Pulmonary vein atrial tachycardia: do we really need to isolate or freeze?

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Received: 12 April 2019 / Accepted: 8 May 2020 / Published online: 28 May 2020
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Focal atrial tachycardias (ATs) have been demonstrated to arise from several anatomic sites in both atria and annexing structures that can be accurately predicted by established P wave morphology algorithms with high sensitivity and specificity [1–9]. Pulmonary vein (PV) ATs account for the majority of left-sided focal ATs with a propensity for the ostium of a single PV, especially the superior PVs [6, 10, 11]. Patients with focal PV ATs are distinct to those with atrial fibrillation (AF) as they are usually younger, with normal sized left atria and paucity of traditional AF risk factors [7, 12]. The arrhythmic mechanism underlying PV ATs is understood to be due to triggered activity or abnormal automaticity whereby the tachycardia cycle length is usually longer than those with AF, who have diffuse atrial remodelling and a spectrum of other re-entrant arrhythmias [7, 13]. Further, in those with AF, the tachycardia foci are often seen in multiple PVs and deeper into the veins, warranting isolation of all four PVs [7]. By contrast, focal ablation strategy in patients with PV ATs has demonstrated excellent long-term success rates with no AF seen at more than 7 years of follow-up [14]. Alternative ablation approach of targeted pulmonary vein isolation (PVI) has also been performed, with a small retrospective series ($n = 26$ patients) demonstrating potential superiority to focal ablation [10]. However, in the absence of prospective randomised

data, the work by Wei and co-workers in this issue of the *Journal* represents a welcome addition to the literature. [15]

In Wei et al.'s single-centre retrospective series of 83 consecutive patients with focal PV ATs, 60 patients (72%) had ATs arising from a superior PV and 74 patients (89%) had an ostial PV focus, in keeping with previous series [7, 10, 11]. Despite this, only 35 patients underwent focal radiofrequency (RF) ablation while the remaining 48 patients underwent either PVI via wide area circumferential RF ablation ($n = 25$) or the cryoballoon (Arctic Front Advance, Medtronic, Minneapolis, MN, USA; $n = 23$). Over a mean follow-up of more than 5 years, there were no significant differences between the RF and cryoballoon ablation groups in acute procedural success, procedural complications (none in either group), or long-term AT recurrence. Similarly, there were no differences in all the above outcomes between the focal ablation and either of the PVI groups. Overall AT recurrence rate in this cohort was low at 8.4%. Reassuringly, during repeat ablation in 6 of those with AT recurrence ($n = 1$ declined re-do ablation), the site of recurrence was at the same PV focus as the initial procedure. In keeping with previous series, none of the 83 patients went on to develop clinical AF during follow-up [7, 10, 11]. The work by Wei et al. reaffirms our understanding regarding the electrophysiological characteristics of focal PV ATs and the excellent success rates that can be achieved with ablative approach. However, one would question the value of PVI in this patient population over a focal ablative approach, and whether there is any advantage in utilizing the cryoballoon over conventional RF?

Fundamentally, these PV ATs are predominantly ostially located and can be focally targeted via RF ablation with meticulous mapping. In their case series of 27 patients with 28 focal PV ATs, Kistler et al. mapped an ostial PV location in 93% and ablated 25 of the 28 tachycardias with focal ablation (89%); PVI via RF ablation was used for the remaining 3 tachycardias. Success rate was high (86%), with 4 recurrences [7]. Baranowski et al. retrospectively assessed 26 consecutive patients with PV AT. Ten of those were treated with focal RF

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Fig. 1 Ablation strategies for pulmonary vein atrial tachycardia

ablation and 16 with PVI to achieve success rates of 70% and 100% respectively over a mean follow-up of 25 months [10]. The between-group difference reached borderline statistical significance ($p = 0.046$); however, the patient numbers were inadequate to draw specific conclusions. In the current series by Wei et al., the different approaches yielded similar success rates with AT recurrences seen in 2 of 25 that underwent circumferential RF PVI, 1 of 23 that underwent cryoballoon PVI and 4 of 35 that underwent focal RF ablation ($p = 0.643$) [15]. Given the overall high combined success rates (~84%) of focal RF ablation in these series, less may indeed be more, as the focal approach obviates the need for double transseptal punctures and additional mapping/ablation catheters, while reducing left atrial dwell time, amount of ablation and consequent fluoroscopy time. All these factors may result in lower procedural related complications as compared with targeted PVI, which may not be apparent from the small number of cases reported to date.

However, PVI may be adopted when the PV focus is more distal into the vein where targeted focal ablation may result in higher risk of phrenic nerve injury and distal pulmonary venous occlusion [7, 10]. Another scenario in which PVI may be adopted is when the tachycardia has become quiescent to preclude focal ablation and mapping has already localised the focus to a culprit PV with a degree of certainty. While the

study by Wei et al. reported similar efficacy with PVI using circumferential RF and cryoballoon ablation, cryoballoon ablation was associated with significantly longer fluoroscopy time (10.1 vs. 8.4 min; $p < 0.001$), although the overall procedural time was identical [15]. Notably, randomised trials of cryoablation in paroxysmal AF patients have shown non-inferiority to RF ablation, without any clinically relevant advantages in efficacy or safety profile [16]. One must remember that unlike PVI in paroxysmal AF ablation, ablation of ATs is not an empiric procedure as confirmatory mapping is an absolute necessity. As mapping is most commonly performed with a RF catheter, it is not cost-efficient to additionally employ a cryoballoon for PVI, which is also a more costly technology than RF. Taken together, successful ablation of PV ATs requires meticulous systematic mapping for localisation of the tachycardia focus to guide the best ablation strategy which in most cases will not require PVI, let alone the need to freeze (Fig. 1).

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