INNOVATIVE TECHNIQUES

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Atrial Fibrillation Cryoablation Assisted by Three-Dimensional Rotational Angiography: A New and Promising Alliance

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ABSTRACT. Three-dimensional rotational angiography is a new X-ray-based tool recently incorporated to atrial fibrillation radiofrequency ablation in many laboratories. The first description of this technique applied to a cryoballoon ablation procedure in a patient with paroxysmal atrial fibrillation is communicated. The role of this technique among the different available image systems assisting atrial fibrillation ablation is briefly discussed.

KEYWORDS. atrial fibrillation ablation, cryoablation, cryoballoon, rotational angiography.

Introduction

Pulmonary vein (PV) cryoablation with a catheter balloon is a well-known therapy for patients with drug refractory atrial fibrillation (AF). Cryoballoons belong to a modern generation of specifically designed PV ablation catheters, also called “single-shot” or “tridimensional” ablation catheters. The main advantage of the cryoballoon is the reduction of fluoroscopy and procedure time with, a similar efficacy to traditional “point-by-point” AF ablation.1

Owing to the complexity and variability of the left atrium (LA) and PV anatomy,2 all modalities of AF ablation usually require the incorporation of complementary imaging techniques. Preprocedural data obtained from cardiac computed tomography (CT) or magnetic resonance imaging (MRI) are valuable tools for procedure planning. Intraprocedural techniques include transesophageal or intracardiac echocardiography and electroanatomical mapping systems.

Three-dimensional rotational angiography is a new imaging modality available in some modern fluoroscopy equipment. This tool is based on contrast-enhanced acquisition of a cardiac structure during fast rotation of the fluoroscopy arc, for subsequent three-dimensional reconstruction and projection on the fluoroscopy screen during the procedure. It has been applied to the LA (called 3D rotational angiography, 3DATG) and used safely and effectively to support traditional “point-by-point” ablation procedures for AF.3,4

The first case of PV cryoablation incorporating 3DATG performed in our center is reported. Peculiarities and potential advantages of this new combination are described.

Case report

A 54-year-old male with paroxysmal AF was referred to our outpatient clinic. Transthoracic echocardiography and thyroid hormones were normal. Flecainide was started but discontinued soon afterwards due to symptomatic bradycardia and pauses, so the patient was scheduled for PV ablation. A preprocedural CT and transesophageal echocardiography were obtained in order to assess the LA–PV anatomy and rule out the presence of thrombus into the left appendix. LA size was normal, the left PV were independent, and a right common trunk for right superior, right intermediate and right inferior PV was detected.

The procedure was performed under deep sedation with fentanyl and midazolam. After placing two diagnostic tetrapolar catheters on the His bundle and coronary sinus for anatomical reference, a transseptal puncture was done. A 6-Fr pigtail catheter was inserted...
through the sheath into the LA and connected to an automated contrast injector. The table was held in the LA isocenter position (i.e. the position in which the LA remains on the screen center independently on the orientation of the X-ray tube). The His bundle catheter was advanced to the right ventricular apex and it was overpaced to 220 bpm in order to minimize ventricular contraction. At the same time, a rotational angiography was performed with an X-ray FD10 flat detector system (Allura Xper, Philips Medical Systems Inc., Best, The Netherlands). It was obtained synchronizing an injection of contrast (60 ml at 20 ml/s) with a quick rotation of the fluoroscopic arc, from 110° left anterior oblique to 110° right anterior oblique, at a sampling rate of 30 frames/s (Figure 1).

Using the tool “EP Navigator” available on the X-ray 3D rotational angiography workstation (Allura 3D Rotational Angiography, Philips Medical Systems), a CT-like image reconstruction of the LA and PV was obtained. It was aligned and fused on live fluoroscopy by carina-based registration as previously described, so that the image rotates in the same direction as the X-tube does.

The pigtail catheter was removed and the 8.5-Fr sheath was changed to a 12-Fr steerable sheath (FlexCath, Cryocath, Medtronic, MN). A 23-mm-diameter cryoballoon (Artic Front, Medtronic) was selected according to the measurements of the PV ostia previously obtained, and was placed through the steerable sheath into the LA. The balloon movement was guided by the rotational angiography image; occlusion was assessed by selective contrast injections through the lumen of the catheter balloon (Figure 2), and PV–LA conduction was analyzed with a specifically designed mapping catheter (Achieve, Medtronic). Ablation was delivered achieving electrical isolation on all PV (Figure 3).

The intervention was completed after 183 min, with a fluoroscopy time of 51 min. There were no complications related to the procedure and the patient was discharged the following day.

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**Figure 1:** Patient’s left atrium and pulmonary vein are contrasted with a pigtail catheter during rotational angiography. Three frames are shown on the left anterior oblique, anteroposterior, and right anterior oblique.

**Figure 2:** Three-dimensional reconstruction obtained from “EP navigator” after the acquisition of rotational angiography, fused with real-time fluoroscopy. (a) External view of the model with a cryoballoon catheter in left inferior pulmonary vein. (b) Internal view of the model that facilitates the evaluation of pulmonary vein occlusion.
Discussion

A deep knowledge of each patient’s anatomy of LA and PV is advisable in AF ablation procedures. It is essential to avoid applications within the vein, which increases the risk of stenosis, or too far away from the ostium, where it is more difficult to obtain disconnection. Cardiac CT/MRI, echocardiography and electroanatomic mapping systems are the main imaging techniques currently available. These techniques have different advantages and limitations.

Cardiac CT/MRI provides excellent spatial resolution and is useful to know the LA anatomy and its relationship with adjacent structures, such as the esophagus or the aortic root. These are not real-time images: they are obtained under very concrete conditions (blood volume, body position, etc.) that may differ from those on the day of the procedure. They are also performed in deep inspiration, which has been shown to displace the position of the inferior PV.

Available electroanatomic mapping systems allow a real-time simultaneous visualization of the anatomy and catheters. Their poor ability to reliably define the position of PV ostia, their additional cost, and the additional time required to perform the reconstruction limit the routinely use of these systems in cryoballoon procedures.

Intraoperative transesophageal or intracardiac echocardiography offers recognized useful images in both “point-by-point” ablation and cryoablation. Besides assisting transseptal puncture, intracardiac echocardiography provides a clear definition of the PV ostia and an accurate evaluation of the occlusion by color Doppler. However, the acquisition and interpretation of the images are difficult and require specific operator training, thereby limiting its use.

3DATG, a new X-ray based image technique, has showed a good correlation with the CT image in the analysis of PV anatomy and size, with shorter image acquisition time and lower radiation dose. Its usefulness in radiofrequency AF ablation has been satisfactory compared with CT and with electroanatomic mapping systems. However, at present there are no published data on its usefulness in AF cryoablation.

3DATG offers a combination of advantages that may be especially interesting in AF cryoablation: first, it is a real-time image obtained during the procedure, with good PV ostia and left atrial appendix resolution; second, it allows simultaneous catheter visualization due to the possibility of fusion with the real time fluoroscopy image; third, it is obtained rapidly, within a few minutes, requiring a low dose of radiation (equivalent to 4 s of conventional cine acquisition); and, fourth,
it is not operator dependent, so it does not require a long learning curve. The LA reconstruction obtained by 3DATG can make it easier to accurately follow the deflectable sheath-balloon system to each PV and for poor positions (too advanced or too far) to be discarded before assessing the occlusion by contrast injections, thus reducing unnecessary use of contrast. The possibility of cutting out the image and obtaining endoviews of the LA enhances the value of 3DATG as a complementary tool in the assessment of PV occlusion with cryoballoon.

A period of ventricular asystole is required during image acquisition in order to avoid LA contrast wash-out during rotation of the arc. This is usually achieved by injection of high doses of adenosine or by ventricular overdrive. We acquired an image of sufficient quality using the latter method, because of a more predictable effect than adenosine and a better tolerance by the patient when awake.

Nevertheless, there are several limitations related to rotational angiography that must be considered. It is necessary to prevent movements of the patient during arc rotation, because of this, general anesthesia is usually required or at least a mechanical contention of the patient. On the other hand, very obese patients do not make the 220° rotation required for angiography acquisition possible, so they cannot be explored with this technique. Stopping ventricular contraction, necessary for obtaining a sharp image, may be sometimes difficult for the operator and uncomfortable for the patient.

Conclusion

Rotational angiography provided easy, quick, and valuable anatomical information of the LA, appendix, and PV during our first AF cryoablation with the aid of this system. It facilitated the cannulation and occlusion of all PV with the cryoballoon properly, so it has been incorporated into routine practice in our laboratory. The utility of the addition of 3DATG to conventional AF cryoablation in reducing contrast, fluoroscopy, and total procedure time should be evaluated in the future.

References


