

## Pacemaker Lead Perforation during Right Ventricular Outflow Tract Pacing -Importance of Heart Rotation at Pacemaker Implantation

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### Abstract

A 70 year-old woman underwent a dual-chamber pacemaker implantation for episodes of transient block and syncope. The transitional zone of her ECG was observed between V4 and V5, indicating clockwise rotation. An experienced physician performed the Right Ventricular Outflow Tract (RVOT) pacing using an active fixation lead without any immediate complications. For RVOT pacing, the lead was placed approximately two-thirds of the distance from the apex to the pulmonary valve in the postero-anterior view and pointing towards the septum in the left anterior oblique view. The ECG revealed a narrow QRS (120 msec) and the lead I morphology was minus-plus. Six days post-implant, a pacemaker interrogation revealed ventricular undersensing and loss of capture with high output pacing. Chest computed tomography revealed the left ventricle was displaced to the left and the left-sided angle between the interventricular septum and horizontal axis of the body was reduced to 16°. It confirmed an RV lead perforation through the RVOT, with 1 cm of the lead positioned outside the heart. We performed a surgical repair. Though ECG and x-rays showed septal pacing, we experienced an unusual case of a subacute myocardial perforation caused by an active fixation lead possibly due to heart rotation. The present case report described a patient with a subacute lead perforation and no hemodynamic instability. It is important for the general cardiologist to pay attention to heart rotation. After implantation, symptoms that can suggest a lead perforation, as major signs such as pericardial effusion are not necessarily present. A pacemaker interrogation shows lower impedance, as well as undersensing or failure to capture the involved chamber in suspicious findings.

**Keywords:** Pacemaker; Clockwise rotation; Lead perforation; Complication; Septal pacing

### Introduction

Several clinical and experimental studies have suggested that long-term right ventricular (RV) apical pacing deteriorates the Left ventricular (LV) function. They have demonstrated the deleterious consequences of an intraventricular conduction delay, particularly that produced by left bundle branch block [1,2]. Alternative sites were tested with a goal to optimize or stabilize the LV function. Septal pacing seems to better preserve the cardiac performance in patients with a normal LV systolic function [3].

Myocardial perforations are rare, but are the most serious complication of pacemaker or Implantable-cardioverter defibrillator (ICD) implantations. The published incidence of this complication varies from 0.4% even up to 5.2%, but nowadays it is usually lower than 1% [4,5]. The use of active fixation leads is associated with a higher rate of cardiac perforations [6]. Development of small diameter leads and active fixation mechanisms has resulted in increased stiffness at the tips of leads, potentially increasing the rate of this uncommon event. McGavigan AD et al., reported that the left lateral radiograph was useful in confirming a true septal location [7]. Though ECG and x-rays revealed septal pacing, we experienced an unusual case of lead perforation. In hemodynamically stable patients, signs and symptoms suggestive of a perforation do not present, and therapeutic management occurs.

### Case Report

A 70 year-old woman was hospitalized with a transient loss of consciousness. Her basal ECG indicated clockwise rotation of the transitional zone (Figure 1a). After admission, she had dizziness and her ECG monitor recording revealed transient atrio-ventricular block and pause. She underwent a dual-chamber pacemaker implantation (Zephyr XL, St Jude Medical Inc, St Paul, MN, USA). A 7-French active fixation lead (St Jude IsoFlex S 1646-T) was inserted via the left subclavian vein and positioned in the Right ventricular (RV) outflow tract septum (left anterior oblique view 50°) without any immediate

complications. The atrial and ventricular sensing was measured at 1.0 and 10.4 mvolts, respectively. The pacing thresholds (volts/msec) were 1.0/0.5 and 0.5/0.5 for the atrial and ventricular leads, respectively.

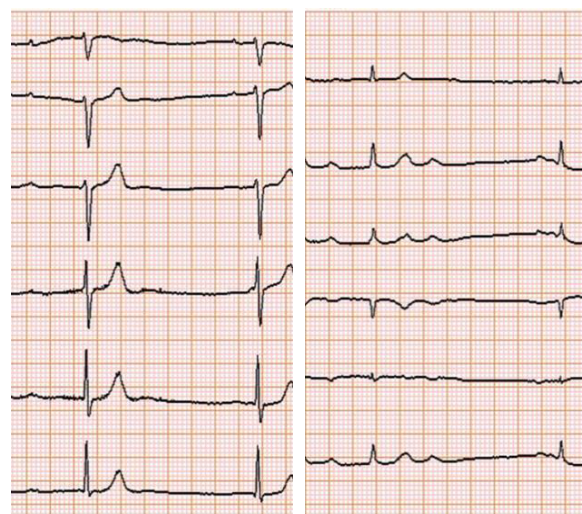


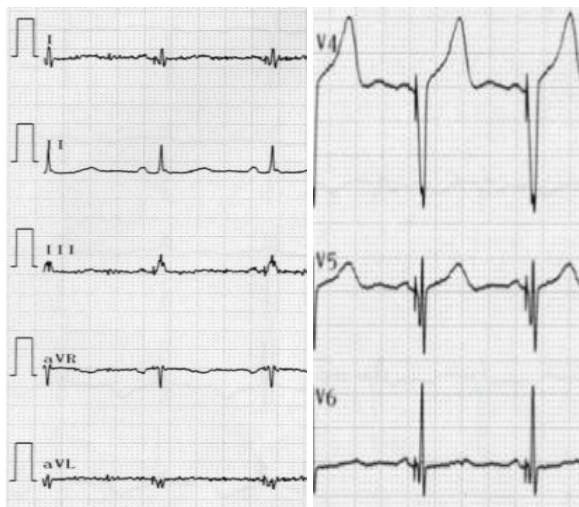
Figure 1(a): Twelve lead ECG before the pacemaker implantation.

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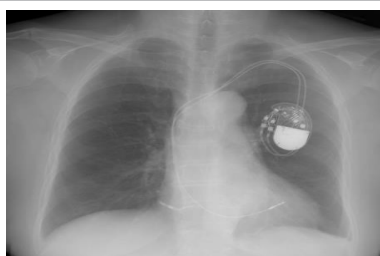
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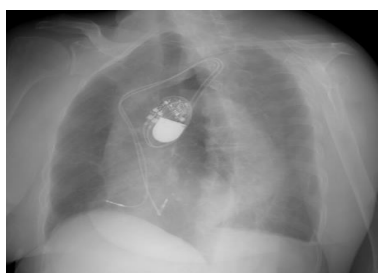
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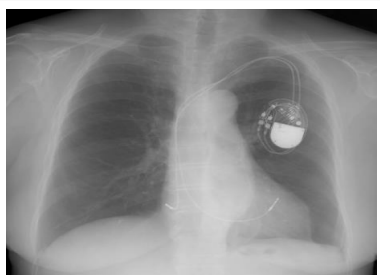
**Figure 1(b):** Twelve lead ECG after the pacemaker implantation. The QRS wide was relatively narrow and lead I had a minus-plus morphology after implantation.



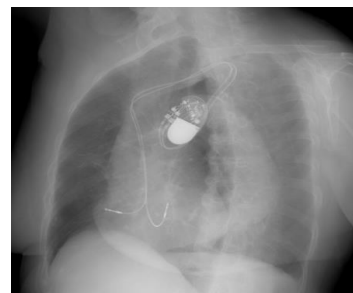
**Figure 2(a):** Chest x-rays showing the right ventricular lead in the right ventricular outflow tract, with a satisfactory position of the ventricular lead and no pneumothorax three days after the implantation.



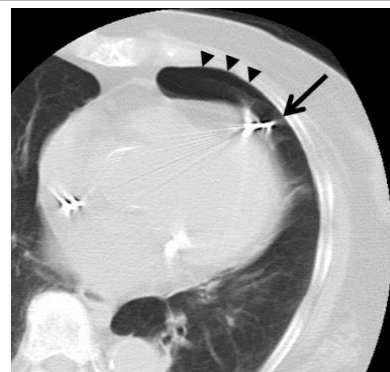
**Figure 2(b):** Chest x-rays showing the right ventricular lead in the right ventricular outflow tract, with a satisfactory position of the ventricular lead and no pneumothorax three days after the implantation.



**Figure 2(c):** The ventricular lead was shown to have migrated to the left side from its original position six days after the implantation.



**Figure 2(d):** The ventricular lead was shown to have migrated to the left side from its original position six days after the implantation.



**Figure 2(e):** Computed tomographic scan of the thorax demonstrating a pneumothorax (arrow) and perforation of the right ventricular wall with the right ventricular lead tip (arrow head). Left ventricle was displaced to the left, and the septal angle reduced to 16°.

The impedances were in the normal range (atrial lead 429 ohms and ventricular lead 727 ohms). The pacemaker was working with atrial sensing and ventricular pacing. The ECG revealed a narrow QRS (120 msec) and the lead I morphology was minus-plus (Figure 1b). Three days after the pacemaker implantation, a chest x-ray and interrogation of the pacemaker did not reveal any problems (Figures 2a and 2b). Although not shown, the position of pacemaker leads was not different between three days after and immediate after the pacemaker implantation. Six days post-implant, a pacemaker interrogation revealed ventricular undersensing and the loss of capture with high output pacing (7.5 volts at 1.5 msec), although the patient showed no symptoms. On the chest x-ray, the tip of the ventricular lead seemed to have moved outside the heart shadow (Figures 2c and 2d). Echocardiography revealed that there was no pericardial effusion and that the ventricular lead seemed to be positioned within the heart. Computed Tomography (CT) of the chest confirmed a pneumothorax and that the ventricular lead was in the lung (Figure 2e). Chest x-ray revealed that the tip of the ventricular lead was outside the heart and the patient was transported to the operation room (Figure 2f). We selected a surgical repair and the lead was removed without any complications. The perforated ventricular lead was positioned at 5 cm from the apex and at 1 cm left to the left anterior descending coronary artery. A new myocardial lead was implanted on the basal side of the heart. The patient was discharged with a good general condition.

## Discussion

Lead perforations are a relatively rare (<1%). Complication of pacemaker and ICD implantations usually occurs within the first 24 hours after the implantation, and more commonly with active fixation leads and in the atrial aspect [8], late perforations are believed to be



**Figure 2(f):** Chest x-ray showing the right ventricular lead in the right ventricular outflow tract extending outside the heart silhouette before the operation.

very rare. The clinical course is extremely variable with some patients presenting completely asymptomatic, while others can develop cardiac tamponade and hemodynamic instability. The clinical predictors associated with lead perforations are the use of temporary pacemakers, active fixation leads and steroids [7,8]. Potential predictors of late perforations, particularly associated with passive fixation leads, include smaller lead diameters and apical positioning of the ventricular lead. In the present case, the chest x-ray and ECG after the initial implant revealed the lead positioned in the RV outflow tract septum [7]. Balt et al., demonstrated that septal RV outflow tract stimulation did not always lead to a negative complex in lead I [9]. It was not possible to develop an algorithm that correlates ECG parameters with lead position because QRS morphology of RV outflow tract pacing sites may be due to variations in baseline depolarization pattern, size, and function of both the right and left ventricle. An analysis of lead position in different views may be required to ensure the outflow tract septal positioning. Previously reported that heart rotation increases with aging due to aortic elongation, but age-related heart rotation may be counteracted by an increase in LV mass index [10]. In this case, the transitional zone of ECG was observed between V4 and V5 indicating clockwise rotation, although there was a weak or no correlation between electrical and anatomical axis in the transverse plane according to some previous reports [11,12]. However, the left ventricle was displaced to the left, and the left-sided angle between the interventricular septum and horizontal axis of the body reduced to 16° by chest CT. We proposed that, in clockwise rotated heart patients, left lateral radiograph was not useful in confirming a true septal location. Some recent studies [13,14] reported that a schema developed to define septal position in the right anterior oblique fluoroscopic view have high agreement with CT images, differently from that in ECG criteria, although we cannot present this view at the end of pacemaker implantation in our case.

In most patients, the leads can safely be removed under fluoroscopic guidance and close monitoring [15]. Although controversial, the emergent risk of a pericardial effusion and tamponade in these situations, as well the presence of surgical backup, can favor the decision for a prophylactic drain insertion. In this case, and however, we selected a surgical lead removal, because pneumothorax was detected by CT images. In addition, the ventricular lead was positioned in the RV outflow tract and the lead could potentially penetrate the coronary arteries. In fact, the lead was positioned 5-6 mm near diagonal branch.

An interesting aspect observed is that progressive technology has resulted in the development of small diameter leads with modified

designs and increased stiffness at the tip, which are related to an increased number of perforations in patients who receive pacemakers or ICDs [16]. The present case report described a patient with a sub acute active-fixation lead perforation and no hemodynamic instability. It is important for the general cardiologist to pay attention to heart rotation. After implantation, major signs that can suggest a lead perforation such as pericardial effusion are not necessarily present. A pacemaker interrogation that shows a lower impedance, as well as undersensing or failure to capture the involved chamber, are suspicious findings.

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