INTERESTING ELECTROCARDIOGRAM

COMPLEX CASE STUDY

An Unexpected Change in QRS Morphology After Connection of New Cardiac Resynchronization Leads to an Impulse Generator: A Caution Against Certain Combinations of Device Hardware

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ABSTRACT. The use of certain combinations of device hardware during biventricular defibrillator implantation may reduce the number of available pacing vectors.

KEYWORDS. anodal stimulation, biventricular pacing, cardiac resynchronization therapy, dedicated bipole, integrated bipole.

Electrocardiogram description

A 77-year-old man underwent implantation of a biventricular defibrillator for long-standing non-ischemic cardiomyopathy and anticipated atrioventricular junction ablation for atrial fibrillation with uncontrollable ventricular rates. The hardware chosen included a Boston Scientific (Natick, MA) pulse generator model N140 (Energen), Boston Scientific left ventricle (LV) lead model 4543 (Easytrak 2 IS-1) and Medtronic (Minneapolis, MN) right ventricular (RV) single-coil defibrillator lead model 6935 (Sprint Quattro Secure DF-4). The RV lead was placed in the RV apex and the LV lead was placed in the basal third of a lateral branch of the coronary sinus. Intraoperative testing of LV pacing (LV tip. RV (right ventricle) high-voltage coil) using external pacing cables revealed an acceptable QRS morphology and pacing threshold (Figure 1). Instructions were given to use the “tip to coil” LV pacing configuration for permanent device programming. After connection to the pulse generator, a different QRS morphology was observed (Figure 2). The industry representative confirmed the LV pacing vector was as requested. What is the mechanism for the change in LV paced morphology before and after connection to the pulse generator?

Points to ponder

Figure 1 shows LV pacing in a LV tip > RV pacing vector (extended bipolar) using external pacing cables and the device programmer. The electrocardiogram shows a right bundle branch block morphology in lead V1 and a negative QRS in leads 1 and AVL, which is characteristic of epicardial pacing from the high lateral wall of the LV.

However, after connection of the lead ends to the device, the QRS morphology of the LV paced rhythm in a LV tip > RV pacing configuration (Figure 2) has a vector almost identical to RV pacing (positive in I, negative in V1, superior axis). This is indicative of pure anodal capture of the RV electrode (i.e. LV pacing with anodal stimulation of the RV electrode). While it is rare to see anodal capture of the RV coil due to the large surface area and reduced current density, it is more common to see anodal capture of RV ring electrodes. Occasionally, the anodal capture threshold of the RV ring electrode may be lower than that of the cathodal threshold from the LV lead.
Figure 1: QRS morphology of left ventricle pacing in a left ventricle tip > right ventricle high-voltage coil pacing vector using external pacing cables during the implantation.

Figure 2: QRS morphology during left ventricle only pacing after attachment of the leads to pulse generator. The pacing vector is programmed left ventricle tip > right ventricle or extended bipole.
This case is an example of an important difference in LV pacing vector circuitry of Boston Scientific cardiac resynchronization therapy defibrillator (CRT-D) platforms compared to other companies. The “extended bipolar” LV pacing vector (LV electrode as cathode, RV as anode) utilizes the ring electrode of the RV pace-sense circuit. If a Boston Scientific integrated bipolar defibrillator lead is chosen, as is typical, this still results in a true “tip to coil” configuration, since the RV ring and RV coil are the same. However, the use of dedicated bipolar defibrillator leads with this platform involves the much smaller RV pacing ring and dramatically increases the chance for RV anodal stimulation. In this case, a Medtronic defibrillator lead (dedicated bipole) was used in combination with a Boston Scientific CRT-D impulse generator. Therefore, the LV > RV (extended bipole) pacing vector resulted in RV anodal capture (Figure 3). The effects of anodal stimulation in CRT remain controversial. While LV anodal stimulation may have beneficial effects on cardiac output and LV function, RV anodal stimulation is less desirable or possibly harmful. In this example, the very low RV anodal capture threshold eliminated two available pacing vectors. The case illustrates an important difference in pacing vector circuitry that can significantly restrain programmability and affect CRT response when using dedicated bipolar leads in conjunction with Boston Scientific CRT-D generators.

References