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Magnetic guidance for cardiac procedures

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Growing up many of us experienced the joy of manipulating needles or other metals with small magnets trying to maneuver them through obstacles. Today this same concept can be used to precisely guide catheters during cardiac procedures. The Niobe II Magnetic Navigation System developed by Stereotaxis (St. Louis, MO, USA) now affords clinicians the opportunity to perform invasive electrophysiology procedures with extreme precision and safety. The navigation system contains 2 large magnets placed on either side of the patient, made of a neodymium-iron-boron compound that is used to create a uniform intra-thoracic magnetic field (Fig. 1). The catheter or guide-wire to be manipulated is fitted with a small magnetic tip which allows the catheter to align with the magnetic field. Movement of the outer magnets and of the magnetic field allows steering and provides for precise and reproducible catheter (or guide-wire) movement within the patient's heart. To date magnetic navigation systems have been used in a variety of cardiac procedures including endocardial and epicardial catheter ablation of arrhythmias, during placement of coronary sinus leads and during percutaneous coronary interventions.

In the electrophysiology laboratory, magnetic navigation has been used to guide catheters in a variety of ablation procedures including ablation of atrial flutter, atrial fibrillation, accessory pathways as well as ventricular tachycardias originating

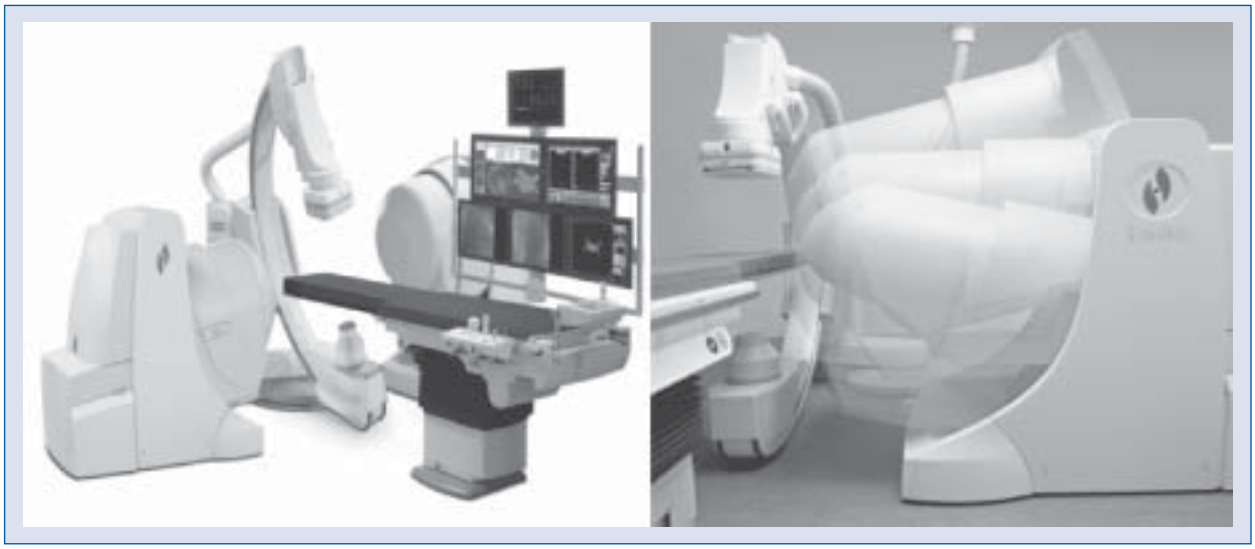

Figure 1. An example of an electrophysiology laboratory equipped with fluoroscopy and a magnetic navigation system. Image on the right demonstrates angulation of the magnets used to manipulate catheters. Printed with permission from Stereotaxis (St. Louis, MO, USA).

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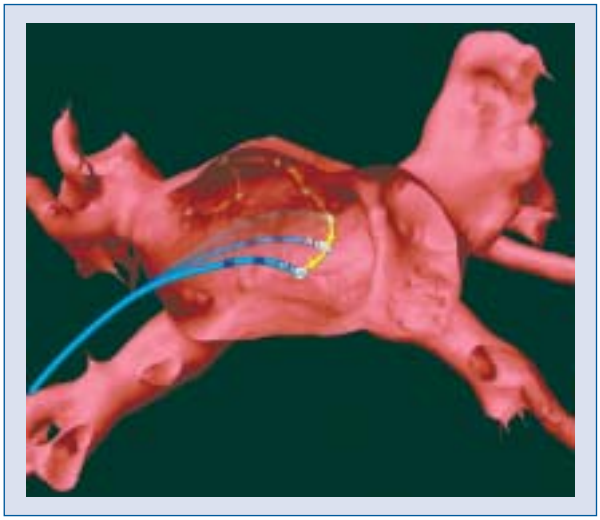

Figure 2. Illustration of precision guidance of an ablation catheter in the left atrium using magnetic navigation. Printed with permission from Stereotaxis (St. Louis, MO, USA).

from the endocardial and epicardial surfaces. Feasibility of magnetic navigation to ablate atrial fibrillation has been described (Fig. 2). However, until recently there has been a lack of an irrigated catheter that can be used with magnetic navigation and this has hindered its wide spread use for ablation of atrial fibrillation [1, 2]. An irrigated tip ablation catheter that is compatible with magnetic navigation has been developed and initial limited experience, largely in Europe, with it is encouraging. Magnetic navigation also holds promise in the delivery of coronary sinus leads used for cardiac resynchronization therapy. Once the coronary sinus anatomy has been determined magnetic navigation is able to accurately and reproducibly deliver a guide wire into selected coronary sinus branches in order to establish effective biventricular pacing [3].

The ability to remotely navigate catheters affords the operator to be in an adjacent control room where they may be better shielded from radiation exposure as result of fluoroscopy. In addition, knowing the precise location of the catheter at all times can obviate the need for intermittent fluoroscopy thereby significantly reducing radiation exposure to patients. At this time cardiac perforation with use of magnetic navigation has not been reported and such complications appear to be far less due to the soft, "floppy" magnetic catheters when compared to procedures requiring manual catheter manipulation. Furthermore, during endocardial catheter ablation of arrhythmias contact with the endocardial wall may be intermittent during systole and diastole. With magnetic navigation continuous endocardial contact during systole and diastole can be maintained resulting in more effective lesion delivery. In the future, using a joystick arm an experienced operator in one medical center may be able to perform a complex ablation procedure on a patient located in a remote medical center using magnetic navigation and tele-medicine, as has already been demonstrated.

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