Four types of complications in paroxysmal atrial fibrillation ablation

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This editorial refers to ‘Pericardial effusion in atrial fibrillation ablation: a comparison between cryoballoon and radiofrequency pulmonary vein isolation’ by G.B. Chierchia et al., on page 337.

A recent worldwide survey shows that radiofrequency (RF) catheter ablation of paroxysmal atrial fibrillation (AF) is associated with a success rate of 75% without antiarrhythmic drugs, with major complications still occurring in 4–5% of the patients.¹ This drives a continuous quest for a more effective and safer ablation approach. Currently, the use of robotic navigation systems, alternative forms of energy (ultrasound, cryo-energy, laser, microwave, and infrared), and the use of ‘single-shot’ devices (e.g. cryoballoon, multi-electrode ablation catheters) are under investigation.

In the present paper Chierchia et al. report on the safety of cryoballoon-based pulmonary vein isolation.² In general, it is hypothesized that cryoballoon ablation of AF is a safer approach, but neither survey nor large randomized trials are available. To address the safety of new technologies, we suggest classifying known AF complications (tamponade, radiation exposure, embolic events, pulmonary vein stenosis, atrio-oesophageal fistula, phrenic nerve palsy, and groin problems) into four partly overlapping categories (Figure 1). Operator experience and patient profile always act as modulating factors.

Energy-dependent complications

Radiofrequency energy has the potential for the development of pulmonary vein stenosis and atrio-oesophageal fistula. Furthermore, even with irrigation, a small risk of stroke remains because of endothelial disruption and the possibility of clot formation. The potential for tamponade by RF-induced perforation is expected to be minimal, especially when ablation is limited to pulmonary vein isolation. Although RF energy-dependent complications can be minimized by operator experience (catheter positioning, catheter contact, power control, etc.) and technological improvement (contact force, robotic navigation, oesophageal cooling), cryo-energy could markedly reduce this category of complications: (i) minimal collagen formation eliminates the potential of pulmonary vein stenosis; (ii) altered healing or limited transmurality reduces the likelihood of atrio-oesophageal fistula; and (iii) the absence of endothelial destruction is expected to reduce partly the likelihood of thrombo-embolic events.³ The positive or negative impact of other energy-sources on this segment of AF complications needs further research.

Procedure-dependent complications

Any AF ablation strategy requires radiation exposure and an access to the left atrium via a transseptal puncture. Even in experienced hands, this technique carries a risk of tamponade of around 1.5% as observed by Chierchia et al.² Also embolic events (thrombus, air, etc.) and groin complications are, to some extent, related to the invasive nature of the procedure (sheaths, guidewires, manipulation, electrical cardioversions) and its peri-operative changes in anticoagulation. It is unlikely that changes in AF ablation technology will completely eliminate these procedure-related complications. Operator experience, patient selection, and optimization of procedural management might be the only way to reduce these inherent procedure-related complications. Continuation of oral anticoagulation at a therapeutic international normalized ratio at the time of ablation is a potentially better strategy to avoid stroke compared with strategies using heparin or enoxaparin.⁴ Chierchia et al. observed that procedural time, the presence of hypertension, or coronary artery disease and not the energy source itself were predictors of pericardial effusion.²

Device-dependent complications

Balloon-based technology (cryo, laser, or ultrasound) is more prone to the development of phrenic nerve palsy when compared with the point-by-point RF strategy. The occurrence of phrenic nerve palsy when using cryo-balloon technology ranges from 2 to 10%.⁵–⁷ In analogy, Chierchia et al. observed three cases of transient phrenic nerve injury (6%), despite preventive pacing of the ipsilateral phrenic nerve.²

For each ablation strategy, the diameter of the device and the number of required exchanges, sheaths, and catheters can contribute to groin complications and embolic events in paroxysmal AF ablation (Figure 1, cross section). In this respect, the need for a

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15 Fr transseptal sheath in combination with an additional mapping catheter remains a handicap for cryo-balloon ablation. Vice versa, it is clear that any future improvement in AF technology such as circular RF catheters, mapping guidewires, robotic navigation, etc. can substantially reduce device-dependent complications.

**Efficacy-dependent complications**

Efficacy-dependent complications are those related to the need for a redo procedure. The patient is exposed to all energy-, procedure-, and device-dependent complications leading to a higher cumulative complication rate. Although the procedure time and number of lesions might be less, some complications might be even more frequent when compared with the first procedure due to hampered groin or transseptal access.8 Also in the field of coronary revascularization, repeat interventions are associated with an increased risk when compared with the first procedure.9

These thoughts imply that maximizing the first pass efficacy rate can markedly reduce the complication rate of any paroxysmal AF ablation strategy. Given an ablation strategy with a 4% complication rate, reducing the redo rate from 40 to 10% would decrease the cumulative complication rate from 5.6 to 4.4% (21% relative risk reduction).

In summary, technological improvements will reduce energy- and device-dependent complications, whereas procedure-related complications will remain an inherent part of any future AF ablation strategy. Therefore, in our opinion, maximizing the first pass efficacy rate is a necessary step to avoid complications in paroxysmal AF ablation.

**Conflict of interest:** none declared.

**References**


