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EDITORIAL

Advanced ventricular arrhythmia ablation: step-by-step problem-solving

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One of the true joys of serving as a Guest Editor for this special Ventricular Arrhythmia issue of the *Journal of Invasive Cardiovascular Electrophysiology* (JICE) has been the opportunity to review manuscripts, compare our own procedural approaches and experiences, and discuss our visions for the future of VT/PVC/VF ablation with my co-editors at our meetings. Many of the co-editors and authors of the manuscripts in this special issue have reputations for taking on the most complex and challenging procedures in the ventricles, and JICE has a long-standing reputation of publishing cutting-edge research on the practical tips and tricks necessary to achieve success (including safety) in the EP lab. Over the course of our academic EP careers, it is not uncommon for our mentees (present and former) to ask us how to tackle a technical challenge that comes up during (or after) a VT or PVC ablation, and our answers often cite old JICE papers that describe nuanced and creative methods. This "Advanced Ablation Methods" sub-section of this Special Issue is *filled* with such approaches, covering each step of ventricular arrhythmia (especially epicardial) ablation problem-solving:

1) *How do I best sedate the patient?* In the earlier phases of my career, I assumed that epicardial ablation had to be performed under general anesthesia and the pericardial puncture with a breath hold. Subsequently, after experiencing my fair share of non-inducibility and hemodynamically unstable VTs under general anesthesia, and with emergence of data that many patients with presumed scar-mediated VT have focal/triggered VTs [1] that may be easier to induce/map/ablate under moderate/deep sedation [2], and less inducible and hemodynamically stable under general anesthesia [3], my current practice has shifted to performing epicardial procedures under deep sedation when able. In this issue, Conti et al. report their single-center experience of 69 patients undergoing epicardial mapping/ablation under conscious sedation with dexmetomidine [4]. Epicardial access and procedural success were readily achieved, and complication rate (7.2%) was comparable to other studies of epicardial ablation (and importantly not related to the anesthesia protocol).
2) *Where do I start ablating?* Matos et al. present data from their registry of 316 patients undergoing VT ablation over 11 years and compare those with a "combined" endo-epicardial approach versus those with "non-combined" approach [5]. First, it should be noted that "combined" ablation did not require that both endocardial and epicardial mapping be performed in the same procedure but could still be performed sequentially/staged (and in their study was performed after a median 162 days). Their data makes a strong case for utilizing a "combined" approach when able, as a propensity-matched comparison demonstrated greater VT recurrence in the "non-combined" group (34%/year) than in the "combined" group (11%/year, $p = 0.003$). Interestingly, while we think of patients with non-ischemic cardiomyopathy as more likely to have epicardial substrate than those with ischemic cardiomyopathy, Matos and colleagues show that the superiority of the "combined" approach was similar in both populations. However, it should be noted that further subgroup analysis demonstrated that the reduced VT recurrence associated with the "combined" approach only applied to patients who had prior endocardial ablation. Thus, the debate of if and when to also perform up-front epicardial ablation lives on but is better informed by this study and the accompanying insightful editorial by Drs. Howell and Moss [6], who further dissect the nuances of this often challenging decision.

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3) *How do I keep the patient from "crashing" but still achieve success?* While its true clinical benefit is still uncertain, the use of mechanical circulatory support for VT ablation has gained popularity recently. While the market for percutaneous mechanical circulatory support is still dominated by the Impella device (Abiomed, Danvers, MA) and used for coronary intervention, novel pumps are in development, including the percutaneous heart pump (PHP; Abbott, Chicago, IL) which was meticulously studied by Aryana and colleagues in an in vivo pre-clinical study of endocardial and epicardial RV and LV ablation that utilized both impedance- and magnetic-based mapping with two different systems (Carto and EnSite Precision) [7]. The PHP was able to adequately support swine in VF and simulated rapid VT with very little electrogram noise or map distortion. A highlight of this study is that the PHP will likely provide a greater degree of hemodynamic support (5 L/min) than femoral access Impella devices, while still utilizing a 14 Fr introducer suitable for a femoral approach (the portion that crosses the aortic valve subsequently expands to 24 Fr).
4) *What if I cannot get into the pericardial space?* Pericardial access is often limited by pericardial adhesions which almost ubiquitously occur after cardiac surgery but can also occur after myocardial infarctions or idiopathically. In 2017, Silberbauer and colleagues demonstrated a novel method of CO2 insufflation after coronary sinus exit to facilitate epicardial access [8], building upon a prior report of the same approach after right atrial exit by Greenbaum et al. [9]. In this Special Issue, Cerantola and Santangeli review and subsequently teach this method step-by-step with high-quality figures and descriptions [10]. In a separate study, Karimianpour et al. present data on their cohort of 35 post-coronary bypass patients with VT, 16 of whom underwent mapping in the coronary venous system, 8 of whom underwent ablation in this space and 7 of whom had at least *some* clinical effect of the venous system ablation as defined by "VT circuit elimination, termination, non-inducibility, or perturbation of the circuit" [11]. In the accompanying editorial, Siontis and Liang wisely remind us: "don't forget the coronary venous system" and provide troubleshooting tips for operating in this space [12]. One such troubleshooting issue in the coronary venous system is navigating the small and delicate (easily dissect-able) intramural branch vessels. The study by Miyamoto et al. describes early clinical experience with a novel mapping catheter (EPstar FIX AIV, Japan Lifeline, Tokyo, Japan) that is Decapolar (1.3-mm electrodes spaced 5 mm), only 2.7 Fr and has a lumen that can accommodate a 0.014″ guidewire and contrast injection for branch venography to help accomplish safe and effective mapping of the coronary venous space [13].
5) *What if it is not endocardial or epicardial?* Mid-myocardial sites of origin are challenges for even the most experienced operators. Intramural branch mapping of the coronary venous system with low-profile microelectrode catheters, as discussed above [13], is helpful diagnostically, but therapeutically, deeper penetration is needed. Huang and colleagues present ex vivo data on a novel, "focused electrical field" technology that consists of a geometrically focused tip that attaches onto an existing RF catheter and collimates the beam, achieving 14-mm deep lesions without increase in steam pops [14]. I look forward to in vivo data from this group, as do Tschabrunn and Frankel, who nicely comment on this study in their editorial [15]. Lastly, Aras and colleagues add to the growing body of literature on VT stereotactic body radiation therapy (SBRT) with their single-center study of 8 patients in whom suppression of VT seemed most prominent in the first 3 months post-SBRT, with questionable long-term efficacy [16].

Declarations

Conflict of interest The author declares no competing interests.

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