, the patient had shocked liver and renal dysfunction requiring continuous renal replacement therapy (CRRT) for several days.

Throughout the rest of his hospitalization, he maintained sinus rhythm. Forty-eight hours later, repeat echocardiogram showed his LVEF had improved to 40%. Impella support was weaned within 48 hours after the PVI, and guideline-directed medical therapy for HFrEF was optimized. There was renal function recovery. The patient was discharged to rehabilitation.

Follow up six months later showed normalization of EF to 62%, moderate to severely dilated left atrium, and was having NYHA I symptoms on guideline-directed medical therapy for HFrEF.

Discussion

Percutaneous hemodynamic support with Impella CP (Abiomed, Danvers, MA) support during PVI/PWI to the best of our knowledge has not been reported in the literature. Pubmed search did not yield case reports where Impella CP was used for hemodynamic support during PVI/PWI. Mantini et al. 2019 reported five series of patients with atrial arrhythmias who underwent various ablation techniques under various mechanical circulatory support (MCS) modalities. The MCS modalities included ECMO, LVADs, and Impella support. However, the only patient in their case report who had atrial fibrillation was cannulated for ECMO and AV node ablation, and pacemaker insertion is done (2). In a similar case report by Kamada et al. 2016, they described a case of tachycardia-induced cardiomyopathy secondary to persistent AF/RVR refractory to rhythm control both pharmacologically and electrically. However, PVI successfully achieved, intra-aortic balloon for MCS was only used after intra-procedurally (3) the patient became hemodynamically unstable. In contrast, our patient had Impella CP at the start of the procedure. Cheruvu et al. 2014, also reported on a successful ablation of refractory AVNRT in a patient on ECMO due to cardiogenic shock (4).

To date, there are no ACC/AHA/HRS/EHRA recommendations regarding PVIs or atrial arrhythmia ablations on MCS.

Most of the literature on mechanical support with Impella has been centered around its use in hemodynamically unstable ventricular tachycardia ablations. Activation and entrainment mapping techniques during ablation of ventricular tachycardias requires the patient to be in continuous VT, which may not be hemodynamically tolerated, may lead to end-organ hypoperfusion and damage(5,6). The use of left ventricular

support provides a better augmentation of cardiac output during ablation for ventricular arrhythmias in at-risk patients.

In our article, we report on a 61-year-old male who developed cardiogenic shock due to tachycardia-induced cardiomyopathy due to persistent AF/RVR complicated by the cardiorenal syndrome. AF was both medically and electrically refractory, PVI under Impella support was pursued. There was instantaneous LVEF recovery, improvement in the RV function, and reversal of resultant end-organ failure.

Animal models have shown that, at the cellular level, high ventricular rates usually result in abnormal calcium handling and reduced energy-storing required for both myocardial relaxation and contractility (7). Changes at the cellular level lead to myocyte elongation, myofibril disorganization, and derangement in the extracellular matrix (7,8).

Over time, LV dysfunction occurs with LV dilatation and eventually RV failure and RV dilation. RV and LV volumes increase, LVEDP significantly increases due to the increase in LV wall stress(7–9). The loss of atrial contribution to diastole in a patient with AF/RVR, especially in patients with Grade 2 diastolic dysfunction leads to elevation of the left atrial volume and pressure, decrease preload and further decrease cardiac output(10). For all of these reasons, patients with AF/RVR can present with cardiogenic shock.

To reverse this spiraling cycle of myocardial dysfunction and heart failure symptoms for patients in AF/RVR, the CASTLE AF trial, which randomized 398 patients to PVI versus standard care, which included maintenance of sinus rhythm. The result showed about a 38% reduction in the primary outcome of all-cause mortality and hospitalization for worsening heart failure (11). CAMTAF Trial reached a similar conclusion, that catheter ablation is effective in restoring sinus rhythm in patients with persistent AF and HF(12).

Atrioventricular junctional ablation with biventricular pacing (AVJA/BiV) in patients with non-ischemic cardiomyopathy is useful for treating AF/RVR associated with HF(1).

However, Khan et al. in 2008 conducted the PABA-CHF trial, where they assigned NYHA II or III heart failure patients with drug-refractory AF and EF less than 40% to undergo PVI or AVJA/BiV. They conclude at the end of the trial that PVI was superior to AVJA/BiV in the following outcomes: freedom for atrial fibrillation, EF recovery, LA size, functional capacity and quality of life(13)

The utilization of the Impella device for circulatory support for mapping ventricular arrhythmias have been well published. (5,6)

Due to the effectiveness of PVI/PWI in patients with tachycardia-induced cardiomyopathy and cardiogenic shock, the Impella CP can be considered an effective MCS to provide hemodynamic stability during mapping and ablation of atrial arrhythmias not only limited to AF/RVR.

The use of the Impella allows time for accurate mapping in the case of atrial re-entrants tachycardia. For PVI/PWI, it allows adequate time for exit block testing and also posterior wall isolation with radiofrequency ablation after the cryoablation of the pulmonary vein ostia. It frees the operator's mind to do thorough mapping and ablation with the knowledge that the patient is receiving adjustable support based on hemodynamic demands during the procedure.

Its use in electrophysiology laboratories is gaining popularity but for ventricular arrhythmia ablations for now. However, this case report is purposed to raise the awareness of the Impella's utility advanced HF. Mainly in cases where ablative techniques are required to achieve hemodynamic stability in HF patients for which the atrial arrhythmia has been determined to be contributing significantly to the patient's deterioration and hemodynamic instability.

Conclusion

To date, there are no ACC/AHA/HRS/EHRA recommendations regarding PVIs or atrial arrhythmia ablations on mechanical circulatory support. Most of the literature on mechanical support with Impella has been centered around its use in hemodynamically unstable ventricular tachycardia ablations.

The use of the Impella CP for PVI/PWI allows adequate time for exit block testing and also posterior wall isolation with radiofrequency ablation after antral cryoablation of the pulmonary vein. It frees the operator's mind to do thorough mapping and ablation with the assurance that the patient is receiving adjustable support based on hemodynamic demands during the procedure.

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