

# Remote Navigation and Ablation of Atrial Fibrillation

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**Remote Navigation and Ablation of Atrial Fibrillation.** We have developed a new approach based on remote navigation and ablation by a magnetic catheter in a large number of patients with paroxysmal, persistent, or permanent atrial fibrillation. The operator sits in a separate control room, away from the X-ray beam and the patient's body. A 4 mm magnetic catheter is integrated with a newly developed electroanatomical mapping system. The catheter is moved by a joystick that allows to and fro movement inside the left atrium. Magnetic field vectors for each navigation target are stored and, if necessary, they are reapplied at any time while the magnetic catheter is navigated automatically. Remote circumferential pulmonary vein ablation is performed with a target temperature of 65°C and a power limit of 50 W. Navigation and ablation targets can be safely and successfully achieved in all patients in a relatively short period of time (usually in less than one hour). The manual approach is totally operator-dependent, while the remote one is not, but it mostly depends on a well-trained team. When combined with an accurate electroanatomical mapping system this remote technology allows not only to optimize contact and stability with tissue, but also to enable movement between preassigned intracardiac points automatically, either avoiding intervening tissue structures or moving at a defined rate across the surface of the intervening tissue. Finally, there is a significant shortening of radiation exposure time, relevant both for the unprotected patient and the operator. (*J Cardiovasc Electrophysiol*, Vol. 18, pp. S18-S20, Suppl. 1, January 2007)

*atrial fibrillation, ablation, magnetic navigation*

## Introduction

Over the past years, several ablative strategies with conventional, manually deflectable catheters have been attempted to treat atrial fibrillation (AF). After the initial experience of Haissaguerre et al.,<sup>1</sup> who reported that electrical isolation of the pulmonary vein (PV) is useful in terminating AF, AF ablation strategy has been aimed at a more anatomically based approach with isolation of the PVs and the use of empiric ablation lines to limit or modify the substrate. Unfortunately, with manually deflectable catheters it may be difficult to create contiguous and transmural lines; and the success rate of noncontiguous and nontransmural lines is variable, mostly depending on operator capabilities. Excellent results of AF ablation have been reported (up to 90% in paroxysmal/persistent AF and up to 80% in permanent AF) in experienced hands, particularly from the pioneering groups.

Transvenous catheter ablation procedures with conventional catheters are increasingly and successfully performed in the treatment of patients with AF, as many patients are severely symptomatic and unable to find relief with current antiarrhythmic drug therapy.<sup>2,3</sup> However, there are some concerns about current AF ablation strategy that include safety and the need for repeated ablations in a significant minority of patients, particularly in those undergoing PV isolation. Long-term efficacy of current strategies often requires the concomitant use of previously ineffective and less toxic antiarrhythmic drugs. Given the relatively long procedure times of many AF ablation approaches and some reluctance on the

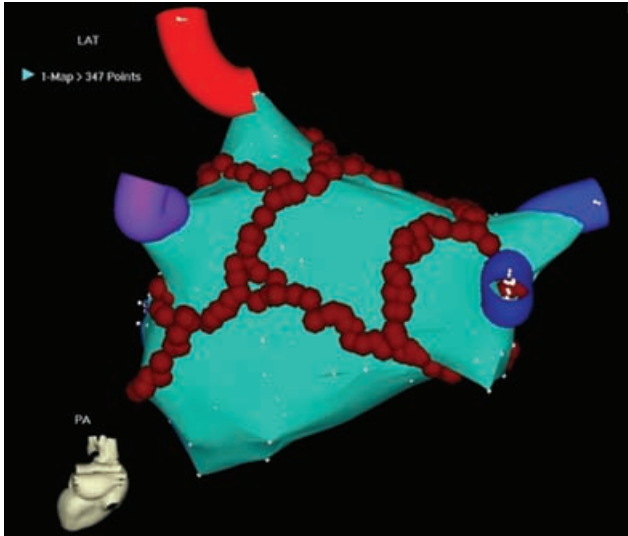
part of patients to undergo repeated ablations with intrinsic increase in risk, the possibility to precisely map and ablate any target in the absence of risk offers an alternative strategy for AF ablation. We first demonstrated that remote navigation and ablation with soft catheters is a safe and feasible alternative in the treatment of patients with AF.<sup>4,5</sup> This can be achieved even in less experienced centers, as this approach requires a short learning curve, perhaps within a few weeks. It is not easy to create with manually deflectable catheters transmural and contiguous lines, and the presence of gaps in lesion lines usually leads to inadequate endpoints.

We have recently developed a new technique (Niobe II, Stereotaxis, Stereotaxis, Inc., St. Louis, MO, USA) for remote ablation using a soft magnetic catheter.<sup>4-6</sup> At present, we have performed about 300 remote procedures in patients with paroxysmal, persistent, or permanent AF. Overall, about 700 patients underwent remote ablation of different arrhythmias in our laboratory. The operator is positioned in a separate control room at a distance from the X-ray beam and the patient's body. A 4 mm magnetic catheter (NaviStar-RMT) is integrated with a newly developed electroanatomical mapping system (CARTO-RMT mapping system). Additional magnets in the distal portion of the device can be deflected in any desired direction and steered by the magnetic navigation system. The catheter can be softly advanced or retracted by a mechanical device (Cardiodrive, Stereotaxis). All magnetic field vectors used for each target navigation can be stored and, if necessary, reapplied while the magnetic catheter is navigated automatically.

## Remote Mapping and Ablation

A transeptal sheath positioned just proximal to the fossa ovalis allows the greatest movement of the magnetic wire catheter. After synchronizing with respiratory and cardiac

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**Figure 1.** Electroanatomical map of the left atrium in postero-anterior view. The map (347 points including both mapping and ablation points) has been reconstructed by the Navistar-RMT magnetic catheter and Stereotaxis system. The lesion set includes circumferential lesions (red circles) around the left- and right-sided PVs with additional posterior lines and the mitral isthmus line.

cycles, such as inspiration and end-diastolic period, a pair of best matched right anterior oblique/left anterior oblique (RAO/LAO) images are transferred into the Navigant screen as background references for orientation and navigation. The Carto system is aligned with the Stereotaxis system, taking up to a few minutes (set-up phase), which is crucial for precise navigation and ablation during the entire procedure. Next, a PV location is selected by a preset magnetic field vector, and during navigation many points can be simultaneously acquired by the NaviStar-RMT magnetic catheter. Remote circumferential pulmonary vein ablation (CPVA) is usually performed with a target temperature of  $65^{\circ}\text{C}$  and a power limit of 50 W (Fig. 1). All ablation lines are performed by sequentially navigating to contiguous points with a single 5- to 10-second application of radiofrequency (RF) current, which is able to achieve a 90% reduction in the bipolar electrogram amplitude. The lesion line can be reset to and recorded on the fluoroscopic image. Potential vagal target sites are also identified during the procedure as with the conventional approach.

Sheath insertion and positioning of diagnostic catheters, including the magnetic catheter, requires a few minutes (min-max, 5–12 minutes). After crossing the atrial septum and positioning the transseptal sheath, the operator leaves the interventional room to perform mapping and ablation from the control room. Based on our experience, remote magnetic navigation and ablation to all targeted sites can be safely and successfully achieved in all patients. At the beginning of the learning curve, tip orientation was frequently adjusted as the catheter was retracted and advanced to access all PVs by using this sequence when feasible: LSPV, left inferior PV (LIPV), right superior PV (RSPV) and, finally, right inferior PV (RIPV). Afterward, the mitral valve annulus and the LAA can be accessed by selecting different field directions on Navisphere. Finally, we navigate the magnetic catheter in rapid sequence to the posterior wall, roof, septal wall, and anterior wall.

### Comparison of Standard Versus Remote CPVA

Initial results indicate that remote navigation and ablation is a simple, safe, and useful system for AF ablation that does not require a substantial learning curve because the endpoint can be successfully reached in almost all patients undergoing such therapy.<sup>4,5</sup> In the first patients, the procedure and fluoroscopy times were long, which was due to the need to visually confirm catheter location and stability during navigation and RF application. The procedure, which included navigation and ablation, was done from the control room, which reduced fluoroscopic exposure time for the operator. The manual approach is operator dependent, while the remote one is not, but it is dependent on a well-trained team.

This may explain why the overall procedure time can be longer in the remote group than in the control group, while mapping times in both approaches are similar. Ablation time to complete circumferential lesions around right-sided PVs is shorter remotely, which indicates that there are no challenging sites as with standard CPVA, thus avoiding unnecessary RF energy applications.

At present, remote technology requires expensive equipment, and significant benefits over conventional catheters must be demonstrated to justify its purchase. Our experience on remote navigation and ablation is excellent and suggests that precision of magnetic guidance has the potential to exceed the reach of even the most experienced operator by tip “pulling” the catheter rather than being pushed by it. The critical purpose of navigation and ablation is a stable contact of the catheter tip with the endocardium at the time of RF applications. When combined with an accurate electro-anatomical mapping system as realized with the Stereotaxis system, the technology promises not only to optimize contact and stability of the interface of the catheter tip with tissue, but also to enable movement between preassigned intracardiac points automatically, either avoiding intervening tissue structures or moving at a defined rate across the surface of the intervening tissue. The main time-consuming factor in AF ablation, which is the number of radiofrequency applications required, may decrease significantly with remote soft catheters that by adhering to the endocardial wall allow a more precise recording and more rapid and controlled potential abatement, particularly when irrigated catheters become available. Electrical disconnection even of challenging targets can be achieved remotely with relatively few ablation lesions, which in turn reduces the risk of pulmonary vein stenosis. We believe that remote ablation is suitable regardless of the AF ablation procedure, as recently demonstrated in pulmonary vein isolation in canines.<sup>7</sup> The decrease of radiation exposure is relevant both for the operator and the unprotected patient. The reason for the reduced exposure for the operator is intuitive, whereas for the patient it is not as obvious. For example, regaining the position of any previously lost target can be achieved in a matter of seconds using stored vectors without further radiation exposure. The shorter procedure times and the efficacy of remote navigation and ablation may constitute a strong stimulus for many electrophysiologists to adopt such technology. We have reached a convergence of different technologies that has the potential to revolutionize our current practice. The era of three-dimensional (3D) reconstruction, robotic control, and high speed connections have found an optimal application in such a rapidly evolving field that is AF, which can potentially soon become the gold standard of AF ablation even in less

experienced hands. Despite the relative advantage of RF energy in the regions of PV, recurrent conduction, particularly after PV isolation with RF energy, is likely to continue to be a problem until systems that provide greater catheter stability and/or lesion continuity are available.

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