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# Atrial Flutter Ablation Using MediGuide<sup>™</sup> Non-fluoroscopic Catheter Tracking System: A Novel Technology to Reduce Radiation Exposure

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## Abstract

We describe the first case of cardiac arrhythmia ablation with the novel MediGuide<sup>™</sup> non-fluoroscopic catheter tracking system in North America. This new technology uses electromagnetic field to track sensor integrated intracardiac electrophysiology catheters which are projected on pre-recorded fluoroscopy cine loops. This new technology permits catheter tracking in virtual biplane fluoroscopy and enhances spatial resolution of conventional 3D mapping systems while drastically reducing radiation exposure.

## Introduction

Radiation exposure related to percutaneous catheter based procedures for cardiac arrhythmias is a problem that is being increasingly recognized in clinical practice. We have previously shown that concerted effort through operator education, minimizing source intensifier distance and collimation helps in minimizing radiation exposure. However, these adaptations still fail to accomplish the ambitious reductions we hope for as fluoroscopy continues to be the gold standard for reaffirmation of stable catheter location in the heart.1 Three dimensional mapping systems have proven to be vital in catheter navigation, arrhythmia mapping and for reducing radiation exposure but patient motion continues to be a problem. A novel electromagnetic technology capable of integrating 3D non-fluoroscopic catheter tracking on a prerecorded fluoroscopic background has been shown to further reduce radiation exposure during EP procedures.<sup>2</sup> We describe the use of this technology for the ablation of a typical right atrial flutter.

#### **Case Description**

A 62 year old female with a history of lung cancer, hypertension, and diabetes mellitus was evaluated for symptomatic atrial flutter due to failed rate and rhythm control on a large dose of AV nodal blockers and Amiodarone. She also had new onset severe Left Ventricular dysfunction likely due to tachycardia induced cardiomyopathy. ECG revealed typical atrial flutter with flutter waves at 240 bpm and ventricular rate ranging from 120-180 bpm.

She underwent an electrophysiological study using the novel MediGuide<sup>TM</sup> navigation system. Before catheter introduction, two fluoroscopic cine

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**Figure 1:** LAO frames from pre-recorded cine loops showing two Mediguide enabled livewires one in the coronary sinus and the other at the superior vena cava. **1A** shows the live fluoroscopic image with visualization of all the bipoles along with the sensor at the tip. **1B** is the virtual image of the same with just the sensors visualized non-fluoroscopically



loops of 3 cardiac cycles are acquired in standard right anterior oblique (RAO 20°, Figure 1) and left anterior oblique (LAO 30°, Figure 2) projections. The two cine loops are run side by side to see the catheters simultaneously in both projections like conventional biplane fluoroscopy. Two steerable decapolar diagnostic catheters with sensor technology (Livewire<sup>®</sup>, St. Jude Medical, Minneapolis, MN) are used for the procedure. The catheters tips are tracked on the background of the pre-recorded fluoroscopic cine loops. The catheters are initially used to map and mark the anatomic location of the superior and inferior venacava, coronary sinus (CS) ostium and tricuspid annulus. One of the catheters is then positioned in the CS.

**Figure 2:** Shows RAO view of the same with an RV catheter and an ablation catheter with landmarks of SVC and parked location of the sensor enabled catheter in CS





An activation map of the flutter was created using the Livewire on the EnSite Velocity Cardiac Mapping System (St. Jude Medical, Minneapolis, MN).

Mapping showed a macro reentrant circuit involving the right atrium with the zone of slow conduction seen as "early meets late" in the region

**Figure 3:** EnSite Velocity Cardiac Mapping System showing ablation line along the cavo-tricuspid isthmus



of the cavo-tricuspid isthmus. An ablation line (maximum temperature:45°C, maximum energy: 41 Watt) on the cavo-tricuspid isthmus (Fig 3) using a DuoFlair (St. Jude Medical, Minneapolis, MN) open irrigated ablation catheter successfully terminated the arrhythmia(Fig 4). Bidirectional block was confirmed using pacing maneuvers to and from the proximal CS. Total fluoroscopy

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Figure 4: Termination of the flutter with resumption of sinus rhythm





#### MediGuide<sup>™</sup> Medical Positioning System

This system uses electromagnetic technology to track sub-millimeter sized sensors in a magnetic field created by a unique field generator.<sup>3,4</sup> An electromagnetic sensor (Fig 5) is integrated into the tip of conventional electrophysiology catheter. A magnetic field reference sensor attached to the patient's chest provides information on the spatial orientation in the electromagnetic field and can compensate for respiratory and patient movement. The electromagnetic field generator is integrated into a conventional fluoroscopy detector of X –ray imaging system which aligns the 3D electromagnetic sensor field with the fluoroscopy field (Figure-6). The sensor tipped catheter is tracked

non-fluoroscopically in the electromagnetic field and projected onto pre-recorded fluoroscopy cine loops. The speed of the cine loop is matched to the real time ECG cycle length to adjust for cardiac cycle dependant changes in catheter position. The catheter tracking on the pre-recorded cine loops in two orthogonal planes gives the added advantage similar to working on a biplane fluoroscopy.

#### Discussion

Our case demonstrates the safety of using this novel technology as well as its efficacy in reducing radiation exposure. We were able to minimize the fluoroscopy exposure time to 3 minutes as compared to 11±6 minutes reported for flutter ablations using 3D mapping with conventional fluroscopy.<sup>5</sup> Fluoroscopy-guided procedures are related to significant radiation exposure to patients and physicians. The mean fluoroscopy times in complicated EP procedures can range from 20 to over 70 minutes.<sup>6</sup> According to the ALARA principle (As Low As Reasonably Achievable)<sup>7,8</sup> there is no magnitude of radiation exposure that is known to be completely safe. This principle confers a responsibility on all physicians to minimize the radiation injury hazard to their patients, to their professional staff and to themselves. These concerns support the need for a navigation system that reduces procedural and fluoroscopy exposure times. Electromagnetic Navigation System have been shown to further lower fluoroscopy exposure while maintaining visual accuracy.<sup>9</sup> The MediGuide<sup>TM</sup> Medical Positioning System (MPS) replaces fluoroscopy for an electro-

Figure 5: Demonstration of the size of the MediGuide TM sensor which is integrated into the catheter tip



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**Figure 6:** Linear diagram of the MediGuide TM system at work with the creation of an electromagnetic field through the magnets in the head of the fluoroscopic unit



magnetic field to track sensor integrated catheters but retains the fluoroscopic background and landmarks which are vital for catheter manipulations. The lack of need for repeated fluoroscopy phenomenally reduces radiation exposure.

The Medical Positioning System also helps to enhance the spatial resolution of the conventional 3D mapping systems. The EnSite Velocity system takes additional geometric data from the MPS sensor.Currently used 3D mapping techniques are independent of conventional 2D fluoroscopy and MediGuide<sup>™</sup> is unique in being able to integrate the two by being able to track the catheter on a fluoroscopic background as well as enhance the resolution of the 3D maps. We used only diagnostic catheters with MPS as MediGuide<sup>™</sup> enabled ablation catheters are not currently available in the United States. Ablation catheters with MPS have been shown to further reduce fluoroscopy times in complex atrial and ventricular arrhythmia ablations. Cine loop acquisition during contrast fluoroscopy of cardiac chambers further aids the non-fluoroscopic tracking of catheters by better defining the endocardial borders in the fluoroscopic background.9 Sensor tipped sheaths and wires have also been used for cardiac resynchronization therapy device implants with considerable reduction in fluoroscopy times.

## Conclusions

The novel MediGuide non-fluoroscopic catheter tracking system for cardiac arrhythmia ablation is a promising innovation which can supplement our current electrophysiology tools to enhance catheter tracking and 3D mapping techniques with a drastic reduction in radiation exposure.

## Disclosures

No disclosures relevant to this article were made by the authors.

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