INNOVATIVE COLLECTIONS

COMPLEX CASE STUDY

Mechanism of Right Bundle Branch Block Pattern During Uncomplicated Right Ventricular Pacing

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ABSTRACT. Transvenous right ventricular pacing usually demonstrates a left bundle branch block (LBBB) pattern. Right bundle branch block (RBBB) pattern of the paced QRS can represent left ventricular (LV) pacing due to either perforation of the right ventricular (RV) septal or free wall, or inadvertent positioning of the pacing lead into the coronary sinus or in the left ventricle. We present a case of uncomplicated RV apical pacing with RBBB morphology. Unique to this case is the interval change in the paced QRS morphology from LBBB to RBBB pattern, which may have been related to progression of the RV dilatation.

KEYWORDS. pacing lead malposition, right bundle branch block, ventricular pacing.

Case presentation

A 94-year-old woman with history of hypertension, moderate aortic stenosis, and pulmonary emphysema underwent dual-chamber permanent pacemaker implantation in 1991 for symptomatic complete heart block. Atrial lead replacement and pacemaker generator exchange (Pulsar Max, model 1270, Guidant, Inc., St. Paul, MN, USA) were performed in 2002. The patient had stable chronic dyspnea on exertion and has been on home oxygen therapy due to long-standing pulmonary emphysema. On routine follow-up visit, pacemaker interrogation revealed a right ventricular (RV) pacing threshold of 1.3 V at 0.4 ms, a right atrial pacing threshold of 1.0 V at 0.4 ms, and a P-wave amplitude of 2.6 mV. Atrial and ventricular lead impedance was 370 ohms and 460 ohms, respectively. The underlying rhythm was sinus with complete atrioventricular block and no escape rhythm. Surface electrocardiogram (ECG) showed sinus rhythm with atrial-tracking ventricular pacing and right bundle branch block (RBBB) QRS configuration (Figure 1). This was a change from previous ECGs obtained following the pacemaker generator exchange in 2002 (Figure 2). Surface ECG was repeated by placing the precordial leads one and then two interspaces lower than standard; however, that did not eliminate the RBBB configuration. What is the cause of the change in paced QRS morphology?

Discussion

Transvenous RV pacing usually demonstrates a left bundle branch block (LBBB) pattern. Paced RBBB pattern can represent left ventricular (LV) pacing due to either perforation of the RV septal or free wall or inadvertent positioning of the ventricular lead in the coronary sinus or in the left ventricle through a retrograde transarterial route or intracardiac defects such as a patent foramen ovale or ventricular septal defect.1–3 On rare occasions, however, RBBB patterns can occur in RV pacing despite correct placement of the ventricular lead. Therefore, careful evaluation is important to determine whether a RBBB pattern is the result of uncomplicated transvenous RV pacing or due to lead malposition or perforation, since such complications can create serious clinical problems and require life-long anticoagulation or lead extraction.

Several ECG features have been reported to predict an uncomplicated RV apical pacing when the paced QRS
has a RBBB configuration, including: 1) elimination of the RBBB appearance with placement of leads V1 and V2 one interspace lower than standard; 2) a maximal QRS vector oriented to the left, superior and anterior, may indicate uncomplicated RV pacing, whereas a RBBB pattern with the maximal QRS vector oriented to the right, inferior and posterior, may be a warning sign of perforation of the right ventricle; 3) a frontal axis of 0° to

**Figure 1:** Surface electrocardiogram obtained in 2007 showing sinus rhythm with atrial tracking ventricular pacing and right bundle branch block pattern in V1 and V2. QRS axis in the limb leads is $-75^\circ$.

**Figure 2:** Surface electrocardiogram (ECG) obtained in 2002 showing dual-chamber pacing and left bundle branch block pattern in V1 and V2. QRS axis in the limb leads is $-75^\circ$, similar to that in a more recent ECG shown in Figure 1.
and precordial transition by V3 separates uncomplicated RV septal or apical pacing from all other forms of LV pacing with 86% sensitivity, 99% specificity, and 95% positive predictive value. The same frontal axis of 0° to −90°, but precordial transition after V4, indicates pacing in the middle cardiac vein or posterior and posterolateral wall of the left ventricle (sensitivity 72%, specificity 100%, positive predictive value 100%). Frontal axes between −90° and −180° or between 90° and 180° indicate other locations of LV pacing.

In our patient, application of the ECG criteria described above provided contradictory results. The frontal axis was around −75° and precordial transition by V3, suggestive of uncomplicated RV apical pacing. However, contrary to what would be expected from uncomplicated RV apical pacing, RBBB configuration could not be eliminated by moving leads V1 and V2 one or two interspaces lower than standard. Furthermore, there was an interval change in the paced QRS morphology over a period of a few years. ECGs following the pacemaker generator exchange in 2002 revealed typical QRS morphology for RV apical pacing (Figure 2). However, current ECGs revealed development of a new RBBB paced QRS morphology. Malposition of the ventricular pacing lead was excluded with the aid of echocardiography and chest X-ray. Transthoracic echocardiography clearly showed the pacing lead traversing from the right atrium to the right ventricle and lying in the RV apex. There was dilatation of the right ventricle with elevated RV systolic pressure (55 mmHg), but no RV free wall or septal perforation. Chest X-ray also revealed a right-sided and antero-inferiorly oriented ventricular pacing lead whose tip was positioned infero-apically in the RV apex (Figure 3).

Several hypotheses have been proposed to explain the RBBB morphology in cases of uncomplicated RV pacing. One hypothesis suggested that the left ventricle activated first through abnormal pathways when the right ventricle is paced, or that portions of the interventricular septum that are anatomically RV may behave functionally and electrically as LV. Another hypothesis suggested that the pacemaker stimulus may enter the right bundle branch and then travel in a retrograde direction to the AV junction and down the left bundle branch. An alternative explanation suggested that the RBBB pattern could be the result of a combination of RV activation delay due to severe disease of the RV conduction system and early penetration of the electrical impulse into the LV conduction system.

In view of the presence of RV dilatation and elevated RV systolic pressure on echocardiogram, we hypothesize that potential progression of RV disease over a few years could have caused significant RV conduction delay, accounting for the change in paced QRS morphology. We could not evaluate native intraventricular conduction patterns since the patient had complete heart block and no escape rhythm. In conclusion, this case illustrates another example of uncomplicated RV apical pacing with RBBB morphology. Unlike previously reported cases, our patient had an interval change in the paced QRS morphology from LBBB to RBBB pattern, which may have been related to underlying cardiac disease, though the exact mechanism remains unclear.

References


