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Commentary

Mapping and ablating ventricular arrhythmias within the coronary venous system

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The coronary sinus venous system (CVS) has played a multi-faceted role in cardiac electrophysiology. The primary utility of this structure has been for positioning pacing electrodes in its various branches to facilitate cardiac resynchronization therapy. However, its unique epicardial location has allowed it to also serve as a vantage point in the mapping and ablation of various cardiac arrhythmias but especially idiopathic focal ventricular tachycardias. One of the first comprehensive series that showed the utility of mapping and ablating ventricular arrhythmias (VAs) within the CVS was the paper by Daniels et al. [1] In that study, the authors identified ECG features of VAs that were successfully targeted from within the CVS. Since that publication there has been a growing body of literature reporting approaches and outcomes of catheter ablation of VAs from the CVS [2,3]. The early enthusiasm with mapping and ablation of VAs from CVS has been tempered by recognition of various limitations associated with this approach. Those include, 1) anatomic constraints of the CVS and its various branches which may not always travel through locations that require mapping, 2) diminishing dimensions of distal CVS branches that may not permit mapping with standard catheters, 3) delivering adequate radio-frequency (RF) energy within the narrow confines of the CVS, 4) proximity of CVS to critical structures, especially major coronary arteries, etc. [2–4] The electrophysiology community has responded to these challenges by improving the tools at their disposable. In particular, the advent of deflectable sheaths and smaller caliber multi-polar catheters have improved our ability to navigate and map the distal aspects of CVS [2–4]. Also, the irrigated and cooled tip catheter platforms can facilitate better lesion creation. It is also being increasingly recognized that mapping within the CVS may serve to identify the arrhythmia site of origin (SOO) which can then be more effectively targeted from adjacent cardiac locations (cusp and outflow tract region) that permit better RF energy delivery [2,3]. Thus the CVS remains an important area for mapping and ablation of VAs and electrophysiologist continue to report their experience in working within this structure. Consistent with that interest, in the previous issue of the Indian Pacing and Electrophysiology Journal, Mar et al. reported their observations on the unique features of VAs that were targeted from the CVS in veteran patients undergoing ablation at their facility [5].

The study cohort comprised 42 patients who underwent VA ablation over a 3-year period at a single facility (a Veteran Affairs Medical Center). In 11 of these patients, ablation was performed within the CVS. The investigators used a fairly standard mapping approach which required catheters being deployed either simultaneously or sequentially in various locations including the CVS. The CARTO platform was used for electro-anatomic mapping and intracardiac echocardiography (ICE) was utilized together with the CARTOSOUND module to facilitate catheter localization in all cases. Ablation was performed with a 3.5 mm irrigated-tip contact force sensing catheter. Standard activation and pace-mapping techniques were utilized for localizing the arrhythmia SOO. Coronary angiography was used prior to ablation within the CVS and energy delivery was deferred if the target site was <4 mm of a coronary artery which, occurred in 2 cases. Acute success was defined as lack of any PVCs for up to 45-min post ablation and clinical success was defined as ≥75% reduction in arrhythmia burden compared to baseline. The authors also had a category of partial clinical success if the arrhythmia burden was <75%; however, they have not specified a cut-off value < 75% reduction that would be considered procedure failure. It is also unclear from the methodology how the patients were followed post ablation. Despite these limitations, the study findings are interesting. There were no significant demographic differences between the two patient groups except the left ventricular ejection fraction which was lower in the CVS group. On the 12 lead ECG, a right bundle branch block (RBBB) morphology was significantly more common for VAs that were ablated within the CVS (82% VS. 9% for non CVS location). The QRS width of the VAs were comparable in both groups as was the local activation time at successful ablation sites. Distal CS and/or its branches were the most common location within the CVS where VAs were targeted. Following ablation, the overall VA burden was reduced from 28% to 5%. Within the CVS group complete suppression was achieved in 6 and partial suppression in 4. From these observations the investigators conclude that in patients presenting with VAs that have ECG features suggestive of epicardial origin, a recording catheter in

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the CVS can help with localization and ablation. They further emphasize the uniqueness of their study because it showed the safety and success of their ablation approach in an exclusively veteran patient population.

The latter conclusion merits further discussion. Not all readers of this journal may be familiar with the veteran patient population. Briefly, veteran is a term reserved for any former member of the United States armed forces. Following active service such individuals are eligible for health care through Veterans Health Administration (VHA) which, is the largest integrated health system in the United States. It comprises 170 Veteran Affairs medical centers (VAMCs) and 1074 outpatient sites that serve over 9 million patients each year [6,7]. As expected, veteran patients are predominantly male and typically older than the average patients seen in other health care facilities. These patients also tend to have more co-morbidities. It is therefore true that the veterans are considered a unique patient population. However, it remains unclear whether the results of the current study truly describe findings that are peculiar to this patient group. The primary reason for this lack of clarity is the absence of a control population i.e., non-veteran patients undergoing ablation for similar VAs in the same time period. The authors could have overcome this issue to some extent if they had substantially increased the sample size of their study. To accomplish that they could have combined the experience from other VAMCs and/or utilized the large data base of veteran patients. Doing that however can be challenging because retrospective multi-center studies and/or data base analysis do not yield the same level of granularity. Despite this limitation, we agree with the authors' conclusion that placing a catheter in the CVS can be helpful during mapping and ablation of VAs that manifest a RBBB morphology and lack precordial transition [8]. The latter is highly suggestive of a basal left ventricular (LV) arrhythmia SOO which, is also called the mitral annular (MA) region. However, the investigators have not provided any data on what specific ECG features compelled them to map in the CVS vs. the MA region. Previous studies have reported certain ECG features that are highly suggestive of an epicardial VA source. Those include a delayed onset to peak deflection of the QRS complex (mean deflection index), predominantly negative QRS morphology in limb lead I, etc. [1,5] However, similar observations were not reported in this study. The only ECG finding that was significantly more common in the CVS group was the presence RBBB morphology. However, that by itself is not diagnostic of a CVS SOO, because most VAs originating in the LV manifest a RBBB morphology. Another limitation of the study is its relatively small sample size and lack of uniformity in the post ablation monitoring and follow-up. Furthermore, post ablation VA burden could not be assessed in 11 patients which amounts to 26% of the cohort. It is also unclear how many patients remained on antiarrhythmic drugs and/or A-V nodal blockers post ablation. Keeping that in mind, complete VA suppression was achieved in only 6 of the 11 patients (55%) when the source was targeted within the CVS. This is significantly less than the success rates that are currently being reported when ablating such arrhythmias. The authors have argued that their study population was unique in that ablation within the CVS was required in as many as 25%. While it is true that CVS ablation was higher in this series than previously reported, that discrepancy may be on account of the mapping/ablation approach used by these investigators rather than uniqueness of their patient cohort. In our experience VAs manifesting a morphology similar to what has been reported in this study can often be successfully ablated from the mitral annular location endocardially [5,8]. It remains unclear whether that was attempted in the current study patients prior to ablating within the CVS? If that was not the case, it is possible that attempting endocardial ablation from the adjoining MA location endocardially may have improved outcomes in the 4 patients where ablation in the CVS achieved only partial VA suppression. It is also interesting to note that the nomenclature used by these investigators to categorize the arrhythmia source as being in the "distal CS" is rather unconventional. As per major anatomical texts, the CVS comprises the main CS which travels in the posterior AV groove and serially receives drainage from the middle cardiac vein (MVC) followed by 2–3 lateral branches. Beyond that it receives drainage from the oblique vein of atrium (also called the vein of Marshall) and the great cardiac vein (GCV) [9]. Using this classification approach, the VA SOO which were identified as being in the distal CS by these investigators are actually located in the GCV.

Notwithstanding all these limitations, this study still provides some interesting insights from an accomplished group of electrophysiologists and so is a welcome addition to the existing literature on this subject. Whether the findings of this study are applicable exclusively to the veteran patient population remains to be proven.

Declaration of competing interest

The authors do not have any pertinent disclosures.

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