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Letters to the Editor

Repolarization Measurement in Brugada Syndrome

The simultaneous publication of 2 articles in a recent issue of the *Journal* (1,2) exemplified the value of activation-recovery interval (ARI) determination in understanding the electrophysiological mechanisms of Brugada syndrome. These publications also highlighted the current controversies surrounding how ARI should be measured in vivo: Nagase et al. (1) determined ARIs at the maximum positive slope of the positive T-wave (conventional approach), whereas Hayashi et al. (2) determined ARIs at the negative slope of the positive T-wave (alternative approach).

Despite a statistically significant correlation between ARI determined by the conventional method and monophasic action potential recordings in experimental models, there is still no satisfactory explanation why clinical validation with monophasic action potentials using contact and noncontact unipolar mapping appears to show that the conventional approach underestimates repolarization timings (3–5). Hence, the timing relationship between epicardial and endocardial repolarization in the Brugada patients in the Nagase et al. study (1) might vary depending on the specific method chosen to measure ARI durations.

In the same study (1), body surface type 1 Brugada electrocardiogram changes corresponded to epicardial unipolar recordings showing coved type ST-segment elevation (Fig. 3 in [1]), but this was not consistently reflected by a concurrent negative deflection in the endocardial signal during phase 1 repolarization. Thus, in Figure 3C in this article, pilsicainide challenge induced prominent J-point positive deflection in the epicardial unipolar recording, whereas the endocardial signal remained isoelectric with no changes in ST/T-wave morphology. This would suggest that coved-type ST-segment elevation might not be fully explained by a unidirectional transmural ventricular gradient originating from the endocardium. Further clinical evaluation, such as noninvasive electrocardiographic imaging, might be valuable to clarify the role of trans-epicardial electrophysiological changes in patients with type 1 Brugada electrocardiogram pattern.

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Reply

We thank Dr. Yue for his interest in our article (1). In general, direct measurement of action potential duration (APD) in humans is very difficult and complicated. Consequently, activation recovery interval (ARI) has been used in several studies for the evaluation of APD in humans. It is still unclear, and further examination is needed to evaluate APD by the ARI method, especially in cases of a positive T-wave. Haws and Lux (2) have reported that ARI was a good measurement of APD irrespective of T-wave polarity. Recently, Coronel et al. (3) also reported that maximum derivative of the T-wave always coincided with final repolarization in any T-wave polarity. However, Yue et al. (4) and Chen et al. (5) have reported that minimum derivative of the T-wave corresponded to final repolarization with positive T-wave.

Because the methods used in their study to validate the use of ARI were inhomogeneous and because the assessment of polarity is difficult in a complicated T-wave, it is still not clear which method is more accurate and appropriate. The limitation of the ARI method is that ARI represents spatial average and contains a far field effect. We should carefully apply and assess the ARI method for evaluation of APD in consideration of this limitation.

Yan and Antzelevitch (6) found in their experimental study that a prominent transient outward current-mediated action potential notch in epicardial cells, but not that in endocardial cells, creates a transmural voltage gradient and thus causes ST-segment elevation. Further accentuation of the notch leads to preferential prolongation of the epicardial action potential, resulting in the development of coved-type ST-segment elevation and terminal inverted T-wave (type 1 electrocardiogram [ECG]) in right precordial leads in Brugada syndrome. In our study, we also found that type 1 ECG is closely related to the prolongation of repolarization in the epicardium compared with that in the endocardium in Brugada syndrome (1). The administration of pilsicainide predominantly affected the epicardial repolarization, and the effect of pilsicainide administration was small in the endocardial site. We cannot completely rule out the possibility that epicardial heterogeneity of the action potential causes type 1 ECG. However, these results suggest that the pathological and critical change mainly observed in epicardial cells caused typical Brugada-type ECG.

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