INTERESTING ELECTROCARDIOGRAM

UNIQUE IMAGE REVIEW

Cardiac Memory Variations in Surface ECG Precordial Mapping

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Case presentation and ECG description

A 66-year-old female with known history of hypertension and hyperlipidemia underwent a dual-chamber pacemaker implantation for symptomatic sinus node dysfunction. She has remained asymptomatic on subsequent follow-ups.

The 12-lead electrocardiogram (ECG) of our patient presented in Figure 1 illustrates a novel manifestation of memory-induced t-wave (TW) changes. Figure 1(a) shows right ventricular apical pacing (RVAP) with AQRS directed leftward and upward (to −60°) and negative conditioning QRS complexes in all precordial leads. After cessation of the RVAP, the ECG was recorded during atrial pacing (AP). Figure 1(b), the ECG was recorded with precordial leads in the standard position and clearly shows TW inversion in all precordial leads, following “the rule” of TW memory. Maintenance and even increase in the negative TW polarity concordant to the conditioning QRS complexes was noted when the precordial leads were displaced to the fifth and sixth ICS as illustrated in Figure 1(c) and (d), respectively. However, TW inversion was attenuated and disappeared when the precordial electrodes were displaced up to the third and second ICS as can be observed in Figure 1(e) and (f), respectively.

Points to ponder

The classic cardiac memory also described as electrotonic modulation of the ventricular repolarization has been referred to as persistent TW changes which appear after a period of abnormal ventricular depolarization once the normal activation is restored. This may be caused by different conditions, including ventricular pacing, ventricular pre-excitation, intermittent left bundle branch block, and wide complex tachycardias.1,2 The electrophysiological basis of post-pacing memory-induced TW changes are attributed to a significant change in the normal ventricular repolarization gradient,3,4 which in turn is affected by the activation time of the ventricular myocardium.5 During RVAP, depolarization begins at the apical region of the right ventricle and ends at the basal region of the left ventricle. Thus, the main electrical depolarizing forces are oriented leftward, upwards, and posteriorly, and lengthening of the repolarization occurs at the apex and shortening at the base.4 Therefore, after cessation of RVAP, ventricular repolarization proceeds in the same direction as the conditioning anomalous depolarization. In our patient, the post pacing T waves were symmetrically negative in all standard precordial leads, reflecting the existence of cardiac memory as the polarity of the TW tracked that of the precedent abnormal QRS complexes. The memory-induced TW inversion became more profound as the leads were displaced to lower intercostal spaces; however, the changes became less marked and completely disappeared when the leads were displaced to third and second ICS, respectively. Why do memory-induced TW changes seem to disappear in the precordial leads when the electrodes are placed in the second and third ICS?
This variation in the TW changes in surface precordial mapping is a novel concept and one can speculate that the lower recording in the precordial mapping is facing the “tail” of the maximum deflection vector of depolarization (directed upward), thus, increasing visualization of the phenomenon. Higher precordial leads (second and third ICS) are facing the “head” of the vector, thus the phenomenon dissipates. It is noticeable that cardiac memory remains unchanged in the limb leads. This case indicates that the memory TW changes in precordial leads may be strongly influenced not only by the spatial direction of the conditioning QRS complexes, but also by location of the leads in the precordium and their position relative to the anatomical position of the heart.

Recognizing cardiac memory-induced TW changes is clinically important for evaluation of the T-wave characteristics and has potential implications for management of patients.

Figure 1: Variations in the recording of cardiac memory according to surface electrocardiogram (ECG) precordial mapping. (a) 12-lead ECG recording obtained during right ventricular apical pacing. Note TW inversion in limb leads and precordial leads. (b–f) Twelve-lead ECG recorded during atrial pacing and precordial leads at fourth, fifth, sixth, third, and second intercostal space (ICS) respectively. Note that cardiac memory remains unchanged in the limb leads. However, displacement to lower ICS accentuates the changes in the precordial leads while displacements upwards of the precordial leads makes cardiac memory disappear.

References