Catheter Ablation of Ventricular Tachycardia in the Setting of Known LV Thrombus: Between Scylla and Charybdis?

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Editorial comment

According to Homer, when passing the straits of Messina, the hero Odysseus was forced to make a terrible choice: lose 6 crewmembers' lives at the hands of the terrible six-headed monster, Scylla, or risk all drowning (or surviving) in the inescapable whirlpool created by the underwater beast, Charybdis. More complex than a simple choice between two bad options, this part of the epic poem mirrors the difficult choices we make when weighing competing risks in our complex patients. In the paper by Rao and colleagues¹¹, morbidity from drug refractory ventricular tachycardia (VT) is weighed against the possibility of thromboembolic complications from known left ventricular thrombus.

Percutaneous catheter ablation is highly effective for the treatment of drug-refractory ventricular tachycardia (VT), providing a reduction of VT episodes and reducing burden of defibrillator shocks.¹⁻⁴ In addition, catheter ablation may rescue patients with electrical storm who otherwise face a dire prognosis from uncontrolled arrhythmia, impending heart failure and inevitable death.⁵ A survey of the Nationwide Inpatient Sample database from 2002-2011 demonstrated a 5-fold increase in utilization of catheter ablation as an adjunct to antiarrhythmic drugs for post infarct VT.⁶ With increasing operator experience and improvements in ablation technologies comes an expected increase in the complexity of referred patients, both with respect to disease substrate and associated medical co-morbidities. For example, the number of patients with non-ischemic cardiomyopathy being referred for catheter ablation has increased, and these patients are known to have a higher incidence of epicardial and intramural substrate for VT, with lower acute success rates and higher risk of recurrence.^{7,8} Furthermore, the population being referred is sicker with greater number of risk factors associated with adverse events such as older age, heart failure and anemia.⁹ Contemporary challenges leading to failure of VT ablation include our inability to target deep intramural substrate for VT, anatomic barriers to successful ablation such as inaccessibility of the pericardial space due to adhesions, or close proximity to critical structures such as the phrenic nerve and coronary arteries.¹⁰

It is thus timely that Rao and colleagues¹¹ in this issue of the *Journal* report their experience with yet another factor to this accumulating list of challenges: VT ablation in the presence of a left ventricular (LV) thrombus. Eight such patients (4 with ischemic and 4 with non-ischemic cardiomyopathy) in whom an LV apical thrombus was present underwent catheter ablation indicated for highly symptomatic, drug-refractory VT. This was indeed a high-risk group with 6/8 presenting with electrical storm, 4/8 having failed prior ablation (including 2 patients who had failed prior stellate ganglionectomy) and 2/8 patients with a concurrent left atrial appendage thrombus. Thrombus chronicity was known in 5/8 patients, but suspected in 3 patients based on imaging characteristics. Transthoracic echocardiography without contrast was used for diagnosis in all patients and bridging heparin was used peri-procedurally.

Salient procedural characteristics included the induction of multiple VTs (mean 3.4/patient) and the need for multiple cardioversions (mean 2.6/patient) for unmappable VTs. Epicardial mapping and ablation was performed in 5/8 patients; 2 of these patients had epicardial only ablation and 3 had epicardial and endocardial RV ablation. Three of 8 patients underwent only LV endocardial mapping/ablation, all via a transseptal approach. Interestingly, only 2/8 patients had VT origin in at the endocardial LV apex in close proximity to the thrombus, whereas others had substrate and putative circuits remote from the LV apex namely the LV septum, epicardial LV mid anterior wall, epicardial LV apex and inferolateral wall and the endocardial right ventricular tricuspid annulus and epicardial RV basal posteroseptum.

Catheter manipulation in the LV apex was avoided on the basis of fluoroscopy and electroanatomic mapping system. The authors state that intracardiac echo (ICE) was not routinely utilized to guide catheter placement in relation to the LV thrombus. LV apical VTs were targeted by ablation of scar border zones and abnormal electrograms. Impressively, complete procedural success (non-inducibility of any VT; 5/8 patients) or partial success (inducibility of non-clinical VT alone; 3/8 patients) was achieved in all patients and only 2/8 patients had VT recurrence in follow-up. Notably, neither of the 2 patients with LV endocardial origin of VT had recurrence. One patient suffered from thromboembolic stroke at 9 days post ablation who had other concurrent risk factors for

thromboembolism including paroxysmal atrial fibrillation, a concurrent left atrial appendage thrombus, prior stroke (CHA₂DS₂-VASc score of 5) and a intra-aortic balloon pump. There were no procedural deaths.

While presence of a *mobile* thrombus is a definite contraindication to endocardial catheter ablation, due to the significant risk of thromboembolism, the presence of a laminated thrombus per se is not a perceived contraindication in the guidelines.¹ Indeed, data on the procedural approaches and outcomes of catheter ablation for VT in such patients is limited to isolated case reports¹²⁻¹⁴ or small sample of patients within a series where epicardial only ablation was performed.^{15, 16}

There are some key issues that are highlighted from the paper by Rao *et al* pertaining to catheter ablation of VT in the presence of a laminated LV thrombus. These are: (i) reliable detection of thrombus and accurate localization of its extent of involvement and chronicity; (ii) the risk of dislodgement and systemic embolization during catheter manipulation, VT inductions or repeated cardioversions and (iii) the management of anticoagulation, both peri- and intra-procedurally, especially if an epicardial approach is to be attempted.

Detection of LV thrombus is a major part of the pre-procedural workup. While cardiac MRI is the gold standard, contrast transthoracic echocardiography is a readily available tool with reliable positive and negative predictive value (93% and 91%, respectively).¹⁷ Routine transthoracic echocardiography, which was reportedly used in the study by Rao *et al*, has a lower sensitivity, specificity for detection of LV thrombus.^{1, 2, 4, 6, 18 17} Assessment of thrombus chronicity should be made in consensus with imaging experts although more refined markers rather than just appearance are clearly needed. Acute on chronic thrombus layering is always a concern, which cannot be reliably eliminated, and data may be confounded when other anatomic abnormalities exist in the area of suspected thrombus. Data on the risk of systemic embolization during cardioversion or induction of VT in the presence of laminated or mobile LV thrombus is sparse, but one retrospective review of 21 such patients undergoing cardioversion electively or emergently did not show any thromboembolic events at 1-year follow-up.¹⁹ When contextualized in the presence of other risk factors for systemic

embolization such as in the study by Rao *et al*, concurrent left atrial appendage thrombus or need for hemodynamic support, this risk would be expected to increase. The risk of stroke from major clinical trials in VT ablation has varied from 0-2.7%,^{1, 2, 4, 6, 18} but these studies did not specifically recruit patients with a LV thrombus. Hence, this paper represents a truly niche group in whom approaches and outcomes are unknown.

This is perhaps one scenario where information about the clinical VT and consideration of substrate evaluation using image integration with cardiac MRI or CT *a priori* and is critical in planning whether an endocardial and/or epicardial approach is attempted. Image integration has many known advantages including scar localization, identification of epicardial substrate,²⁰ and even potentially guiding novel substrate based ablation strategies.^{21, 22} Furthermore, intra-procedural image integration using intracardiac echocardiography with electroanatomic mapping (CARTOSound, Biosense Webster, Diamond Bar, CA, USA), may allow more clear definition of thrombus location, extent of involvement, identification of scar regions and help avoid inadvertent catheter entry into the thrombus.^{13, 23} Alternative strategies such as such as transcatheter ethanol ablation, surgical cryoablation,¹⁰ renal denervation,²⁴ and left or bilateral cardiac sympathetic denervation²⁵ should be strongly considered, allowing avoidance of direct entry into the LV endocardium when possible.

Limitations of these approaches have been acknowledged including unsuitable coronary branch targets, extensive collaterals, thromboembolic complications and the inability to precisely target one particular region with transcatheter ethanol ablation.¹⁰ Nevertheless, we have previously reported the feasibility of this approach in localized substrate such as apical hypertrophic cardiomyopathy and remains a useful tool in the armament of other non-radiofrequency ablation strategies.²⁶ Surgical approaches, although associated with high efficacy, are associated with substantial morbidity.¹⁰ It is thus prudent to consider all available options to maximize efficacy and minimize harm when confronted with a patient with LV thrombus and uncontrollable VT. This is also a scenario where uninterrupted anticoagulation should be considered, especially if an endocardial, transseptal approach is the only planned approach. While data from atrial ablation is abundant,²⁷ this information during endocardial VT ablation is clearly lacking. The risk of transseptal catheterization in the setting of

known left atrial appendage thrombus is also likely significant, though not systematically investigated.

The paper by Rao *et al*, while retrospective and limited to a small population accumulated over 4 years, comes from a highly experienced center and highlights key issues in the accumulating list of challenging patients referred for catheter ablation. The series is underpowered to comment on the true incidence of thromboembolic events in this population, but feasibility is clearly demonstrated. While the presence of laminated thrombus may be a daunting finding in a patient with drug-refractory VT being referred for catheter ablation, the fact that the majority of patients had circuits unrelated to the location of the thrombus teaches us that detailed pre-procedural assessment of clinical VT morphology and the option of ‘targeting’ VT source from nearby vantage points such as the epicardium and right ventricle should at least be entertained in these challenging cases.

The authors ought to be commended on their successful management of this high-risk group of patients, in whom options beyond catheter ablation were desperately limited. More importantly, the paper highlights key areas of deficiencies in our knowledge in this area, which need to be addressed in the context of a collaborative multicenter effort.

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