Atrial fibrillation (AF) is one of the most common types of tachyarrhythmia. Pulmonary-vein (PV) isolation by catheter ablation has been shown to be much more effective on sinus rhythm maintenance compared with antiarrhythmic drug therapy and has become a standard approach for the treatment of drug-refractory AF. Radiofrequency catheter ablation (RFCA) has been the most common procedure for PV isolation. However, balloon ablation methods were also developed recently. Cryoballoon-based ablation (CBA) is a procedure which applies single-shot cryogenic energy to PV ostia, leading to cellular necrosis by freezing. CBA was reported to have the same efficacy for the treatment of patients with drug-refractory paroxysmal AF as RFCA, and it has been widely performed in clinical practice as an alternative therapy to RFCA.

These two methods are different in terms of the energy sources of ablation; tissue heating by RFCA versus tissue cooling and ice formation by CBA. The injury of CBA on the tissue might be less than that of RFCA because of several unique features such as well demarcated lesions or preservation of the extracellular matrix. Acute edema after RFCA in human cases was reported in several modalities. On the other hand, regarding CBA, there have been very few reports on this important issue in human cases.

In this issue of the International Heart Journal, Miyazaki, et al evaluated acute tissue reactions after second-generation CBA in human cases using intracardiac echocardiography. They demonstrated that diffuse acute tissue edema appeared immediately after cryoballoon application. Furthermore, they also showed that the spread of tissue edema was involved in the nadir balloon temperature, which indicates that tissue edema would be attributed to cryoenergy effects on tissue, and not physical injury due to the procedure. Baran, et al previously reported on the acute influences of CBA on PVs. In their paper, they found that PV edema was frequently seen after CBA (72-88%). The acute edema was recognized as hypoechogenic abnormal tissue by intravascular ultrasonography. However, the spread of the edema was different from that of the present study. The depth of the former was between 2.1 and 2.7 mm while the depth was between 0.25-0.5 mm in the present study. The reason for this discrepancy in the edema area is unknown. Baran, et al observed dissection-like images in the PVs, but they were not mentioned in the present study. There may be differences in the physical damage to the tissue due to the procedure between the two reports, in addition to the possibility that the discrepancy might come from a difference in the modality of the measurements; intravascular ultrasonography versus intracardiac echocardiography.

The main limitation of the present study is the clinical implication of atrial edema after CBA. Electrical reconnections between the left atrium and PVs are often seen in AF recurrence cases. Complete PV isolation during the acute phase of the procedure does not always guarantee permanent PV isolation. Arujuna, et al reported that a combination of reversible and irreversible atrial injury was involved in acute pulmonary vein isolation in AF RFCA cases. They examined the conditions of acute injury of the left atrium after RFCA for patients with AF using MRI. The higher T2 signal (predicting edema) on acute scans and greater decline in delayed enhancement area on chronic imaging were recognized in patients with AF recurrences. They speculated that more reversible tissue injury such as edema might provide a potential mechanism for pulmonary vein reconnection, resulting in arrhythmia recurrence. It is unknown whether this RFCA case applies to CBA cases. In the present study, the atrial edema after CBA was recognized in all patients, but 8 out of 10 patients were free from arrhythmia recurrence. Furthermore, PV reconnection was recognized in only one of the 2 patients with recurrence. Yamashita, et al evaluated acute edema volume in canine ventricular tissue after cryoablation using MRI. In their paper, they showed that acute edema by cryoablation was significantly smaller than that by RFA. The relationship between the atrial edema and AF recurrence might be less in CBA compared...
with RFA. Further evidence is needed to clarify this point.

Finally, the present study provides a clue to elucidation of the influence of CBA on atrial tissue. We hope that further studies will lead us to gaining an understanding of the mechanism of AF recurrence and eventually amelioration of the outcome of catheter ablation.

Disclosures

Conflicts of interest: None.

References


