

## CASE REPORT

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# Cross stimulation and unusual ventricular activation in a patient with dual chamber pacemaker

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## Abstract

Cross stimulation is defined as stimulation of one cardiac chamber when the stimulation of the other chamber is expected. We present a case of an eighty three year old patient with history of dual chamber pacemaker implantation with recent generator change which showed interesting ECG findings.

## KEYWORDS

cross stimula, dual chamber pacemaker, electrocardiogram

## 1 | CASE

Eighty-three-year-old female with a history of coronary artery bypass grafting, and aortic valve replacement in 1998. An Abbott (Assurity MRI TM 2272 Pacemaker 9177160) dual-chamber pacemaker was implanted in 2013 for third-degree atrioventricular block. A post-implantation electrocardiogram (ECG) is shown in [Figure 1](#). The generator was replaced in 2020 for battery depletion. A follow-up ECG was obtained on the clinic visit is shown in [Figure 2](#). Which of the following is the most likely explanation for the ECG changes in [Figure 2](#)?

- A Normal right atrial and right ventricular pacing.
- B Left ventricular pacing with cross stimulation of atrial and ventricular chambers.
- C Left ventricular pacing with dislodged atrial lead into the ventricle.
- D Left ventricular pacing with atrial lead under sensing.

## 2 | EXPLANATION/DISCUSSION

Cross stimulation is defined as stimulation of one cardiac chamber when the stimulation of the other chamber is expected (Levine et al., 1985), which is extremely rare and is due to the misplacement of the

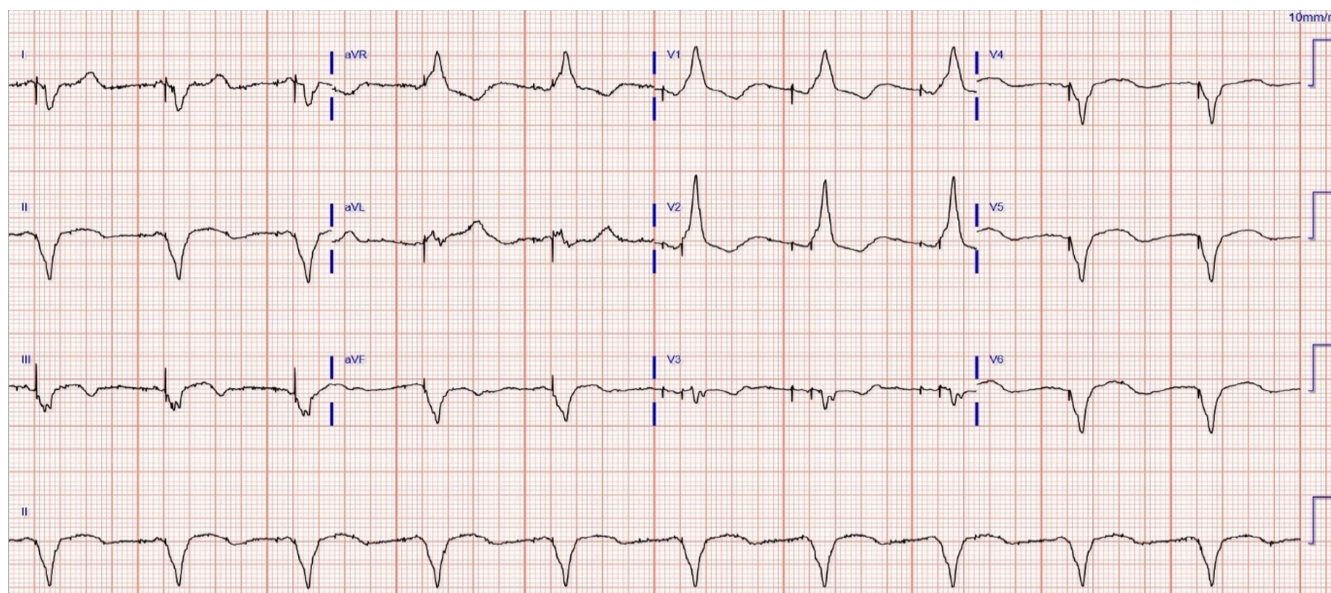
atrial lead to the ventricular connector and ventricular lead to the atrial connector of the pacemaker generator. In this case, the initial post-implant ECG ([Figure 1](#)) shows bipolar atrial and ventricular pacing with an AV interval of 150 milliseconds (ms). The presence of a right bundle morphology with ventricular pacing is consistent with either implantation of the ventricular lead in the coronary sinus or placement of the lead deep in the right ventricular septum. Other differential diagnosis includes (1) left ventricular (LV) endocardial stimulation (a) via Patent Foramen Ovale (PFO) or atrial septal defect (ASD), (b) via unrecognized arterial access, (c) via ventricular septal defect (VSD) or (2) right ventricular (RV) apical stimulation with some rotation or enlargement. A subsequent lateral chest X-ray confirmed the posterior location of the ventricular lead most likely in a branch vessel of the coronary sinus ([Figure 3](#)).

The patient was following up with an outside hospital where the pacemaker generator was replaced. Three months post generator change, she presented to our clinic. ECG was obtained at that time and shown in [Figure 2](#).

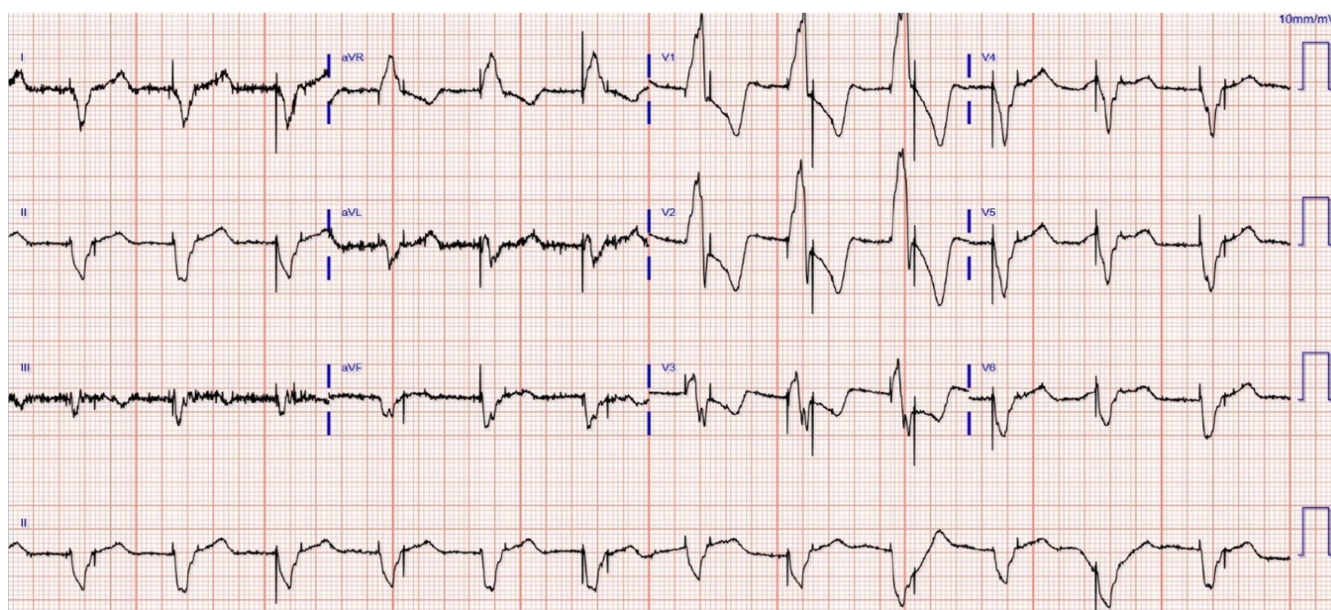
The second ECG ([Figure 2](#)) shows two pacing spikes, with the first spike activating the ventricles and the second spike occurring exactly at an interval of 150 ms. The first spike is originating from the atrial port, connected to the ventricular lead, activating the left ventricles followed by the second spike, which is connected to the atrial lead, activating the atria. Ventricular depolarization following the "atrial" spike is due to the inadvertent connection of the

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**FIGURE 1** Twelve-lead ECG following implantation of a dual-chamber pacemaker in 2013 shows atrial and ventricular pacing spike followed by atrial and ventricular capture respectively



**FIGURE 2** Twelve-lead ECG on admission, 3 months after generator replacement showing atrial spike stimulating ventricle and ventricular spike resulting in p wave which is low amplitude and buried inside ST interval

ventricular lead into the atrial port of the dual-chamber generator during generator replacement. Since it was a double switch and the atrial lead was attached to the ventricular port, the second or “ventricular” spike occurs due to relative under sensing on the ventricular channel (Since this channel was supposed to sense R wave instead of P wave, it was programmed at 3 mV to sense R waves, but due to lead misplacement, this channel, which is now an atrial channel, is under sensing P waves because of higher programmed

amplitude than measured P wave amplitude), which results in atrial depolarization most likely hidden inside the ST interval. Paced P wave was observed to be relatively lower amplitude even in Figure 1. Also, there is no retrograde atrial activation to inhibit the second spike, due to underlying atrioventricular block. When the pacemaker was programmed to AAI mode the second spike disappeared, effectively changing the pacemaker mode to VVI mode. Since the procedure was performed at outside hospital, she was given the option

**FIGURE 3** Chest X-ray showing lateral view after device implantation. The white arrow represents the posterior location of RV lead



to either continue observation or open the pocket and correct the leads. The patient decided to continue observation. The patient is being closely followed up in the clinic at regular intervals and has been doing well.

### 3 | CONCLUSION

This ECG has two important teaching points. First, left ventricular activation instead of the right ventricle was present in a patient with a standard dual-chamber pacemaker. Second, inadvertent placement of leads into opposite ports which resulted in relative under sensing of the ventricular channel with subsequent atrial depolarization. This reminds us of the importance of device interrogation during generator replacements and every effort should be made to assure the correct placement of the leads in their respective ports.

#### CONFLICT OF INTEREST

All the authors had no personal, financial, commercial, or academic conflicts of interest separately.

#### ETHICAL APPROVAL

Consent was granted.


#### AUTHORS' CONTRIBUTIONS

AMI, First author, wrote the manuscript. SG, Edited the manuscript. GF, edited, supervised and finalized the manuscript.

#### DATA AVAILABILITY STATEMENT

Data are available from the corresponding author upon reasonable request due to privacy or other restrictions.

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#### REFERENCE

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