

MediGuide-assisted atrial flutter ablation in a patient with a HeartMate II left ventricular assist device



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Introduction

The increasing complexity and duration of electrophysiology procedures have led to the development of alternative methods of mapping and ablation. One recent technological advance is the MediGuide Positioning System (St. Jude Medical, St. Paul, MN). This system superimposes electromagnetic field tracking over prerecorded fluoroscopic cine loops, with dynamic compensation for respiratory and cardiac motion. This system facilitates real-time navigation while reducing the need for additional fluoroscopy.^{1–2}

Left ventricular assist devices (LVADs) are increasingly implanted for patients with end-stage heart failure, to improve survival and functional status. Unfortunately, they have been reported to produce electromagnetic noise sufficient to result in significant device–device interactions.^{3–6} Despite increasing experience with MediGuide, the potential for electromagnetic noise from the LVAD to interfere with normal functioning of the catheter-tracking system is unknown. We hereby report our successful experience using the MediGuide technology during an atrial flutter ablation procedure in a patient with and LVAD implant.

Case report

A 69-year-old man with severe nonischemic cardiomyopathy (left ventricular ejection fraction 15%) underwent implantation of an LVAD (HeartMate II; Thoratec Corporation,

Pleasanton, CA) in September 2012 because of refractory heart failure symptomatology unresponsive to maximal medical and cardiac resynchronization therapy (Figure 1). Although this resulted in initial symptomatic improvement, he represented in February 2013 with acute decompensated heart failure due to rapid atrial flutter (Figure 2). Despite therapy with carvedilol at maximum tolerated doses, his ventricular response remained uncontrolled at 95–110 beats per minute (bpm) at rest. The situation was discussed with the heart-failure and cardiac-transplant team, and a decision was made to proceed with cavotricuspid isthmus ablation for the treatment of the typical atrial flutter, in an effort to restore atrioventricular synchrony.

Given the patient's ongoing flutter, the procedure was performed under therapeutic oral anticoagulation with warfarin (international normalized ratio 2.30). A preprocedural transesophageal echocardiogram excluded intracardiac thrombus. Oxygen saturation and invasive hemodynamic parameters were continuously monitored throughout the electrophysiology procedure. In addition, a cardiac perfusionist continuously monitored the HeartMate II parameters (pump speed 8400 rpm, pump flow 4.1 L/min, pulse index 5.1, pump power 5.1 W) to ensure there was no device dysfunction related to either radiofrequency ablation or MediGuide use.

The ablation procedure was undertaken via 2 femoral venous punctures. Through a 7-French (F) sheath, a MediGuide-enabled Livewire steerable decapolar diagnostic catheter (St. Jude Medical) was placed on the lateral wall of the right atrium as an intracardiac reference (cannulation of the coronary sinus [CS] was avoided in order to prevent dislocation of the CS lead). Through a steerable 8.5F introducer (Agilis; St. Jude Medical) a MediGuide-enabled 4-mm bidirectional irrigated radiofrequency ablation catheter (Safire BLU Duo; St. Jude Medical) was advanced into the right atrium. Two short fluoroscopic loops (3 seconds) of the heart were then recorded in posteroanterior and left anterior oblique views. Those prerecorded electrocardiograph-gated fluoroscopy cine loops were simultaneously displayed, allowing biplanar real-time tracking of the CS and ablation catheter tips within the cine loops. Live fluoroscopy was performed as needed. Typical counterclockwise right atrial flutter was demonstrated by activation mapping along the atrial lateral and septal walls.

KEYWORDS Left ventricular assist device; HeartMate II; Atrial flutter; Catheter ablation; MediGuide

ABBREVIATIONS bpm = beats per minute; CS = coronary sinus; LVAD = left ventricular assist device (Heart Rhythm Case Reports 2015;1:290–292)

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KEY TEACHING POINTS

- In rare cases, the electromagnetic noise generated by a left ventricular assist device has been reported to result in significant device–device interactions.
- Our findings suggest that catheter ablation using MediGuide technology can be performed in patients implanted with a HeartMate II left ventricular assist device.
- Whether MediGuide technology is useful in reducing radiation exposure during complex catheter-ablation procedures in patients implanted with a HeartMate II device remains unknown.

Cavotricuspid isthmus ablation was performed during flutter (temperature 48°C, power 35 W, flow rate 17 mL/min), and it resulted in slowing of the tachycardia cycle length, followed by abrupt termination. Postablation bidirectional block was confirmed using differential pacing from the lateral and the septal aspects of the ablation line. Total procedural and fluoroscopy times were 1 hour 16 minutes and 14 minutes respectively. The procedure was well tolerated, and the patient was discharged 6 days post procedure.

Discussion

Herein we have discussed the first experience with MediGuide-assisted ablation in a patient implanted with a HeartMate II LVAD. The HeartMate II is a continuous-flow LVAD. It consists of an electric motor that operates by creating a magnetic field that spins a permanent magnet located within the rotor. The subsequent rotary motion (usually 7000–10,000 rpm) pumps blood.

Unfortunately, electromagnetic interference emanating from the LVAD is known to occasionally severely impair telemetry communication between certain defibrillators and their programmers.^{3–6} Specifically, the electromagnetic signal generated by the HeartMate II pulse width modulator, which serve to regulate voltage input to the LVAD motor, operate at the 7.2-kHz frequency and can interfere with the 8-kHz operating frequency of the defibrillator telemetry wand. This problem has been reported with both St. Jude Medical and Sorin Group (Milan, Italy) devices.^{3–6}

The MediGuide Positioning System consists of 3 components: a transmitter generating a 3-dimensional electromagnetic field, an electromagnetic field reference sensor attached to the patient chest, and a miniaturized coil sensor assembled within the electrophysiology catheters. The MediGuide transmitter produces a set of magnetic fields in a range of frequencies between 10 and 15 kHz, with a magnitude of up to 200 μT. This transmitter is mounted on the fluoroscopy detector, aligning the 3-dimensional electromagnetic field with the fluoroscopy field. The reference sensor provides information about the spatial relationship between the chest wall and the fluoroscopy detector and allows accurate

compensation for respiratory and patient movement. The sensor-tip catheter is tracked nonfluoroscopically within the 3-dimensional electromagnetic field and projected onto the prerecorded cine loops. Prerecorded fluoroscopy cine loop speed is gated to real-time electrocardiograph cycle length. Additionally, this information can be incorporated in a 3-dimensional electroanatomic mapping system to contribute to the creation and stabilization of cardiac geometry images. The use of MediGuide technology enhances catheter tracking while reducing of radiation exposure during electrophysiology procedures.^{2,11}

Our concern was the possible interaction between the HeartMate II and the MediGuide Positioning System, which could lead to a compromise in HeartMate II function or the functioning or accuracy of the MediGuide nonfluoroscopic navigation system. Fortunately, despite similar operating frequencies and operation near the electromagnetic field reference sensor, we noted no adverse impact with the use of MediGuide navigation system on the LVAD parameters. Similarly, there was no interference of the HeartMate II pump on the magnetic field with the ability to accurately track the MediGuide catheter tip (Figure 3), nor with the quality of electrograms observed on the ablation catheter. This finding is consistent with previous reports that have suggested no significant electromagnetic interference between the HeartMate II device and radiofrequency delivery; electroanatomic mapping with the CARTO system, which generates a magnetic field of 2.5–65 μT at frequencies of 2, 2.2, and 3 kHz (Biosense Webster; Johnson & Johnson, New Brunswick, NJ), or EnSite NAVx system (frequency 5.7 kHz; St. Jude Medical).^{7–10}

Although the use of the MediGuide 3-dimensional catheter-tracking system was safe and feasible in this case, the primary objectives of fluoroscopy- and procedure-time reduction were not achieved. This result was due to the need for intermittent fluoroscopic imaging in order not to damage or

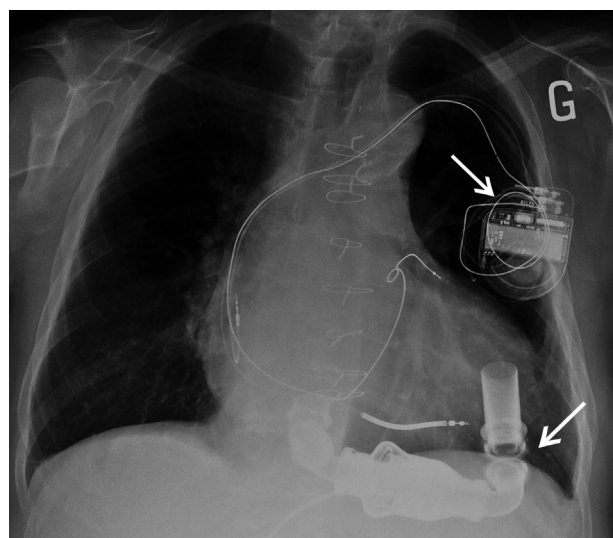


Figure 1 A chest X-ray image of the patient implanted with a biventricular defibrillator (upper arrow), and HeartMate II left ventricular assist device (lower arrow).

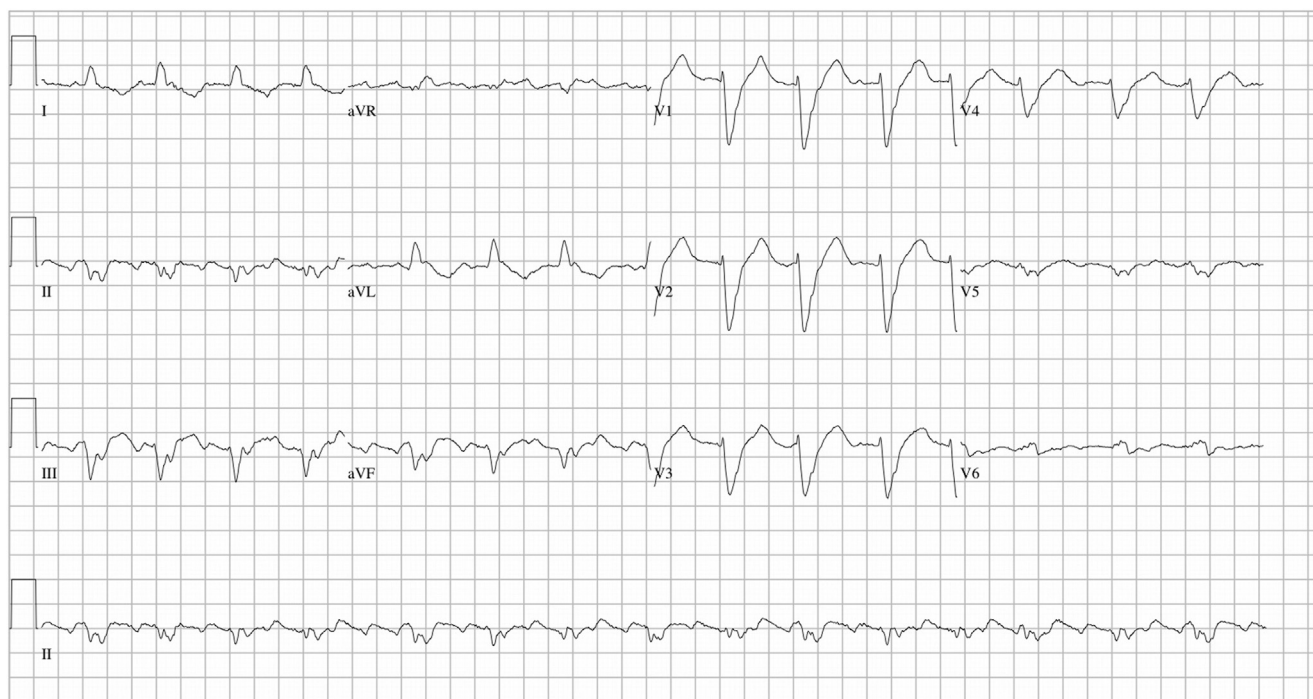


Figure 2 A twelve-lead electrocardiogram demonstrating typical counterclockwise atrial flutter.

dislodge the pacing and defibrillator leads. Moreover, it would be anticipated that the MediGuide system would be less useful for left-sided procedures in patients with continuous-flow LVADs, because of the compressed chambers and presence of inflow cannula requiring close fluoroscopic surveillance.

Conclusion

This case report suggests MediGuide technology can be safely used in the presence of an LVAD. The number of patients with ventricular assistance devices is growing, and among them the prevalence of atrial and ventricular arrhythmias is high. Catheter ablation can be an effective and safe treatment option for such patients. Whether the MediGuide technology is useful in this population to reduce radiation

exposure during complex catheter-ablation procedures needs to be studied.

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Figure 3 A fluoroscopy image confirming accurate tracking of the MediGuide-enabled catheter tip during the flutter ablation procedure. CR = cranial; LAO = left anterior oblique; SID = source to image distance.