

Circulation: Arrhythmia and Electrophysiology – CHALLENGE OF THE WEEK

ANSWER TO APRIL 23RD QUESTION

C. The ventricular capture threshold is ≤ 0.8 volt.

Explanation

The shock ECG in the Figure demonstrates T waves with a prolonged QT interval consistent with the clinical history of long QT syndrome. The long QT interval is a manifestation of the prolonged action potential duration of cardiomyocytes when the cells are in the physiologic refractory period. The end of the T wave marks the recovery from refractoriness and availability of the ventricular myocardium for ventricular pace testing. The ventricular pace (VP) events in the Figure panel A marked by vertical dotted lines occur prior to completion of the T wave, in other words prior to recovery from refractoriness, and are thus not expected to generate captured QRS

complexes. VP outputs occurring after the elapse of the QT interval duly capture the ventricle and generate QRS complexes (asterisks). These captured VP outputs at 0.9 volt and 0.8 volt demonstrate that the capture threshold is at most 0.8 volt (option C). The two captured/asterisked QRS complexes are not followed by any consistent retrograde atrial complexes to demonstrate retrograde VA conduction. The last beat in panel A is an incidental sinus rhythm beat (A2) that conducts antegradely and captures the ventricles [VS]. The resulting shorter RR interval leads to shortening of the subsequent QT interval (cycle length dependence)¹ allowing serial capture of VP outputs as shown in panel B, which confirms the capture threshold to be

REFERENCES:

Franz MR, Swerdlow CD, Liem LB, Schaefer J. Cycle length dependence of human action potential duration in vivo. Effects of single extrastimuli, sudden sustained rate acceleration and deceleration, and different steady-state frequencies. *J Clin Invest.* 1988;82:972-9.
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(A)

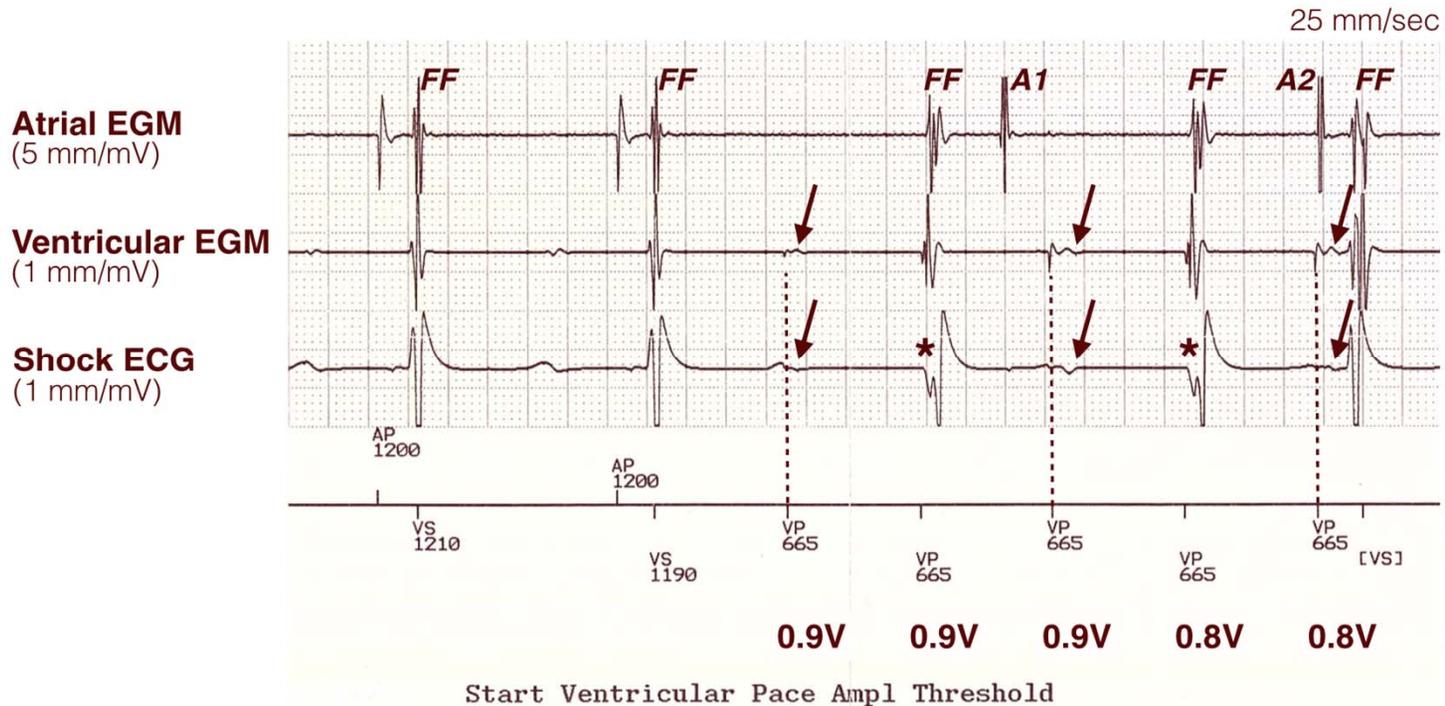


Figure. Dual-chamber implanted cardioverter-defibrillator tracings from ventricular pacing threshold test. The atrial and ventricular electrograms (EGM) and shock electrocardiogram (ECG) are shown. (A) The first two beats are seen as atrial paced (AP) followed by atrioventricularly conducted ventricular sensed (VS) events. Subsequently the ventricular pacing capture test commences with ventricular pacing at cycle length of 665 ms with 3 pacing outputs at 0.9 volt followed by 2 outputs at 0.8 volt. Asterisks depict the evoked QRS complexes from ventricular pacing at 0.9 volt and 0.8 volt. There are 3 ventricular pacing outputs (vertical dotted lines) that time with the T-waves (arrows), when the ventricle is still physiologically refractory (phase 3 of action potential) and unable to be depolarized. Far-field signals (FF) correlating with QRS complexes on shock ECG are noted on the atrial EGM throughout the tracing but are appropriately blanked and do not registered any sensed event markers. A1 and A2 are intrinsic atrial events occurring during ventricular pacing.

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(B)

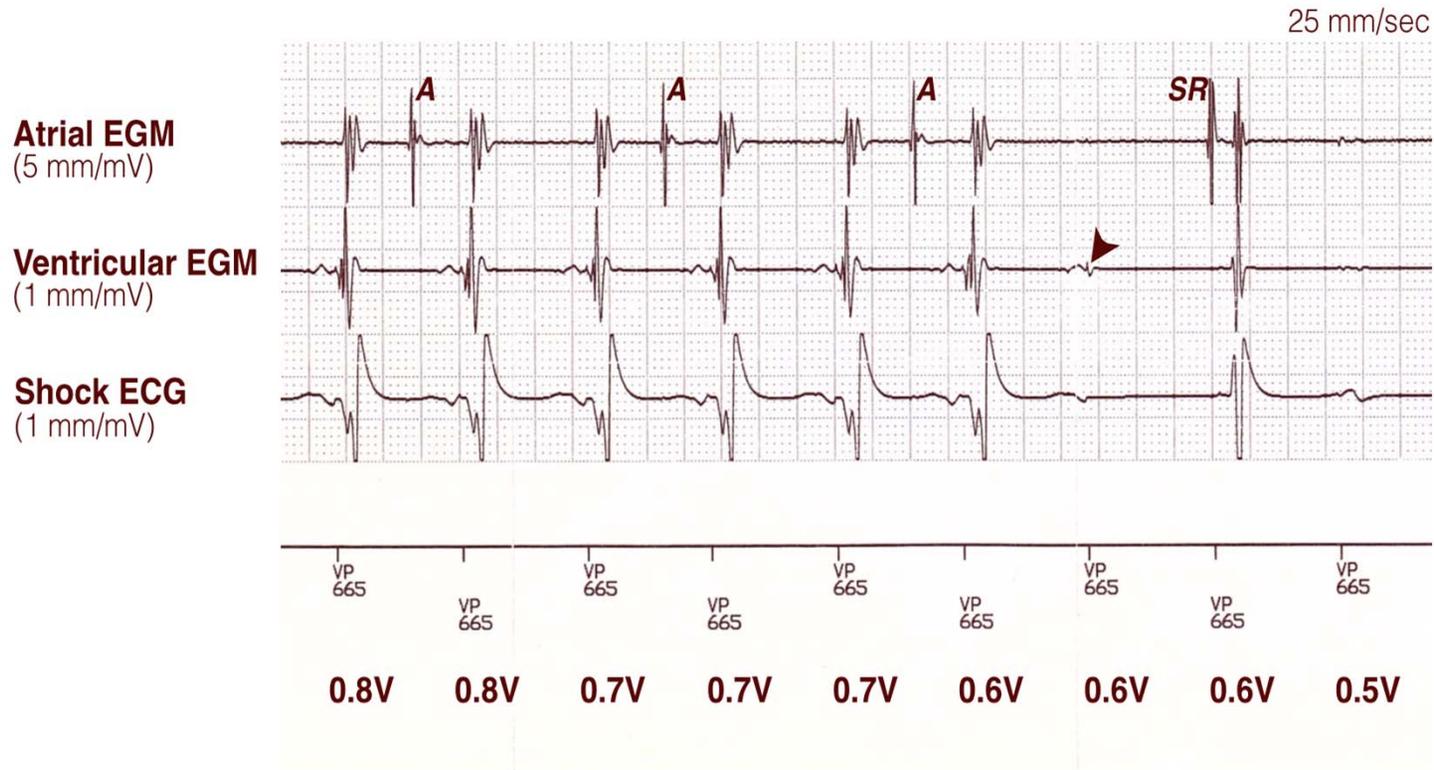


Figure. Dual-chamber implanted cardioverter-defibrillator tracings from ventricular pacing threshold test. The atrial and ventricular electrograms (EGM) and shock electrocardiogram (ECG) are shown. (B) Further continuation of ventricular pacing and sequentially decreasing outputs is shown with evoked QRS complexes seen at 0.8 volt and 0.7 volt with loss of capture occurring at the second output at 0.6 V (arrowhead). This confirms the ventricular pacing capture threshold of 0.7 volt. There is retrograde ventriculoatrial 2:1 conduction generating complexes labelled as A on the atrial EGM, with subsequent recovery of sinus rhythm (SR) after loss of ventricular capture.