QRS complex maximum deflection index in aortic cusp premature ventricular complexes

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Electrocardiographic characteristics of premature ventricular complexes (PVC) can be suggestive of their anatomic origin which is pivotal for procedural planning before catheter ablation. The accurate identification of all likely ectopic foci is of even higher importance when an epicardial ablative approach is considered given the associated procedural complexities. Prior studies have identified characteristics associated with epicardial origin of ventricular tachycardia (VT) [1–3]. Specifically, a large maximum deflection index (MDI) of the VT, which is a metric of the rapidity of depolarization of the myocardium, is thought to indicate epicardial foci. In the Daniels et al. [2] study, MDI ≥ 0.55 had 100% sensitivity and 98.7% specificity for epicardial VT. In the Valles et al. [3] study in patients with non-ischemic cardiomyopathy, however, there was no significant difference in MDI between epicardial and endocardial sites, and MDI ≥ 0.55 had poor sensitivity (33%) and moderate specificity (75%) for epicardial origin. It is possible that other non-epicardial anatomic locations may be characterized by ectopic ventricular foci with a large MDI. The aim of this study was to describe the MDI and morphology of PVCs with earliest point of activation in the aortic cusps.

We identified all consecutive cases of idiopathic PVC catheter ablation procedures performed in our Electrophysiology laboratory in 2011–2013 and reviewed CARTO tracings, Prucka recordings and operative reports to identify those where successful ablation of a PVC focus was performed in the aortic cusps. PVC morphology and axis were used to identify the point of origin. Successful ablation was defined as elimination of the ventricular ectopy with intraprocedural observation and attempted induction with isoproterenol infusion. For each case we recorded patient demographic and clinical characteristics (gender, age), the exact anatomic site of successful ablation, and electrocardiographic characteristics based on the 12-lead surface electrocardiogram. Specifically, we documented QRS duration in sinus rhythm and in the PVC (interval between the earliest rapid deflection of the ventricular complex in any of the 12 leads to the latest offset in any lead), PVC QRS morphology in lead V1, net amplitude in leads I and aVF, precordial transition in sinus rhythm and PVC, presence of pseudo-delta wave in the PVC (determined by two independent investigators with 100% agreement), and the MDI of the PVC. The MDI was calculated by dividing the time from onset of the QRS complex to the earliest point of maximum deflection (positive or negative) in the precordial leads by the QRS duration (Fig. 1) [2,3]. Electrocardiographic interval measurements were performed with electronic calipers that were placed manually on Prucka recordings. All assessments pertained to the dominant morphology high-density PVC that was repeatedly observed in the electrophysiology laboratory in isolation and not in couplets or VT runs.

Fig. 1. Calculation of the maximum deflection index. The maximum deflection index was calculated by dividing the time from onset of the QRS complex (point a) to the earliest point of maximum deflection (point b) in the precordial leads by the QRS duration (large double arrow).
The above characteristics and electrocardiographic measurements are reported per patient and summarized as frequencies and percentages for categorical variables, and means and standard deviations (SD) or medians and interquartile ranges (IQR) for continuous variables. All patients had provided research consent. This study was approved by the Mayo Clinic Institutional Review Board.

We identified 185 cases of successful or attempted catheter ablation of symptomatic PVCs of patients in whom pharmacologic management had failed. In 17 of those patients (mean age 56.9 ± 15 years, 8 females) PVCs were successfully ablated in the aortic cusps. Sustained elimination of ventricular ectopy as defined by Holter monitoring or symptom resolution was observed in 15 of 16 (94%) patients with available post-ablation follow-up (median 88 days). As shown in Table 1, the left coronary cusp (LCC) was the most common PVC origin (n = 12), followed by the right coronary cusp (RCC) (n = 4) and the RCC–LCC commissure (n = 1). rS was the most common PVC morphology in V1 (in 14 cases). Mean QRS duration was 88 ± 8 ms in sinus rhythm and 137 ± 12 ms for the PVCs. Pseudo-delta wave was absent in all but one PVC, which originated from the RCC.

MDI ranged from 0.28 to 0.68 (mean 0.53 ± 0.10, median 0.50, IQR 0.47–0.60). In all (100%) cases MDI was >0.40 and in 7 (41%) cases it was >0.55. There was no statistically significant difference in the MDIs of PVCs originating from the LCC and the RCC. The MDI in the PVC with a pseudo-delta wave was 0.61.

MDI values exceeding 0.55 are considered suggestive of epicardial VT sites. It should be cautioned, however, that endocardial sites may have similarly large MDIs under certain circumstances due to delayed conduction through the aortic valve apparatus to the myocardium. Our finding of large MDIs in aortic cusps arises from the aortic cusps in our case series. Among the limitations of our study are the small sample size and the possibility that some of the PVCs targeted endocardially in the aortic cusps could have in fact represented epicardial foci. Other groups have demonstrated that it is possible to eliminate epicardial foci with endocardial ablation and thus this possibility cannot be eliminated [6].

In conclusion, PVC origin in the aortic cusps should be considered along with the epicardium when MDI is in the vicinity of 0.55, especially in the absence of a pseudo-delta wave.

Conflict of interest
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