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Shift From Left to a Right Bundle Block on ECG Leading to the Diagnosis of a Malpositioned Lead in the Coronary Sinus: A Case Report

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Abstract On electrocardiography (ECG), ventricular pacing appears as a spikes that precede induced QRS complexes. The induced complexes with a right ventricular lead have the morphology of a left bundle branch block (LBBB). We describe a case of malposition right ventricular (RV) lead in the coronary sinus diagnosed based on the changes noted in the ECG tracing. An 80-year-old man with a pacemaker implanted for high-grade AV block was found unresponsive. Six minutes of cardiopulmonary resuscitation resulted in return of spontaneous circulation. The ECG demonstrated a new paced right bundle branch block (RBBB) pattern. Chest radiography revealed a misplaced right ventricular (RV) lead in the coronary sinus which was confirmed by 2D-echocardiography. The patient's healthcare proxy (HCP) declined invasive interventions. The patient expired due multiorgan failure secondary to ventilator associated pneumonia. When an RBBB pattern is seen with RV pacing, patients must be evaluated for mispositioning of the RV lead navigation through an atrial septal defect (ASD) or perforation of the ventricular septum, aberrant retrograde conduction, pre-existing right bundle disease and the "pseudo-RBBB" pattern (seen with the ventricular lead placed in the RV apex/distal septum). A frontal axis of 0˚ to 90˚ and precordial transition by lead V3 differentiates RV septal pacing from all forms of LV pacing, including lead placement in the coronary sinus. Our patient had precordial transition at V3.

Keywords: *dual-chamber pacemaker, bradyarrhythmia, right lead perforation, right bundle branch pattern, pseudo-RBBB*

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1. Introduction

A cardiac pacemaker is a device that generates artificial electrical impulses to restore and/or maintain a normal heart rate and rhythm. It also enables the operator to interrogate and control the pacing rate, the pulse width, and the voltage of the impulses delivered [1]. A dual-chamber pacemaker consists of two parts: a power source or generator that generates electrical impulses and transvenous pacing leads placed in the right atrial appendage (RA) and the right ventricle (RV) [2]. The atrial lead is placed in the right atrial appendage and the ventricular lead at the apex of the right ventricle [2,3]. The most common indication for pacemaker implantation is symptomatic bradyarrhythmias. These arrhythmias may be secondary to sinus node dysfunction, high-grade atrioventricular block, bifascicular block, or sick sinus syndrome [4]. Dual-chamber pacemakers can sense the underlying cardiac rhythm and pace the RA, RV or both the chambers with the goal of maintaining the heart rate above a programmed threshold while preserving atrioventricular synchrony [2,3,4]. On an electrocardiogram (ECG), atrial pacing appears as spikes that precede the induced P waves, while ventricular pacing appears as a spike that precede the induced QRS complexes. The induced ventricular complexes have the morphology of a left bundle branch block (LBBB) [5]. Though rare, complications related to cardiac pacemaker implantation include lead misplacement, infection, pneumothorax, myocardial perforation, venous thrombosis, and erosion [6]. We describe a case of a malpositioned ventricular lead in the coronary sinus after cardiopulmonary resuscitation (CPR) in an 80-year-old man with a dual chamber pacemaker. The QRS complexes had a Right Bundle Branch (RBBB) morphology on ECG.

2. Case Report

An 80-year-old man with a history of diabetes, hypertension, hyperlipidemia, coronary artery bypass graft, Alzheimer's disease, and permanent pacemaker implantation for a high-grade AV block was found unresponsive at home. Emergency medical services initiated CPR for pulseless electrical activity and ROSC was achieved six minutes into resuscitation. The patient was also intubated on the field for airway and was started on vasopressors for hypotension. On arrival to the emergency room, the patient was afebrile, had a heart rate of 60 beats per minute and a blood pressure of 143/58 mm of Hg. No gross abnormality was noted on physical examination. A diagnosis of a non-ST segment myocardial infarction (NSTEMI) was established after ST-segment depressions were noted in leads V2 to V5 on ECG (Figure 1) and serum troponin level was found elevated at 15.8 ng/mL. The patient underwent a computed tomography scan of the head, which ruled out an acute intracranial hemorrhage, and subsequently was started on dual antiplatelet therapy, high intensity statins and full-dose anticoagulation. Patient was also placed on hypothermia protocol. The patient's pacemaker was interrogated, and revealed a normal working pacemaker with acceptable impedance, sensitivity, and thresholds of the RA and RV leads. On day three of his hospitalization, the ECG revealed a paced rhythm but now with a RBBB QRS morphology, with extreme (northwest) axis deviation and a QS pattern in lead I (Figure 2). The RBBB pattern was also detected upon asynchronous pacing when a magnet was placed over the can of the permanent pacemaker (Figure 3). This was concerning for possible RV lead perforation into the left ventricle. A Chest X-ray revealed a misplaced RV lead in the coronary sinus (Figure 4). A transthoracic echocardiogram confirmed the presence of the RA lead in the right atrial appendage and the misplacement RV lead in the coronary sinus. No intervention to correct the displaced RV lead was performed as the HCP opted to defer any surgical intervention for the patient.

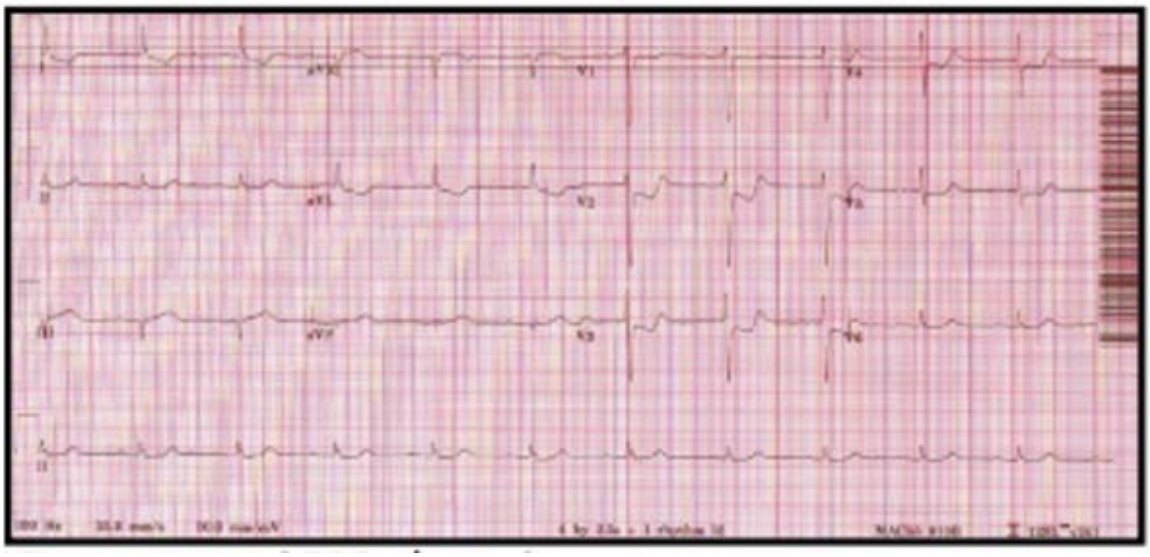

Figure 1. Initial EKG showing normal sinus rhythm, note ST-Segment depression in lead V2- V3

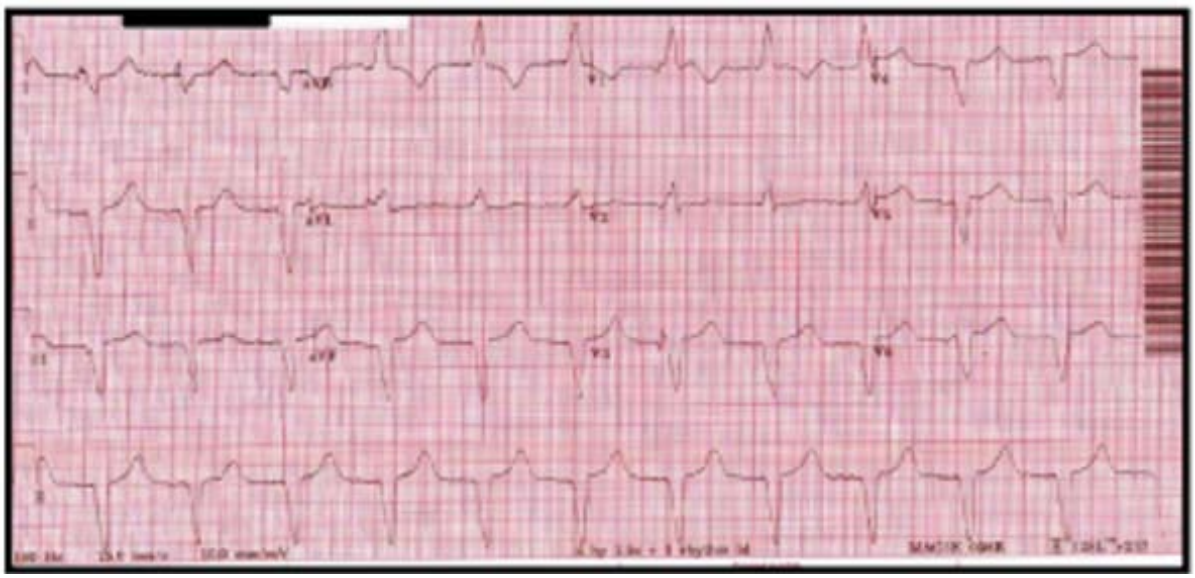

Figure 2. EKG showing RBBB pattern with RV pacing

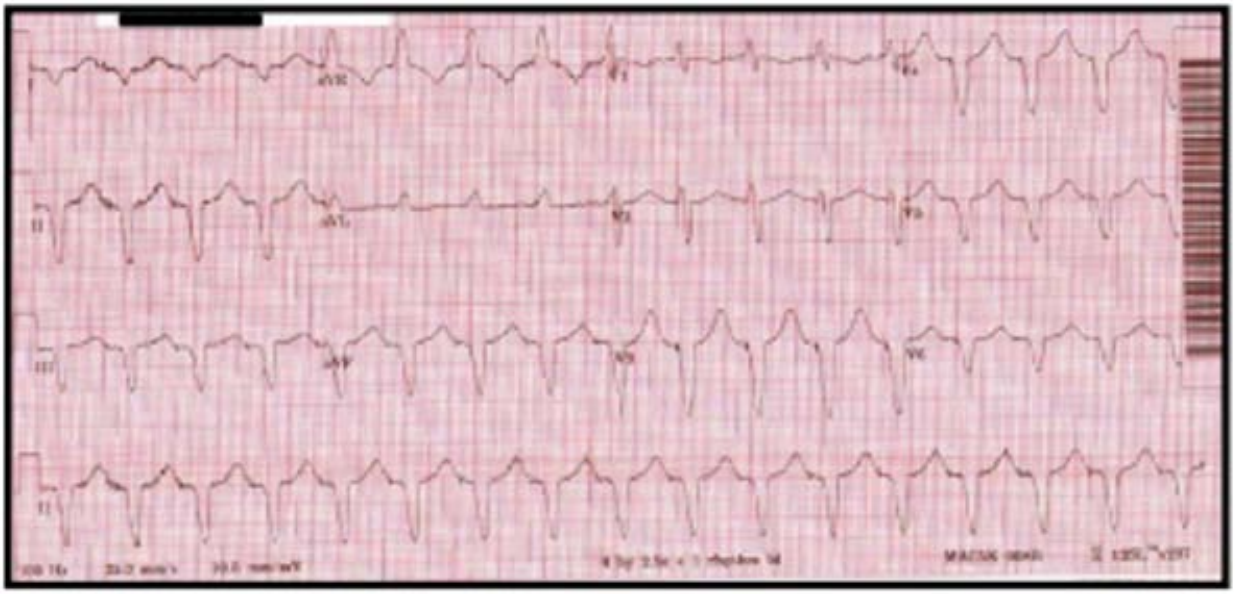

Figure 3. EKG with asynchronous pacing (with magnet on the pacemaker) showing RBBB

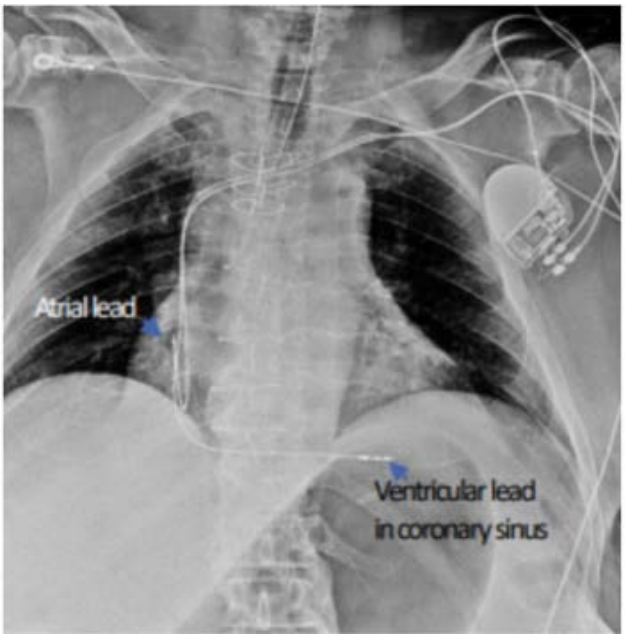

Figure 4. Chest X ray showing mispositioned right ventricular lead in the coronary sinus

On day four of hospitalization the patient developed a fever of 102.8^0 F. Chest radiograph demonstrated a new opacity in the right lower lobe. Treatment with piperacillin-tazobactam, levofloxacin and vancomycin for a suspected ventilator associated pneumonia was initiated. Despite the antibiotic regimen, his oxygen and vasopressor requirements continued to escalate. Chest imaging evolved to bilateral pulmonary opacities compatible with acute respiratory distress syndrome (ARDS). Over the next two days, he progressed to severe ARDS and developed acute renal failure. While discussing the possibility of continuous renal replacement therapy and his overall prognosis with HCP, a decision was made to terminate all resuscitative efforts and the patient was terminally extubated on day nine of the hospitalization.

3. Discussion

On ECG, RV pacing normally results in a QRS morphology similar to that of a LBBB, whereas left ventricular pacing result in a QRS morphology similar to that of a RBBB [7,8]. When an ECG reveals a RBBB pattern when RV pacing is intended patients must be evaluated for malpositioning of the RV lead with a chest X-ray and an echocardiogram. The right ventricular lead can potentially navigate through an atrial septal defect and the left atrium and be positioned in the left ventricle, resulting in inadvertent pacing of the left ventricle and consequently a RBBB pattern on ECG. [9]. A RBBB pattern can also be seen if the ventricular lead is erroneously placed in the arterial system instead of the venous system, resulting in trans-arterial pacing of the left ventricle [10-14]. Unintended trans-arterial LV pacing can sometimes have deleterious consequences, such as acute myocardial infarction due to lead placement in a coronary artery [13] or stroke secondary to an arterial thromboembolism [14]. Also, an RBBB pattern on ECG can result when the ventricular lead perforates the interventricular septum and enters the left ventricle [7].

A RBBB QRS morphology may also appear in a normally placed RV lead. Klein et al. described the “pseudo-RBBB” pattern seen with an RV lead as an RBBB pattern in leads V1 and V2 but a LBBB pattern in lead I [15]. This unique pattern is not due to a mispositioning of the RV lead but appears when the ventricular lead is placed either in the RV apex or distal septum and is explained by the marked superior and slight anterior orientation of the main QRS complex in right ventricular pacing. The pseudo-RBBB pattern resolves when the V1 and V2 leads are placed one costal space lower than the standard placement [16]. This pseudo-RBBB pattern is not position-dependent and did not disappear on ECG when the ventricular lead was repositioned to the mid-interventricular septum. This pseudo-RBBB pattern was the result of RV depolarization preceding LV depolarization [15,17]. If a pseudo-RBBB

pattern is seen on EKG and a proximal or mid-interventricular septal lead placement has been ruled out, one can differentiate between RV and LV pacing using an algorithm developed by Coman et al [17]. Their analysis demonstrated that a frontal axis of 0̊to 90˚ and precordial transition by V3 differentiates RV septal pacing from all forms of LV pacing, including lead placement in the coronary sinus. They describe their algorithm to yield an 86% sensitivity, 99% specificity, and 95% positive predictive value [17].

Pseudo-RBBB and RBBB morphologies of QRS complexes may appear in correctly placed ventricular leads due to pre-existing conduction abnormalities in the heart. Specifically, abnormal circuitry in the interventricular septum may result in LV depolarization followed by RV depolarization [18]. RBBB patterns in RV pacing may appear secondary to an aberrant retrograde impulse conduction that circles through right branch, the atrioventricular node and finally through the left bundle, resulting in a relatively earlier LV depolarization [18]. RBBB morphology of the QRS complex may also appear due to portions of right-sided interventricular septum mimicking the left ventricle mechanically and electrically [19]. Finally, pre-existing RBBB and severe right bundle disease are other conditions that result in RBBB of the QRS complex despite appropriate position of the right ventricular lead. In our case, the patient had an RBBB pattern and precordial transition at V3. The position of the lead in the coronary sinus was confirmed by echocardiography.

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