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EDITORIAL

Considerations on outcomes, patient selection, and safety of catheter ablation for ventricular arrhythmias

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In 1983, Hartzler first reported on the use of a percutaneous catheter to treat ventricular arrhythmias (VAs) by delivering intracardiac direct current 300-joule shocks in three patients with VAs refractory to medical therapy [1]. In the nearly five decades since this report, there has been tremendous growth in the technology, techniques, and safety of catheter ablation (CA), which is now an established adjunctive therapy for VAs in current multisociety guidelines [2]. Intriguingly, recent trials have suggested that there may be a role for CA as a first-line therapy for VAs [3–5]. In light of this growing body of evidence and worrisome epidemiologic projections of dramatic increases in cardiovascular disease burden [6], there is a need to define the role of CA in the management of VAs. Additional data are required comparing clinical outcomes of CA to AADs, to guide considerations for patient selection and to understand possible complications and safety issues related to CA. This issue of the Journal of Interventional Cardiac Electrophysiology presents six studies examining these issues in detail.

First, Ravi et al. report an updated systematic review and study-level meta-analysis of 11 studies (9 randomized control trials (RCTs) and 2 observational studies) comparing CA to medical therapy with antiarrhythmic drugs (AADs), including 3 contemporary trials published in 2022 [7]. While the primary pooled RCT analysis of 1103 patients found no difference in all-cause mortality between groups (RR 0.94, p = 0.71), CA was associated with a significant decrease in ICD shocks (RR 0.64, p = 0.008), recurrent VT (RR 0.79, p = 0.005), and cardiac hospitalizations (RR 0.76, p = 0.005) compared to AAD therapy. In a secondary analysis of all 11 trials comprising 2126 patients, a similar pattern of decreased VT recurrence, ICD shocks, and cardiac hospitalizations emerged in favor of CA over AADs, as did a notable signal for a 25% reduced risk of all-cause mortality (RR 0.75, p = 0.07). Interestingly, in a prespecified subgroup analysis of studies with mean LVEF <35%, CA was associated with a statistically significant 31% reduced risk of all-cause mortality (RR 0.69, p = 0.01). While these findings will need to be demonstrated in a prospective randomized trial to prove causality, the authors provide hypothesis generating findings which should inform future trial design.

With epidemiologic trends pointing toward an increasingly aged population, there is a need to better understand the efficacy and safety of CA in this growing cohort of patients who are underrepresented in existing studies. Blandino et al. shed light onto this issue in a systematic review and meta-analysis of 5 retrospective studies examining outcomes of VT ablation in the young versus elderly comprising 2778 patients [8]. The definition of "elderly" varied between studies, with the lower limit of age ranging from ≥70 years to 80 years. With regard to acute outcomes, elderly patients had similar rates of acute ablation success (63% vs. 69%, OR 0.78, p = 0.189) and minor complications (4% versus 3, OR 1.71, p = 0.205) compared to younger patients, though there was a trend for increased major complications (8% vs. 4%, OR 2.30, p=0.110) and a significant increase in all complications (15% vs. 7%, OR 2.67, p = 0.001) and periprocedural mortality (5% vs 3%, OR 1.93, p=0.004). Over a mean follow-up period of 18 months, elderly patients had a similar rate of VT recurrence compared to younger patients but also had a significantly higher rate of all-cause mortality. While these findings are not unexpected, they may help clarify the role of CA in the elderly patients whose main goals may be palliation rather than longevity.

In a related, but inverse approach, Patel and colleagues evaluate secular trends in VA presentation and outcomes in patients less than 45 years of age [9]. Using inpatient claims

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data from the USA, the authors evaluated approximately 300,000 VA-related hospitalizations between 2005 and 2018, reflecting approximately 6% of all VA-related hospitalizations during this period. They identify a secular increase in all-cause in-hospital mortality during the study period (7.4% from 2005 to 2009 versus 9.0% from 2015–2018, p<0.01) underscored by parallel increases in the prevalence of several cardiovascular, pulmonary, and metabolic comorbidities. When stratified by race/ethnicity, African American patients had the highest absolute rates of VT-related hospitalization as well as the highest prevalence of comorbidities. This work highlights the shifting and increasingly complex epidemiology of VA in younger patients and draws attention to the ongoing need to understand the clinical and contextual factors that underly race- and ethnicity-based differences in VA presentation and outcomes.

Women constitute another underrepresented group in trials of CA for VA, an issue of importance as the epidemiology and biology of VAs in women may differ. Pham et al. report on the sex-based clinical characteristics and procedural outcomes of patients undergoing CA for VA based on their 10-year, single-center experience [10]. Of the 287 patients in their cohort, 182 were women (36.6%). There were numerous differences in demographic and clinical characteristics between women and men, with women more likely to be younger, have a higher EF, present for CA of PVCs, and to have fewer non-cardiovascular comorbidities. The authors examined patients in 3 groups: ischemic cardiomyopathy, non-ischemic cardiomyopathy, and idiopathic VAs. Within these groups, demographic and clinical differences between men and women were substantially diminished but not eliminated. Kaplan-Meier analysis revealed that there was no significant difference in VA-free survival between women and men with idiopathic VA, ICM, and NICM at 1 year and long-term follow-up. Cox-proportional hazard modeling revealed that sex was not a predictor of survival free of death/transplant within each group. While this study is limited by reporting a single-center experience, it suggests that although women who present for CA for VAs may have significantly different clinical and demographic characteristics versus men, outcomes appear to be similar. This finding stands in contrast to a previous large retrospective observational study, a discrepancy which the authors nicely explore [11].

While numerous endpoints have been described to gauge the success of CA for VAs, non-inducibility in response to programmed electric stimulation (PES) remains the current gold standard. However, situations remain in which PES is not or cannot be performed after CA. Kitamura et al. report on the clinical outcomes of these patients in their single-center experience [12]. Of the 182 patients included in the study, 53 did not undergo PES after CA. Among these, the most common reason for deferring PES was non-inducibility before CA (26 patients, 47%), followed by procedure time >6 h (16 patients, 26%), complications (6 patients, 10%), intolerant hemodynamic state (6 patients, 10%), and an inaccessible/unsafe target (3 patients, 5%). The authors report that the 2-year VT-free survival rate was significantly higher in patients with PES deferred due to non-inducible VT prior to CA versus PES deferred for other reasons (92% versus 36%, p <0.001). Moreover, patients with PES deferred due to pre-CA non-inducibility had a similar VT-free survival rate compared to the 116 patients who had underwent PES with no inducible clinical VT after CA. While this single-center experience has limited generalizability, the findings shed light onto the not uncommon real-world situations in which PES is not performed after CA.

As CA continues to establish itself as a potent therapy for VAs and as the population of patients accrue additional comorbidities, safety considerations need to be well defined. Pastapur et al. have complied a comprehensive review of potential complications of CA for VAs. The authors nicely examined the spectrum of safety concerns, spanning common vascular complications to the less common hemodynamic decompensation, thromboembolism, valvular injury, aortic injury, CIED lead dislodgement, proarrhythmia, conduction system injury, coronary injury, and epicardial injury [13]. This is a valuable resource for clinicians to reference as they design treatment plans for patients with VAs.

The last five decades have seen an astonishing maturation of catheter-based treatments for VAs since Hartzler's high-energy direct current shock therapy. As this modality continues to mature, clinicians will need guidance on how, when, in whom, and at what potential cost to reach for the catheter when treating VAs. The authors are to be congratulated for each of their contributions in addressing these questions.

Declarations

Ethical approval N/A

Conflict of interest The authors declare no competing interests.

Informed consent N/A

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