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Electromagnetic interference complicating Impella® use during pediatric ablation

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ABSTRACT

In children, the Impella® is most commonly used in the setting of cardiogenic shock. There are few reported cases of Impella® use in pediatric patients undergoing ablation; description of troubleshooting techniques may improve success rates. We describe a pediatric patient with tachycardia-induced cardiomyopathy due to incessant ectopic atrial tachycardia whose ablation was notable for significant electromagnetic interference (EMI) from the Impella® leading to incomplete mapping. This case highlights the need for multidisciplinary planning and consideration of possible EMI with the use of magnet-based electroanatomic mapping systems as well as troubleshooting techniques to reduce the impact of EMI.

Keywords: Ablative therapy, cardiomyopathy, electrophysiology, left ventricular assist device

INTRODUCTION

Ectopic atrial tachycardia (EAT) can lead to tachycardia-induced cardiomyopathy (TIC). The peri-procedural period is high-risk for hemodynamically unstable patients with TIC undergoing ablation.[1,2] This microaxial flow pump unloads the ventricle by pumping blood across a competent aortic valve, thereby reducing wall tension and end-diastolic pressure as well as myocardial oxygen demand. In this pediatric patient with TIC in whom an Impella® CP device was used for procedural support, we highlight the need for consideration of electromagnetic interference (EMI).

CASE REPORT

A 13-year-old, 63 kg, female presented in heart failure. Her heart rate was 140 bpm, and an electrocardiography showed abnormal P-wave morphology with a superior axis [Figure 1]. She had normal perfusion, a gallop, and bilateral lower extremity pitting edema. An echocardiogram demonstrated severely reduced left ventricular (LV) systolic function with an ejection fraction of 18%, moderately reduced right ventricular (RV) systolic function, moderate LV dilation, mild mitral valve regurgitation, and a small pericardial effusion.

In addition to medical management, an ablation was planned and a decision was made for an Impella CP® use. Pediatric electrophysiology, interventional cardiology, cardiac anesthesia, perfusion, and cardiothoracic surgery teams were present. Following intubation, an Impella CP® was advanced into the LV by a pediatric interventional cardiologist.

A CARTO3® (Biosense Webster Inc., Diamond Bar, CA, USA) system was used for three-dimensional mapping. A Biosense Webster NAVISTAR® NAV catheter was used to create maps of the right atrium (RA) and coronary

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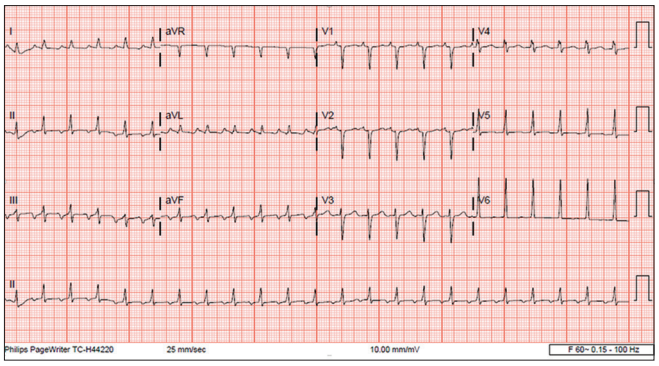

Figure 1: ECG at presentation. ECG: Electrocardiography

sinus (CS). A Biosense Webster EZ STEER™ catheter provided a timing reference from the CS. A decapolar Inquiry™ (Abbott Laboratories, Chicago, IL, USA) catheter recorded His bundle and RV electrograms. A Biosense Webster PENTARAY® catheter was used to create RA and LA maps [Figure 2]. There was instability in the displayed location of the mapping catheter when positioned in the anterior LA. During this time, the catheter flickered and moved erratically on the map while being held in a stable position. This was coupled with alerts from the mapping system regarding magnetic distortion and an elevated mapping catheter metal value, both of which were caused by EMI due to proximity to the motor. This led to incomplete mapping near the mitral valve annulus. It was noted that no interference in the local electrograms was seen. Consideration of transiently pausing the Impella® was made; this was not attempted as the mitral valve region of the LA was determined to be relatively far from the origin of the tachycardia and mapping it was therefore not critical. The tachycardia was determined to be a focal atrial tachycardia. RF lesions were delivered to the site of earliest activation anterior and inferior to the right inferior pulmonary vein [Figure 2] with a Biosense Webster THERMOCOOL SMARTTOUCH® catheter. Tachycardia was terminated with the first lesion. A similar tachycardia though with a shorter cycle length was seen immediately after the lesion; this tachycardia terminated during the second lesion and ectopy was not seen for the remainder of the case. Eight additional lesions were delivered to consolidate the two initial lesions.

The Impella® was removed after a trial of decreased flow demonstrated hemodynamic stability. A repeat echocardiogram showed a left ventricular ejection fraction of 20% and moderate LV dilation. The patient was discharged home following a 14-day hospitalization. Her symptoms resolved with medical therapy and she has remained well in the 18 months since her hospitalization. Holter monitors have shown no significant atrial ectopy, and her echocardiogram has normalized.

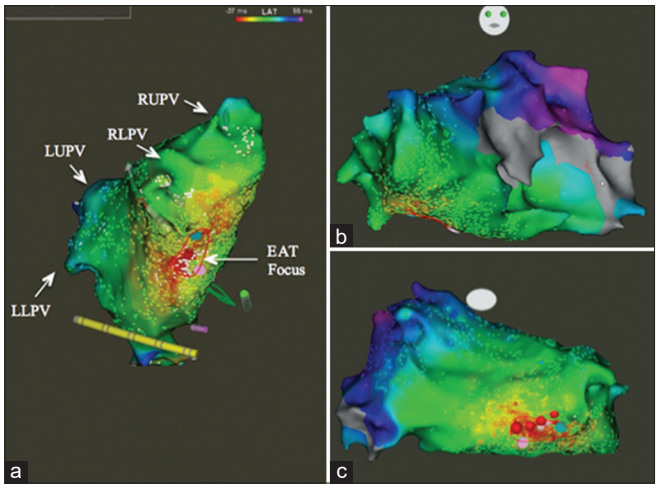

Figure 2: LA activation map, right posterolateral (a), RAO (b), and posterior-inferior (c) views. LLPV: left lower pulmonary vein. LUPV: left upper pulmonary vein. RLPV: right lower pulmonary vein. RUPV: right upper pulmonary vein

DISCUSSION

This report highlights the possibility of EMI from an Impella® contributing to the procedural difficulty. In this case, instability in the displayed location of the mapping catheter and alerts regarding magnetic interference and an elevated mapping catheter metal value were seen when the mapping catheter was in proximity to the Impella® motor. A sensor in the tip of the mapping catheter monitors for metal within the field. When the metal value is detected to be outside the working parameters of the CARTO3® system, an alert is displayed so that the operator is made aware that the accuracy of the catheter location may be affected. If no warnings or errors are displayed, catheter location should be as expected.

EMI may prevent the operator from obtaining complete data and may increase procedural risk. If not promptly recognized, the operator may react to erroneous catheter location, increasing the risk of perforation, loss of transseptal access, and other unintended catheter movements.

Several studies have described EMI with the use of multiaxial flow devices (MFDs) and magnet-based mapping systems during ventricular tachycardia ablations.[3] EMI is most often noted when mapping in proximity to the MFD motor. When using a magnet-based mapping system, the motion of the impeller within the MFD can cause EMI, which can impair accurate catheter localization, point acquisition, and integration of respiratory compensation algorithms.[4]

Vaidya *et al.* evaluated magnet-(CARTO3®) and impedance-(EnSite™ Velocity System/EnSite™ NavX™, Abbott Laboratories, Chicago, IL, USA) based systems

during ablation procedures using Impella® 2.5 MFDs in canine subjects.[5] Severe EMI, defined as the display of an interference alert and inability to reliably localize the mapping catheter, was observed at 9.4% of points attempted when using the magnet-based system and was not observed when using the impedance-based system. Severe EMI occurred at points closer to the MFD motor. Accordingly, the Impella® product manual states that the best performance is seen when the motor is located ≥3 cm from the mapping catheter sensors.[6] In a case report of an adult male undergoing VT ablation, Maury *et al.* addressed Impella®-induced EMI by generating electroanatomic maps with the Impella® turned off for 3 min at a time; they then transitioned to an impedance-based approach with the Impella turned on for the remainder of the case.[7]

Vaidya *et al.* propose that the MFD performance, or motor speed, can be changed when the Impella® is used on "P-level mode" rather than "Auto" mode to resolve EMI.[5] The motor's revolutions per minute (RPM) can be selected, with different P-levels corresponding to different RPM in various Impella® models. Severe EMI resolved to either no or mild EMI, defined as an alert with continued ability to reliably localize the catheter by reducing the performance from P-8 to P-6. This approach to resolving interference would rely on the patient's ability to tolerate a decrease in cardiac output. If needed for patient tolerance, the performance level could be decreased for brief periods while mapping near the motor. Alternatively, an impedance-based mapping system could be used.

Considering the effect of distance between the mapping catheter and the MFD motor, EMI may be more likely to occur in pediatric patients. In addition to known risks of Impella® use, the possibility of EMI should be considered. The use of magnet- versus impedance-based electroanatomic mapping systems and the potential need to troubleshoot EMI should be considered in preprocedural planning.

This pediatric patient with TIC underwent ablation of an EAT substrate with the hemodynamic assistance of an Impella® CP catheter. This case highlights the need for multidisciplinary planning and consideration of the possibility of EMI as well as its troubleshooting techniques.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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