Fully equipped to defeat the pulmonary vein potentials: on the quest for sinus rhythm

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This editorial refers to 'Pulmonary vein isolation with radiofrequency ablation followed by cryotherapy: a novel strategy to improve clinical outcomes following catheter ablation of paroxysmal atrial fibrillation' by M. H. Tayebjee et al., on page 1250.

Since its inception more than a decade ago, catheter ablation has dramatically changed our therapeutic approach to atrial fibrillation (AF). The irruption of catheter ablation occurred through the recognition of the pulmonary veins (PVs) as main triggers initiating paroxysmal AF. Initial ablation strategies aimed at suppression of these focal triggers. However, radiofrequency (RF) lesions placed inside the veins produced PV stenosis, so that ablation had to move from the veins to its antrum. Segmental PV isolation was based on this principle, and targeted only preferential connections between the antrum and the PV at its ostium. This yielded quite good results in paroxysmal AF, but produced much more modest outcome in patients with persistent forms of AF.

In circumferential antral PV isolation ablation lesions are extended to encompass the left atrial PV mouth. Due to its complex histological structure, the PV antrum itself plays an important role not only in initiation, but also in maintenance of AF, so that larger lesions around the PV antrum allowed achieving better results than smaller ones. However, pulling ablation lesions outside the veins has two main drawbacks. On one hand, circumferential encircling of ipsilateral PV necessitates the creation of longer lines in the atrium, increasing the chances of local conduction recovery. On the other hand, the farther from the vein ostium, the harder it gets to achieve transmural lesions due to an increased and heterogeneous myocardial thickness. As a matter of fact, durable PV isolation is hard to achieve, the rate of PV reconnection shortly after catheter ablation is high. Technical difficulties converge with these anatomical obstacles: creating long lines in the left atrium requires advanced catheter manipulation skills. The learning curve is long, and results are difficult to reproduce.

Aiming to achieve faster and more stable lesions, one-shot balloon-mounted devices were developed. Some of them, however, had to be prematurely withdrawn due to safety issues. The cryoballoon appears to offer the right safety — efficacy ratio. It combines a one-shot device with cryothermia, a form of energy that has already long been used for myocardial ablation in the surgical field. Cryoablation devices have the advantage of sticking to myocardial tissue during applications, and display a very favourable safety profile. However, cryoballoon ablation also encountered its own technical problems: the form and the size of PV antrum are very heterogeneous among the patients and even in the same patient, making it hard for a single-sized device to fit all variants. On average, two available balloon sizes (23 and 28 mm) cover 90% of possible PV anatomies. Ten per cent of PV require focal applications to achieve complete isolation; whether the circles created only with the balloon and the ones completed with discrete lesions offer the same stability is still a matter of discussion.

As an alternative to new devices, more extensive ablation strategies have also been proposed to improve the results, both for paroxysmal and persistent AF patients. However, should we not try to improve the stability of our first proposed lesions before adding new ones, which may also be eventually prone to failure leading to recurrence? AF recurrence after initial PV isolation has been shown to be highly associated with PV reconnection. Moreover, a recent study showed that clinical results after PV isolation can be consistently improved just by consolidating the previously drawn lesions, even in patients with long-persistent AF.

In this issue of the Journal, Tayebjee et al. present a novel strategy allowing ‘double PV isolation’ in one procedure by combining conventional 3-D guided irrigated-tip RF ablation with cryoballoon PV isolation. In this retrospective study, the combined approach was not associated with more complications than either of these techniques alone, and provided significantly better results after one single procedure than a single approach. With the combined approach, the proportion of arrhythmia-free patients (80%) was comparable with the best published results after repeat conventional irrigated-tip RF ablation procedures, whereas clinical success with isolated techniques performed by the same team of
physicians (56% for the cryoballoon and 52% for RF ablation) was average.

The key to these outstanding results might lie in the simultaneous creation of two concentric circular lesions around PVs in order to minimize the rate of reconnections. The closer circle has to deal with a thinner myocardium and less connection between the PV and the atrium. The largest one, though, encompasses other important structures such as ganglionic plexi and the PV antrum itself. This points to the fact that a theoretically perfect, large, stable, and reliable circumferential PV isolation provides much better clinical results than those obtained with the currently available technology. The combination of two different energy sources in one procedure might also have contributed to its excellent results, but should be regarded with caution. Little is known about the histological effects of successive RF and cryoenergy applications on the atrial myocardium. Supplementary data exploring this issue are mandatory before its wider introduction.

As the authors have correctly acknowledged, the combined approach has one major disadvantage: it is significantly more expensive. On the other hand, improved clinical results would save the potential costs of several further procedures, and, importantly, would help to avoid risks associated with a new transseptal puncture, thromboembolic events, etc.). Other technological improvements such as contact force monitoring during RF ablation or improved cryoballoon designs able to cope with all PV anatomical variants could also yield significantly more stable myocardial lesions, making the simultaneous use of two ablation devices redundant.

The achievement of stable, durable, and safe lesions for PV isolation is still the first milestone in the quest for sinus rhythm. The excellent results obtained by the combined approach described by Tayebjee et al. underline the need for tools that allow us to achieve better PV isolation, ideally in one single procedure.

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**References**