Bipolar Ablation for Outflow Tract Ventricular Arrhythmias: When the Going gets Tough, Two Catheters may be Better than One

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May 26, 2022

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Funding: None

Disclosures: None

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Radiofrequency catheter ablation (RFCA) is an effective treatment strategy for patients with symptomatic ventricular arrhythmias (VAs). Conventional RFCA involves unipolar ablation in which the radiofrequency energy current is delivered between the catheter tip and a dispersive skin electrode. Ablation lesion size with unipolar ablation depends on multiple factors such as power, temperature, impedance, duration of energy delivery and catheter-tissue contact force but is generally limited to 5-6 mm in depth. However, the substrate for VAs may occasionally be intramural, residing deep within the myocardium, and in some cases unipolar ablation- even sequential unipolar ablation from both sides of the intramural substrate- may be inadequate to eliminate the VA substrate. Several adjunctive methods of creating deeper lesions have been used in clinical practice such as use of half-normal saline as a catheter irrigant, simultaneous unipolar RFCA, bipolar RFCA, coronary venous ethanol ablation, radiofrequency needle ablation, electroporation and noninvasive radiotherapy. With bipolar ablation, a second ablation catheter functioning as a return electrode in the circuit can be positioned opposite to the other active ablation catheter and simultaneous

heating and concentrated thermal injury with RF delivery between the catheter tips can then lead to deeper, more transmural lesions.

In this issue of *Journal of Cardiovascular Electrophysiology* , Zhou, et al. report results from a retrospective 2-center study, describing outcomes in 12 patients with outflow tract ventricular arrhythmias (OT-VAs) (7 left ventricular (LV) summit, 3 intramural septal OT, and 2 with right ventricular (RV) diverticuli at the anterolateral free wall) who were treated with bipolar RFCA after sequential unipolar RFCA had failed (transient suppression or no effect).[1] In their experience, bipolar RFCA was rarely required (only done in 1% of patients treated with ablation over the study period). Bipolar RFCA was successful in 10 patients (mean inter-catheter distance 9.7 mm) and unsuccessful in 2 patients (inter-catheter distances 23.9 and 13.5 mm). Bipolar configuration was from within to the along the outer edge of a diverticulum in 2 patients with VAs originating from RV diverticuli; from the RVOT to aortic cusp in 3 patients with intramural septal OT VAs; and from the LV to cusps, cusps to great cardiac vein (GCV), and LV to GCV in patients with VAs originating from LV summit. Interestingly 2 patients with unsuccessful outcome acutely had eventual late resolution of VAs over time. There was 1 steam pop and no other complications related to bipolar RFCA.

The efficacy of bipolar RFCA to treat VAs has been well described. Intramural VAs originating from various areas such as the LV summit, intramural OT, interventricular septum, LV free wall and papillary muscles which were unable to be eliminated with unipolar RFCA have been reported to be successfully eliminated with bipolar RFCA. One unique aspect of this study is that the authors are the first to describe bipolar ablation targeting outflow tract VAs originating from RV diverticuli.

The success rate of bipolar ablation in Zhou, et al.'s study was 83% acutely and increased to 100% after subsequent follow-up. Delayed suppression of intramural septal outflow tract VAs after RFCA despite acute failure has been previously described in the literature,[2] and the late suppression with bipolar ablation which was seen in 2 patients in the current series despite acutely unsuccessful ablation is especially interesting and hypothesis provoking. The authors have appropriately acknowledged some important limitations to their study including small sample size, lack of pre-procedural cardiac magnetic resonance imaging (MRI), the fact that several mapping tools such as intracardiac echocardiography and multielectrode microcatheters were not used. Furthermore, the use of half normal saline as a catheter irrigant was not attempted prior to bipolar ablation. Several issues regarding the application of bipolar RFCA in this study remain to be elucidated. First, as this is a retrospective study, the population included may subject to a selection bias. The question of which patients would theoretically benefit most from bipolar ablation remains unanswered. Second, the configuration and orientation of both ablation catheters plays a vital role in determining the trajectory of the bipolar ablation current, and the current study does not clearly explain the catheter configurations in detail. While the authors describe that several bipolar ablation configurations were attempted in some patients, further analysis comparing the ineffective and effective configurations would have been helpful. Detailed mapping of coronary venous system branches with multielectrode microcatheters to identify the true site of origin can facilitate more accurate targeting of OT VAs via anatomic approach,[3, 4] and identification of true site of origin can help pinpoint the optimal ablation trajectory to guide catheter placement during bipolar ablation. Lastly, pre-ablation cardiac MRI can be helpful to identify areas of scar which may represent VA substrate which can be targeted with ablation.[5]

While bipolar RFCA can be an effective bailout strategy for some patients with intramural OT VAs refractory to standard sequential unipolar ablation, its general use still remains limited by potentially increased risk of complications as well as technical challenges including the requirement for specific cables and setup to visualize both catheters simultaneously on 3D mapping system and to deliver RF energy. With the current bipolar ablation systems, temperature at the catheter tip cannot be accurately monitored simultaneously for both catheters. Impedance is affected by catheter tip-tissue orientation of both catheters, which needs to be monitored closely to avoid steam pops. Potential collateral damage to nearby structures such as the coronary arteries or the conduction system may be possible and coronary angiography should be performed in some cases to ensure that the ablation catheter is distant from major epicardial coronary arteries.

We applaud the authors for sharing their experience describing the efficacy and safety of bipolar RFCA in

a series of patients with challenging OT-VAs refractory to unipolar ablation. Pre-procedural cardiac MRI to delineate VA substrate and detailed mapping with multielectrode microcatheters or wires to identify the true site of origin would be helpful to guide selection of appropriate tools and alternative strategies in these challenging cases. Further clinical studies in a larger study population with various structural heart diseases are required to confirm the generalizability of bipolar ablation for OT VAs.

REFERENCES:

1. Zhou B., Yu J., Ju W., Li X ., Zhang F. , Chen H., Li M., Gu K., Xie X. , Cheng D., Wang X. , Wu Y. , Zhou J., Zhang B. , Kojodjojo P., Cao K. , Yang B. , and Chen M. , *Bipolar Catheter Ablation Strategies for Outflow Tract Ventricular Arrhythmias Refractory to Unipolar Ablation.* J Interv Cardiovasc Electrophysiol, 2022.

2. Ding L, Hou B, Wu L, Qiao Y, Sun W, Guo J, Zheng L, Chen G, Zhang L, Zhang S, Yao Y. Delayed efficacy of radiofrequency catheter ablation on ventricular arrhythmias originating from the left ventricular anterobasal wall. *Heart Rhythm.* 2017; 14(3):341-349.

3. Liang JJ, Bogun F. Coronary Venous Mapping and Catheter Ablation for Ventricular Arrhythmias. *Methodist Debakey Cardiovasc J.* 2021.

4. Ghannam M., Liang J., Sharaf-Dabbagh G., Latchamsetty R., Jongnarangsin K., Morady F., and Bogun F., *Mapping and Ablation of Intramural Ventricular Arrhythmias: A Stepwise Approach Focused on the Site of Origin.* JACC Clin Electrophysiol, 2020; 6(11): p. 1339-1348.

5. Ghannam M., Liang J. J., Dabbagh G. S., Siontis K. C., Attili A., Cochet H., Jais P., Juhoor M., Latchamsetty R., Jongnarangsin K., Morady F., and Bogun F., *Impact of Intramural Scar on Mapping and Ablation of Premature Ventricular Complexes.* JACC Clin Electrophysiol, 2021; 7(6): p. 733-741.