

Incidental Detection of Inadvertent Pacing Lead Placement in the Left Ventricle by Myocardial Perfusion Imaging Study

Robert T. Tung, M.D., FACC

U.S. Department of Veterans Affairs, Eastern Kansas Health-Care System, Topeka, KS

Received Jun. 17, 2019; Accepted for publication Sept 17, 2019; Published online Feb. 28, 2020

INTRODUCTION

Inadvertent pacing lead placement in the left ventricle (LV) is an uncommon complication of cardiac pacing therapy, first reported by Stillman and Richards in 1969.¹ This can occur when the lead was passed through an atrial-septal defect, a patent foramen ovale (PFO),^{2,3} via perforation of the intraventricular septum¹ or subclavian arterial insertion.⁴ It is associated with increased risk of thromboembolic events and increased morbidity and mortality.^{5,6} It can be detected by various cardiac imaging modalities including echocardiography or cardiac computed tomography (CT).⁵ However, incidental detection of pacing lead in the LV by low-resolution CT with myocardial perfusion imaging (MPI) has not been reported previously.

Single photon emission computed tomography (SPECT) myocardial perfusion imaging (MPI) is a well-established technique for evaluation of coronary artery disease (CAD).⁷ To improve image quality, low-resolution CTs commonly are used for anatomical correction and artifact attenuation during SPECT MPI.⁸ The low-resolution, unenhanced CT images are considered low-quality, therefore, labelled by manufacturers as “non-diagnostic”. The CT portion of the MPI at many centers is used only for image fusion and attenuation correction, and their images are not reviewed or reported routinely by cardiologists.⁸

This report describes a case of incidental detection of inadvertent placement of pacing lead in the LV by low resolution CT used during cardiac MPI. This case suggested that it is appropriate and necessary to review low-resolution CT images during cardiac MPI for incidental findings of clinical significance.

CASE REPORT

An 83-year-old male had a history of thromboembolic stroke years ago. At that time, he had a full neurological and cardiac workup including transesophageal echocardiography (TEE) which showed a small PFO. Medtronic Reveal LINQ™, a continuous cardiac monitor, was inserted for evaluation of potential cryptogenic causes of his stroke. He was lost to follow-up until he had episodes of near syncope and was evaluated in our cardiology clinic.

His Reveal LINQ™ interrogation showed multiple sinus pauses of greater than 4.5 seconds without other cardiac arrhythmias. Because of his symptoms suggestive of sick sinus syndrome, a pacemaker (PM) was inserted successfully using a left subclavian venous approach. An

anteroposterior (AP) chest X-ray was performed post-implantation and appeared to show a satisfactory lead position without pneumothorax (Figure 1). He was discharged the following day.

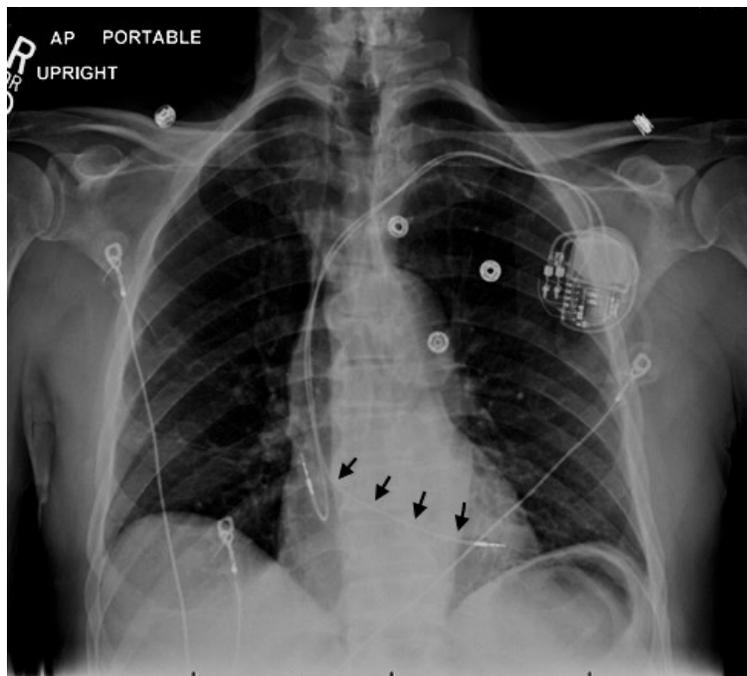


Figure 1. Post-operative portable chest X-ray; arrowheads indicate the ventricular lead.

A pre-discharge check showed normal pacemaker sensing and pacing parameters, and the patient was enrolled for remote PM monitoring. When a 15-beats run of non-sustained ventricular tachycardia (Figure 2) was detected by remote PM monitoring three months after insertion, a pharmacological SPECT/CT MPI was obtained to rule out myocardial ischemia. The MPI showed normal myocardial perfusion and LV systolic function, however, the CT imaging revealed that a pacing lead was inadvertently placed in the LV via intra-atrial septum (Figure 3). Because of this finding, he was admitted to a tertiary hospital where he underwent ventricular lead revision successfully. He suffered no apparent clinical sequelae from the inadvertent pacing lead placement in the LV.

DISCUSSION

Inadvertent pacing lead placement in the LV is a rare complication of cardiac pacing therapy and associated with increased risk of thromboembolic events and other complications.^{5,6} Therefore, during device implantation, special care should be given to patients with known history of PFO. A few simple and helpful tips that might be considered in such patients are:

1. Intra-operatively, after the ventricular lead is placed in the superior vena cava, a soft-tipped, straight stylet should be employed and the lead advanced to the junction of right atrial (RA) and inferior vena cava junction. At that time, the straight stylet can be replaced with a pre-curved one, then the lead can be withdrawn back carefully until it crosses the tricuspid valve into right ventricle (RV). This will decrease the chance of inadvertent lead crossing of PFO into the left-sided chambers.
2. After the lead is secured in the RV, it is necessary to review the RV lead position carefully by fluoroscopy using both antero-

posterior (AP) and left anterior oblique (LAO) views, particularly in LAO view to verify its more anterior RV position.

3. Post operatively, AP and lateral chest x-ray should be performed/reviewed routinely to confirm appropriate RA/RV leads position. A 12-lead electrocardiogram (ECG), with and without magnet should be performed routinely to confirm appropriate ECG pattern of RV pacing.

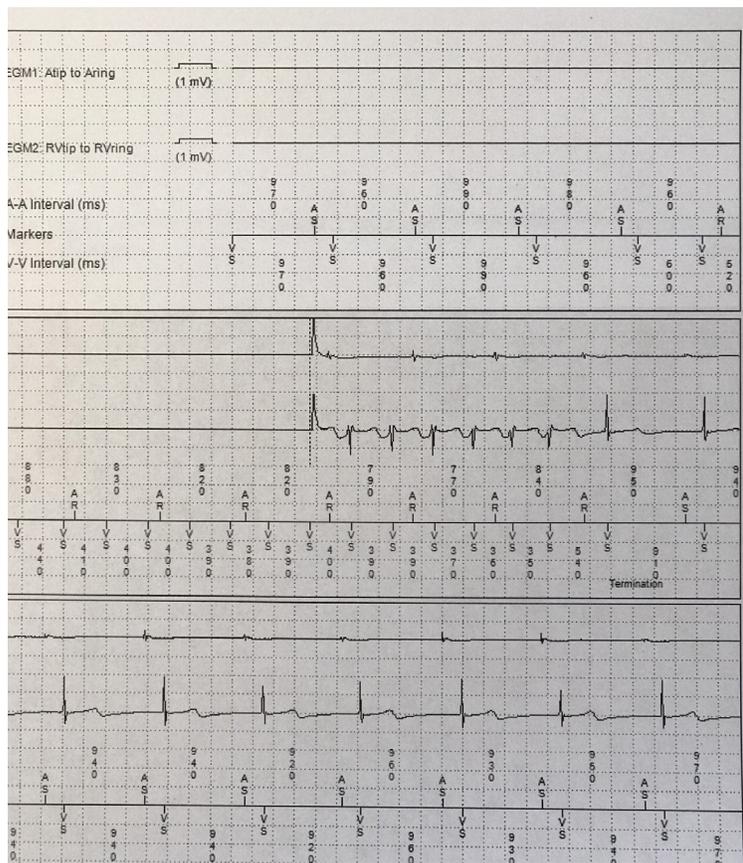


Figure 2. Recordings of intracardiac atrial and ventricular electrogram (EGM) from pacemaker interrogation. It showed non-sustained ventricular tachycardia (middle strip) as evidenced by ventriculo-atrial (VA) dissociation (shorter V-V sensing interval than A-A sensing interval) and different QRS morphology of the intracardiac recordings on the EGM2 during tachycardia as compared to those during normal sinus rhythm (marked as VS). Abbreviations: AS: atrial sensing; EGM1: EGM from atrial lead tip-ring recording; EGM2: EGM from ventricular lead tip-ring sensing; VS: ventricular sensing.



Figure 3. CT image of pacemaker leads in the right atrium (RA), left atrium (LA), and left ventricle (LV). Abbreviation: IAS: intra-atrial septum.

The incidental findings on low-resolution CT during cardiac MPI are frequent.^{9,10} Clinically significant findings, however, are relatively infrequent. The majority of cardiac MPIs are reviewed and interpreted by nuclear cardiologists. The increased use of hybrid SPECT/CT for attenuation correction gives rise to the issue of reviewing and interpreting these CT images during cardiac MPI. Since these low-dose, low-resolution CTs are considered “non-diagnostic”, they are not routinely and readily reviewed by cardiologists.^{8,11-14} A review of incidental findings of cardiac CT by Earls¹⁵ suggested that all cardiac CTs should be reconstructed in the maximal field of view available and images should be reviewed adequately to detect pathological findings. This led to an important discussion regarding the role of cardiologists and radiologists in this issue.¹⁶ At this time, there are no uniform or consensus recommendations of reporting incidental findings during cardiac CT imaging. They ranged from no recommendations,¹¹ optional reporting,¹² recommended reporting,¹³ to mandatory reporting.¹⁴

This report described, for the first time, a case of incidental detection of inadvertent placement of the pacing lead in the LV by low resolution CT used during cardiac MPI. It highlighted the importance of reviewing low-resolution CT imaging during cardiac MPI to detect findings of clinical significance, such as the detection of inadvertent pacing lead placement in the LV. Special attention should be given for device implantation in patients, particularly with known history of PFO to avoid inadvertent lead placement in the LV through PFO.

ACKNOWLEDGEMENT

The author thanks Johannes Heyns, M.D., Department of Radiology, for his expert guidance and assistance for Figure 3.

REFERENCES

- 1 Stillman MT, Richards AM. Perforation of the interventricular septum by transvenous pacemaker catheter. Diagnosis by changes in pattern of depolarization on the electrocardiogram. *Am J Cardiol* 1969; 24(2):269-273. PMID: 5799087.
- 2 Wynn GJ, Weston C, Cooper RJ, Somauroo JD. Inadvertent left ventricular pacing through a patent foramen ovale: Identification, management and implications for postpacemaker implantation checks. *BMJ Case Rep* 2013; pii: bcr2012008312.
- 3 Bodian M, Aw F, Bamba MN, et al. Sinus venosus atrial septal defect: A rare cause of misplacement of pacemaker leads. *Int Med Case Reports J* 2013; 6:29-32. PMID: 23847433.
- 4 Mazzetti H, Dussaut A, Tentori C, Dussaut E, Lazzari JO. Trans-arterial permanent pacing of the left ventricle. *Pacing Clin Electrophysiol* 1990; 13(5):588-592. PMID: 1693195.
- 5 Trohman RG, Sharma PS. Detecting and managing device leads inadvertently placed in the left ventricle. *Cleve Clin J Med* 2018; 85(1):69-75. PMID: 29328900.
- 6 Schulze MR, Ostermaier R, Franke, Y, Matschke K, Braun MU, Straszer RH. Images in cardiovascular medicine. Aortic endocarditis caused by inadvertent left ventricular pacemaker lead placement. *Circulation* 2005; 112(25):e361-e363. PMID: 16365199.

⁷ Hendel RC, Berman DS, Di Carli MF, et al. ACCF/ASNC/ACR/AHA/ASE/SCCT/SCMR/ SNM 2009 Appropriate use criteria for cardiac radio-nuclide imaging: A report of the American College of Cardiology Foundation Appropriate Use Criteria Task Force, the American Society of Nuclear Cardiology, the American College of Radiology, the American Heart Association, the American Society of Echocardiography, the Society of Cardiovascular Computed Tomography, the Society for Cardiovascular Magnetic Resonance, and the Society of Nuclear Medicine. *Circulation* 2009; 119(22):e561-e587. PMID: 19451357.

⁸ Hendel RC, Corbett JR, Cullom SJ, DePuey EG, Garcia EV, Bateman TM. The value and practice of attenuation correction for myocardial perfusion SPECT Imaging: A joint position statement from the American Society of Nuclear Cardiology and the Society of Nuclear Medicine. *J Nucl Cardiol* 2002; 9(1):135-143. PMID: 11845140.

⁹ Osman MM, Cohade C, Fishman EK, Wahl RL. Clinically significant incidental findings on the unenhanced CT portion of PET/CT studies: Frequency in 250 patients. *J Nucl Med* 2005; 46(8):1352-1355. PMID: 16085594.

¹⁰ Goetze S, Pannu HK, Wahl RL. Clinically significant abnormal findings on the "nondiagnostic" CT portion of low-amperage-CT attenuation-corrected myocardial perfusion SPECT/CT studies. *J Nucl Med* 2006; 47(8):1312-1318. PMID: 16883011.

¹¹ Dorbala S, Ananthasubramaniam K, Armstrong IS, et al. Single photon emission computed tomography (SPECT) myocardial perfusion imaging guidelines: Instrumentation, acquisition, processing and interpretation. *J Nucl Cardiol* 2018; 25(5):1784-1846. PMID: 29802599.

¹² Tilkermeier PL, Bourque J, Doukky R, Sanghani R, Weinberg RL. ASNC imaging guidelines for nuclear cardiology procedures: Standardized reporting of nuclear cardiology procedures. *J Nucl Cardiol* 2017; 24(6):2064-2128. PMID: 28916938.

¹³ Dorbala S, Di Carli MF, Delbeke D, et al. SNMMI/ASNC/SCCT guideline for cardiac SPECT/CT and PET/CT 1.0. *J Nucl Med* 2013; 54(8):1485-1507. PMID: 23781013.

¹⁴ Dilsizian V, Bacharach SL, Beanlands RS, et al. ASNC imaging guidelines/SNMMI procedure standard for positron emission tomography (PET) nuclear cardiology procedures. *J Nucl Cardiol* 2016; 23(5):1187-1226. PMID: 27392702.

¹⁵ Earls JP. The pros and cons of searching for extracardiac findings at cardiac CT: Studies should be reconstructed in the maximal field of view and adequately reviewed to detect pathologic findings. *Radiol* 2011; 261(2):342-346. PMID: 22012900.

¹⁶ Douglas PS, Cerqueria M, Rubin GD, Chin AS. Extracardiac findings: What is a cardiologist to do? *JACC Cardiovasc Imaging* 2008; 1(5):682-687. PMID: 19356500.

Keywords: cardiac pacing artificial, incidental findings, cardiac myocardial perfusion imaging, SPECT CT