

Percutaneous Modalities for Atrial Fibrillation Ablation

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Pulmonary vein isolation (PVI) is now accepted as a cornerstone modality for the treatment of paroxysmal atrial fibrillation (PAF) ablation (1). The technique has been started with focal pulmonary vein (PV) ablation of AF triggers or ostial isolation of the PVs (2-5). Nowadays, wide circumferential ablation of the PV antrum is the preferred approach (6). The potential role of different non-PV targets for the treatment of PAF (either alone or as an adjunct to PVI) has been inconclusive, yet.

The description of PV as a trigger site of AF attracts leads to investigations that target focal ablation those sites within the PVs. However, the long-term results were unsatisfactory and the technique was associated with a significant risk of PV stenosis. So, segmental ablation at the anatomical ostium of the PVs was attempted in order to electrically isolate muscle sleeve connections between the PV and left atrium. Due to high recurrence ratios, the technique which initially targeted only the PVs with evidence of arrhythmogenic activity evolved electrically isolation of all PVs. To cope with PV stenosis, the ablation target was removed from PV ostium to the left atrial tissue defined as the PV antrum. Various three-dimensional electroanatomic mapping systems were used to achieve antral PV ablation (7,8).

The recent trials showed that triggers exist not only within the PV but also outside the PV (e.g. superior vena cava, atrial septum, crista terminalis) (9). Once AF has been triggered, two mechanisms are responsible for sustaining the arrhythmia. One of them is multi-wavelet reentry (10). This theory is linked to the "critical mass" hypothesis of AF, whereby a certain atrial size is required to sustain enough wavelets for the arrhythmia. The second is the localized source model in which macro-organization in the form of spiral wave reentry (rotors) (11). According to the multi-wavelet hypothesis, the constant formation of new wavelets occurs through the process of wave splitting which occurs because of non-uniform dispersion of refractoriness and anatomic heterogeneity. This continuous propagation of multiple wavelets in the atria and wavelets as offspring of atrial reentry circuits might explain the mechanism by which AF is perpetuated without continuous focal discharge.

Multi-wavelet reentry hypothesis has caused to investigate some ablation modalities. One of them is ablation of complex fractionated atrial electrograms (CFAEs), which are thought to represent either continuous reentry of the fibrillation waves into the restricted area or an overlap of different wavelets entering the same area at different times (12). Ablation of these electrograms has been performed with the aim of eliminating wavelet reentry (13). Another approach is linear ablation lines within the left atrium which compartmentalizes the atria with the aim of preventing the formation of macro-reentrant circuits that have been postulated to maintain AF (14-16). Ablation lines include a roof line, a mitral isthmus line, and an anterior line.

Narayan et al. investigated the potential role to be sustained by localized sources such as electrical rotors and focal impulses (17). To identify rotor cores, focal impulse and rotor modulation mapping was developed using basket catheters by phase mapping. Rotors and focal sources identified by this approach are spatially constrained, temporally conserved, and drive AF based on maps of propagation and the ability of localized ablation at these sites to eliminate AF.

The autonomic system activity may play a role in the initiation and maintenance of AF, and modulating autonomic nerve function via ganglionated plexi (GP) ablation may increase the success of AF ablation. Ganglionated plexi sites may identify using continuous high frequency stimulation before antral PVI or circumferential PV ablation (18).

Although PVI is usually enough for the success in PAF ablation, a stepwise ablation approach which consists of PVI, linear ablation, CFAE ablation, non-PV triggers ablation, and discretionary right atrial ablation are often necessary in persistent or long-standing persistent AF ablation. Isolation of PVs and posterior wall ablation are beginning steps, but identification and ablation of non-PV triggers or extensive substrate ablation are important to achieve long-term success.

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