

Segmental pulmonary vein isolation versus the circumferential approach: Is the tide turning?

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In the July issue of *Heart Rhythm*, Lemola et al¹ presented the results of a study of the mechanisms of recurrence of atrial fibrillation (AF) after previous segmental pulmonary vein (PV) isolation, and the outcome after repeat intervention using 2 opposing methods for these patients, selected by operator preference. Left atrial ablation, with extensive circumferential lesions to encircle PVs and additional lines in the posterior wall and mitral valve isthmus, proved superior to segmental PV isolation using a circular mapping catheter at a follow-up of 6 months. The authors conclude that circumferential PV ablation is preferable to selective PV isolation for repeat procedures in patients with paroxysmal AF, particularly in the absence of detectable PV automatic activity.

At present, the multiple potential mechanisms of AF in humans are incompletely understood despite years of research. Based on experimental and clinical studies, 2 major factors, drivers and multiple wavelet reentry, are postulated for the initiation and perpetuation of AF. Primary drivers are particularly active in patients with paroxysmal AF^{2,3} and are often located in the PVs, within other thoracic veins⁴ such as the superior vena cava, vein of Marshall, or coronary sinus, or within the left or right atrium. The multiple wavelet reentry hypothesis, as described by Moe,⁵ proposes that a critical number of circulating wavelets is needed for the perpetuation of AF. Based on these 2 mechanisms, successful ablation of AF requires elimination of drivers as well as the modification of the atrial substrate to prevent wavelet propagation. The demonstration in both human and animal studies that the PVs and the posterior wall of the left atrium play a substantial role in triggering and in driving the fibrillatory activity has opened new avenues of research into the mechanisms of initiation and maintenance of AF. This important finding has resulted in the development of 2 different approaches: PV isolation to "electrically isolate" the PVs guided by PV spikes and circumferential PV ablation guided by 3-D electroanatomical mapping.⁶⁻⁸

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PV isolation

The recognition of PV foci that trigger AF has led to the development of an ablation technique to identify not only the electrical communications between the left atrium (LA) and PV, but also, in many cases, the ectopic foci themselves. A circular multipolar mapping catheter is positioned in the PV ostium, and the earliest points of LA-PV communication are identified and ablated. Pulmonary vein tachycardias are not always found, despite provocation with isoprenaline. Veins may be quiescent at a first procedure yet active at a repeat intervention. In patients with trigger-driven AF, this is an appealing approach and yields good results in selected patients, particularly when it is possible to isolate all PVs. Recent data from Oklahoma suggest that the veins most likely to contain automatic foci are also the ones with the broadest or most numerous PV-atrial connections,⁹ rendering the segmental ablation approach more difficult, with a higher risk of the potentially serious complication of PV stenosis. One of the challenges with this technique is isolating the vein at the ostium using sufficient energy to cause permanent electrical disconnection without causing stenosis. This risk has reduced significantly in recent years with increased operator experience and the use of intracardiac echo to guide catheter positioning, and the use of micro-bubble formation as a warning of impending tissue overheating.¹⁰

Freedom from recurrent AF can be achieved in around 60% to 65% of patients with paroxysmal AF and in about 25% of patients with chronic AF, suggesting that PV isolation alone has only a limited role in the more "burdened" patients because this approach addresses only one of the factors responsible for chronic AF.

Repeat intervention is often necessary due to recurrence of symptoms. Gerstenfeld et al¹¹ found that in patients with recurrent symptoms, the foci responsible for triggering AF after previous PV isolation were often in veins with recurrent conduction, or in previously silent veins, or foci on the atrial aspect of previous points of isolation. Cappato et al¹² used a staged protocol to isolate PVs and found that at the second planned procedure, 80% of previously isolated veins had recovery of conduction. Despite this, clinical success

was obtained in a proportion, suggesting that the actual isolation of the vein may not be the only factor responsible for success.

Circumferential PV ablation

Circumferential PV ablation is an anatomical approach to encircle the PVs by ablating on the atrial aspect of the LA-PV junction, some distance from the venous tissue. Circumferential PV ablation has features in common with both PV isolation and the surgical Maze procedure. The veins and PV ostia are encircled, and additional lines in the posterior wall and mitral valve isthmus are created to reduce the potential risk of iatrogenic left atrial flutter. Recently, a randomized study demonstrated that circumferential PV ablation was effective in 88% of patients, compared to 67% with PV isolation, after 1 year of follow-up.¹³ The higher efficacy of circumferential PV ablation can probably be attributed to the elimination of more atrial and PV tissue, therefore not only isolating triggers, but also compartmentalizing the left atrium, reducing the substrate for fibrillatory conduction. Recently, an additional benefit has been demonstrated from modification of the regional vagal cardiac innervation.¹⁴ In this study, vagal reflexes were elicited in at least 30% of patients during the ablation procedure, with these areas being concentrated particularly around the left superior and inferior PVs. Abolition of these reflexes with continued radiofrequency application resulted in a greater attenuation of the parasympathetic component of heart-rate variability, and a success rate approaching 100% at 1 year. These additional factors are almost certainly the explanation for the higher successes observed with circumferential PV ablation.

The future is now

The advancement of catheter ablation for definitively curing AF mostly depends on the understanding of all mechanisms responsible for AF. It may well be that more specific targeting of cardiac autonomic innervation may provide higher success rates with a concomitant reduction in the amount of ablation. Studies are ongoing to examine the efficacy of both surgical and percutaneous, selective vagal denervation in the prevention of AF. Atrial fibrillation is a common problem and is a significant burden for healthcare systems worldwide, particularly with the aging population demographics. It is likely that in the near future we will be performing AF ablation in an ever-increasing number of patients. Techniques and technology will be refined, but it is unlikely that we will ever be able to offer 100% success in 100% of patients. Our goal should always be to choose the best available treatment for each individual patient, exposing him or her to the minimum risk. The Michigan experience with both procedures demonstrated that circumferen-

tial PV ablation should be considered a first-line approach for patients with paroxysmal AF, and the article in this issue by Lemola et al¹ would certainly suggest that it is more appropriate to perform circumferential ablation at a repeat procedure rather than further segmental PV isolation. At present, there are few centers practicing both techniques. Perhaps we should all follow in the footsteps of the Michigan group, and be able to offer a tailored approach to our patients.

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