Very Low Fluoroscopy Ablation for Atrial Fibrillation Can Be Fast and Safe

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Radiation Risk of Catheter Ablation

X-ray fluoroscopy is universally established as the primary imaging modality to guide electrophysiology procedures. These fluoroscopy systems have advanced significantly over the last decade and low frame rate digital fluoroscopy provides low radiation exposure with high resolution imaging. Both stochastic and deterministic effects of radiation are rare and mostly only manifest decades after exposure, and radiation dose is seldom a pressing concern of the operator. Avoiding complications (usually aided by significant fluoroscopy in complex cases) is a far more immediate priority. Yet the accumulation of radiation exposure over time is a growing concern, particularly in the United States. The rise of musculoskeletal injuries and reports of head and neck cancer among interventional cardiologists should caution the indiscriminate use of fluoroscopy. Moreover, we do not measure life time cumulative dose of medical radiation, despite the exponential increase in medical imaging in all specialties. Our radiation training teaches us the principle of ALARA—keeping radiation exposure as low as reasonably achievable, and it is good for us to pause and consider what that means for atrial fibrillation (AF) patients. AF ablation, including the pre- and postprocedure imaging and potentially multiple long fluoroscopically guided ablation procedures, has the potential to significantly add to the life time radiation exposure of individual patients. It is our responsibility as electrophysiologists to mitigate this risk as much as possible. Most electrophysiologists are well aware of these risks but are faced with the real challenges of long and complex ablation procedures. There is no doubt that, if nonfluoroscopic ablation techniques were fast, safe, affordable, and effective, they would be widely used.

Evolution of Nonfluoroscopic Techniques

Techniques to substantially reduce or even eliminate x-ray fluoroscopy during catheter ablation have been reported for more than a decade. Initial reports were of small observational studies, demonstrating the feasibility of catheter guidance using a 3D mapping system to completely eliminate x-ray fluoroscopy, predominantly in pediatric patients. In 2002, Drago reported 21 cases of successful right-sided accessory pathway ablation without x-ray fluoroscopy using a single catheter guided by the CARTO mapping system (BioSense Webster, Diamond Bar, CA).1 Other physicians reported successful ablation of right-sided supraventricular tachycardia using multiple catheters with virtual guidance using the EnSite NavX system (St. Jude Medical, St Paul, MN).2-5 The subsequent addition of transesophageal echo guidance facilitated nonfluoroscopic transseptal puncture for left-sided accessory pathway ablation, first reported in 2008.6 These techniques were then adapted to catheter ablation of AF, and small series have demonstrated the feasibility of completely eliminating x-ray fluoroscopy for complex left atrial ablation using the combination of 3D mapping and intracardiac echocardiography.7,8

The adoption of these nonfluoroscopic techniques for AF ablation has been relatively slow, despite the widespread availability of 3D mapping systems. Resistance to trying these techniques has centered around concerns regarding procedure complexity, safety, and how much time they might add to an already lengthy procedure.

Integration of X-Ray Fluoroscopy and 3D Mapping

Two recent technologies have introduced the integration of x-ray fluoroscopy images with the 3D mapping system. These systems are intuitive to use and help electrophysiologists, familiar with the fluoroscopic guidance, to transition to nonfluoroscopic catheter manipulation. Both systems use electromagnetic fields to accurately detect the 3D location of the catheter. There are numerous differences between the 2 systems. With the MediGuide system (St. Jude Medical, St Paul, MN), the 3D position and orientation of the catheter tip is transferred to the fluoroscopy system and visualized in a virtual biplanar view projected on 2 cine loops recorded at the beginning of the case. The cine loops play continuously and are ECG-gated to ensure that the movement of the virtual catheter tip and the previously recorded cine loop remain synchronized. With the CartoUniv system (BioSense Webster, Diamond Bar, CA), still or cine images are transferred to the mapping system. The virtual catheter and 3D chamber geometry can then be displayed over the previously acquired fluoroscopic image without requiring continuous fluoroscopic acquisition. Both of these systems offer the familiarity of catheter manipulation based on fluoroscopic images. The virtual catheter moves in real time over the screen, but the fluoroscopic image is a short snapshot taken earlier in the case. The fluoroscopic images can easily be updated later in the case, if necessary.

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In this issue of the Journal, Sommer and colleagues\(^5\) present an observational study of AF ablation using the MediGuide system. The primary objective was to assess the safety of this technology. The study included 375 patients with paroxysmal and persistent AF undergoing catheter ablation by 6 skilled operators (>300 prior AF ablations). This is the largest study of a nonfluoroscopic AF ablation technique. Briefly, their workflow included cine loops in right anterior oblique and left anterior oblique recorded at the start of the procedure to use with MediGuide; a single transseptal puncture; pulmonary venography was obtained before ablation, mostly via direct injection through the deflectable sheath; a 3D CT image of the left atrium was uploaded to the mapping system (EnSite Velocity, St. Jude Medical); pulmonary vein isolation was confirmed with a spiral mapping catheter after ablation, and substrate-based ablation was only performed in patients who had low-voltage areas.

The procedures were fast. The median ablation procedure time was 135 minutes [113; 170]. Little fluoroscopy was used with a median fluoroscopy time 2.8 minutes [1.5; 4.4] and median radiation dose 789 cGy*cm\(^2\) [470; 1466]. In addition, there was a clear learning curve to using this technology. Comparison of the first 50 to the last 50 cases showed a reduction in fluoroscopy time from 6.0 to 1.1 minute and radiation dose from 2363 cGy*cm\(^2\) to 490 cGy*cm\(^2\). What is not clear from this study is how much manipulation was done using only the MediGuide system versus using the 3D geometry and navigation of the mapping system. Nevertheless, these are impressive reductions in fluoroscopic radiation.

Safety data were collected prospectively for the 48 hours before discharge and also at 3 month follow up. There were complications in 10/375 (2.7%) patients. Cardiac tamponade was most common and reported in 5 patients (1.4%). There were 4 pseudoaneurysms and 1 stroke. This rate of complications is comparable to AF ablation cases done at this center before the ablation, although the rate of re-do ablations was 5.3%, forming as safely as standard fluoroscopically guided ablation. Nevertheless, these are familiar with this technology, AF ablation can be performed quickly with no apparent increase in complications. This certainly makes nonfluoroscopic techniques more attractive and should spur us on to incorporate them into our own practice. The individual approaches to minimizing fluoroscopy for AF ablation will likely remain diverse. The techniques will evolve depending on new technologies such as MediGuide and CartoUnivu, what catheters are used, the use of force-sensing technology, the use of ancillary intracardiac echocardiography, the technique for transseptal puncture, the use of pulmonary venography and CT scans, the general approach to AF ablation lesion sets, and perhaps new technologies, such as the development of real-time cardiac MRI. As in this study, operators who commit to reducing fluoroscopy will face a learning curve. Fluoroscopy reductions may at first be modest but, as operators become familiar with these techniques, substantial reductions can be made.

There is more work to be done before nonfluoroscopic techniques can be widely adopted by electrophysiologists. We need prospective multicenter trials to demonstrate that these techniques are not only fast and safe but are also effective in patients with AF.

**Disclosures**

Dr Ferguson is a consultant for St. Jude Medical and BioSense Webster.

**References**


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