Less Invasive Ablation of Atrial Fibrillation Achieved by Contrast-Free Cryoballoon Ablation

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Cryoballoon ablation (CBA) has become one of the most frequently used techniques for ablation of atrial fibrillation (AF). The pulmonary veins (PVs) are isolated effectively and efficiently by a single-shot cryo-energy application, which has been shown to be non-inferior to conventional radiofrequency ablation (RFA) in terms of efficacy and safety, and the total procedure time has been shortened.¹ Furthermore, another advantage of CBA is that the learning curve is short and the procedural success is less operator-dependent.² Because of its high efficacy and versatility, CBA has become the mainstream

Article p 256

procedure for AF ablation, and several tips and techniques to improve performance have been reported (**Figure**).^{3–6} There are also plenty of tips for avoiding complications associated with CBA (i.e., PV stenosis and phrenic nerve injury (PNI)).^{7,8} In particular, as compared with RFA, which can be accomplished contrast-free by using a 3D mapping system, CBA usually requires a step with contrast infusion from the distal tip of the balloon catheter to

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confirm occlusion of the PVs with the balloon before cryo-applications. This process is one of the important limitations of CBA and mostly concerns patients with renal dysfunction or allergies to contrast media.

In this issue of the Journal, Suzuki et al⁹ show a practical and quantitative method for confirming balloon fitting to the PVs by using intracardiac echocardiography (ICE) during the procedure. This ICE-based assessment, which has the potential to overcome the limitations of CBA, is a further less invasive ablation strategy for AF patients.

In order to perform CBA without contrast injection, the appropriate balloon-contact with the PVs can be confirmed by tactile feedback,¹⁰ balloon motion under fluoroscopy, and pressure waveforms acquired from the distal tip of the catheter;¹¹ however, all those methods lack quantification. Although confirming peri-balloon leakage with ICE and adjusting the balloon-position has been reported recently, the goal is set as complete disruption of the PV leak flow (i.e., a total PV-occlusion), and there has been less study of peri-balloon leak flow velocity (PVLV).¹²

In the first phase of the present investigation, peri-balloon leakage was compared between ICE and conventional contrast infusion. PVLV was assessed by ICE and the electrical PV lesion gaps were evaluated by a high-density electroanatomical mapping system. Although the presence of PV leakage assessed by ICE did not always result in failure of PV isolation, a correlation was shown between higher PVLV and smaller electrical PV lesion gaps, which can be naturally understood from the relationship of blood flow velocity and the blood flow passing area. Interestingly, PV leakage was confirmed more often with conventional contrast infusion than with an ICE-guided evaluation and was not always consistent. This could be explained by overestimation of PV leakage due to the excessive PV pressure caused by contrast infusion, which may incite unnecessary pushing of the balloon on the PVs. ICE-guided CBA enables more accurate and quantitative assessment of PV leakage, and reduces the risk of excessive balloon contact with the PVs inducing stenosis and PNI.¹³⁻¹⁵

In the second phase, efficacy was compared between the conventional contrast-guided method and the ICE-guided protocol based on the ideal PVLV analyzed from the first-phase analyses. In the ICE-guided group, PV isolation was successfully achieved in all cases without a “rescue” contrast injection, and there was no difference in the recurrence rate compared with the conventional protocol group at 6 months after the procedure without increasing the complications. This study showed the feasibility and efficacy of ICE-guided contrast-free CBA, and moreover, less invasiveness of the procedure not only in terms of renoprotection but also for avoiding complications related to the ablation procedure itself (i.e., PV stenosis, PNI). In the future, it will be necessary to confirm the versatility of this ICE-guided procedure by other operators and to ensure the accuracy of PVLV evaluation by conducting multicenter randomized controlled trials.

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