

Intraoperative Transesophageal Echocardiography: A Complement to 18F-Fluorodeoxyglucose Positron Emission Tomography-Computed Tomography in Localizing Pacemaker Lead Endocarditis

Abstract

Lead endocarditis (LE) is a serious complication of permanent trans-venous pacing. Localizing LE may be challenging with conventional imaging modalities. 2-deoxy-2-[fluorine-18] fluoro-D-glucose positron emission tomography-computed tomography (FDG PET/CT) has recently emerged as a promising tool in the diagnosis of LE particularly in cases with normal echocardiographic imaging findings and/or negative blood culture. However, this technique is associated with some drawbacks. Knowledge of these drawbacks and correlating its limitations with other imaging modality is essential for the echocardiographer while evaluating such patient. We report a case where transesophageal echocardiography was complementary to FDG PET/CT in the diagnosis and localization of vegetation over pacemaker leads during intraoperative period.

Keywords: 18F-fluorodeoxyglucose positron emission tomography-computed tomography, lead endocarditis, transesophageal echocardiography

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Introduction

Lead endocarditis (LE) is a serious complication of permanent trans-venous pacing. The diagnosis is often delayed or even missed due to obscure symptoms and clinical course. Localizing the infection in LE may be challenging with conventional imaging modalities.^[1] 18F-fluorodeoxyglucose positron emission tomography-computed tomography (FDG PET/CT) has recently emerged as a promising tool in the diagnosis of LE, even in patients with normal echocardiographic findings, negative blood culture, or both.^[2] The knowledge of shortcomings in FDG PET-CT imaging and correlating its findings with clinical and other imaging modalities is essential for the echocardiographer while evaluating such patient.

We report the FDG PET CT and intraoperative transesophageal echocardiography (TEE) findings in a patient with pacemaker lead endocarditis where intraoperative TEE was instrumental in localizing the vegetation.

Case Report

A 64-year-old male with an insitu pacemaker needed for sick sinus syndrome for 8 years

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was presented to our institution with persistent fever for 2 months. He had been re-implanted with a dual chamber cardiac pacemaker 6 months ago on the opposite infraclavicular region, following erosion and pus discharge from previous implant site. His blood investigation showed total leucocyte count 4000/dl and platelet count 85,000/dl. Blood and urine culture showed growth of *Pseudomonas aeruginosa*, which was treated with appropriate intravenous antibiotics based on sensitivity report (amikacin and piperacillin-tazobactam) for 14 days. Ultrasonography examination of thorax showed a 5 mm fluid filled area along the lead in the left infraclavicular region. Transthoracic echo reported both leads *in situ* and left ventricular ejection fraction of 55-60%. The 18F-FDG PET/CT study showed increased focal tracer uptake along the pacemaker lead in the right atrium suggesting localized infection in the right atrium [Figure 1]. He was planned for surgical removal of the pacemaker and infected lead followed by epicardial pacemaker insertion via median sternotomy under cardiopulmonary bypass (CPB).

In the operating room after instituting standard monitors and invasive radial artery

How to cite this article: Sarkar S, Ganesan R, Kumar B, Singh H, Basher R, Sood A. Intraoperative transesophageal echocardiography: A complement to 18F-fluorodeoxyglucose positron emission tomography-computed tomography in localizing pacemaker lead endocarditis. *Ann Card Anaesth* 2020;23:524-7.

Submitted: 21-Jan-2019

Accepted: 23-Apr-2019

Published: 19-Oct-2020

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DOI: 10.4103/aca.ACA_9_19

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monitoring, anesthesia was induced using intravenous administration of fentanyl, titrated doses of propofol. Injection vecuronium was used to achieve muscle relaxation. Tracheal intubation was achieved using flexible fiberoptic bronchoscope in view of limited neck mobility. Pre CPB, TEE confirmed pacemaker leads in the right atrium and right ventricle, with no extraneous mass in either of the chambers, normal valves and biventricular function [Figure 2]. Detailed TEE examination in the modified ascending aortic short axis view and modified bicaval view showed an irregular echogenic mass (0.6 cm) around the lead in the superior vena cava (SVC). The SVC was narrowed (maximum diameter 1.4 cm). Colour flow Doppler examination showed turbulent flow pattern and continuous wave Doppler demonstrated increased flow velocity in the SVC [Figure 3a and b; Videos 1 and 2].

The surgery proceeded with exploration of bilateral infraclavicular pacemaker pockets followed by midline sternotomy and placement of temporary epicardial pacing lead. An attempt to cannulate the SVC high up above the lesion for institution of CPB failed. Innominate vein and right subclavian vein were also of inadequate size for cannulation due to severe adhesions. The CPB was instituted with inferior vena cava cannulation and using sucker bypass for SVC return after right atriotomy. Surgery was accomplished using on CPB and beating heart technique. The pacemaker leads were removed from the right atrium. Vegetation was found attached to the pacemaker lead in the SVC, which was removed in piecemeal using traction on the lead. The SVC cannulation could be accomplished only after the removal of leads and vegetation. Pericardial patch augmentation of the SVC was done [Figure 4a and b]. Total CPB time was 244 minutes.

Termination of CPB was done using combination of epinephrine and norepinephrine. Total urine output during intra operative period was 1300 ml, without any obvious feature of hemolysis. In the postoperative period patient developed vasoplegic syndrome and sepsis. He succumbed to the resulting multiple organ dysfunction syndrome on the 3rd post-operative day.

Discussion

Infective endocarditis due to pacemaker lead infection is a high-risk factor for mortality and morbidity. The incidence of pacemaker-related infections varies from 0.13% to 19.9%.^[1-3] While *Staphylococcus* species (*Staphylococcus aureus* and *Staphylococcus epidermidis*) account for the majority of infections, *Pseudomonas aeruginosa*, other gram-negative bacilli, *Enterococcus faecalis*, *Candida*-species have also been reported. TEE is found to be superior (sensitivity 94%) to transthoracic echocardiography (sensitivity 23%) in its diagnosis.^[4]

FDG PET/CT is a dual imaging modality, uses the CT to interpret the PET findings. The PET component

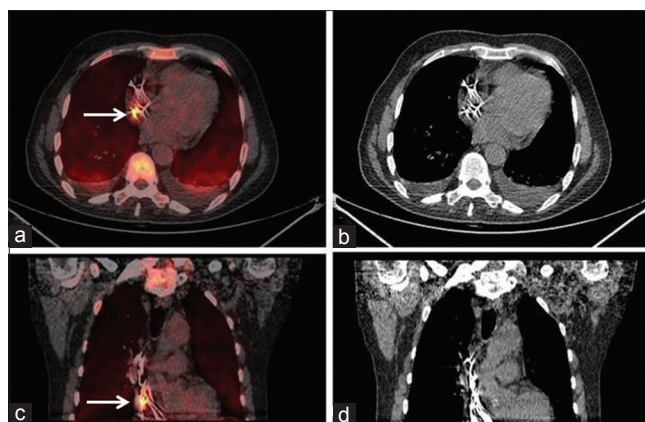


Figure 1: Focal tracer uptake (SUV max 8.7) in the pacemaker lead in the right atrium (white arrow) as shown in trans axial fused PET/CT (a) and CT (b) and corresponding coronal fused PET/CT (c) and (d) CT images, suggestive of active infection in the right atrium

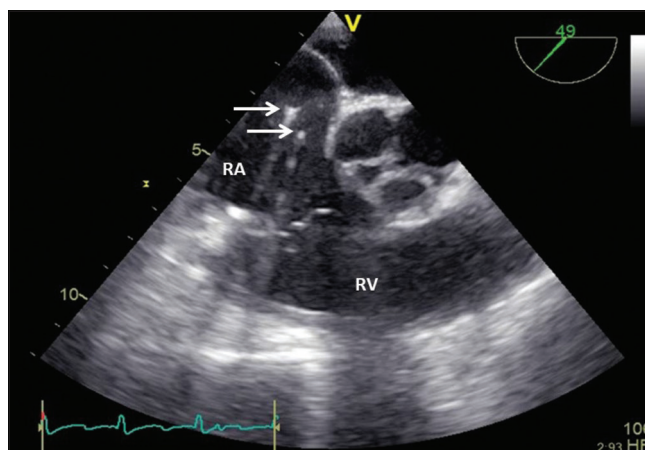


Figure 2: Mid esophageal aortic short axis view showing pacemaker leads in right atrium with no vegetation

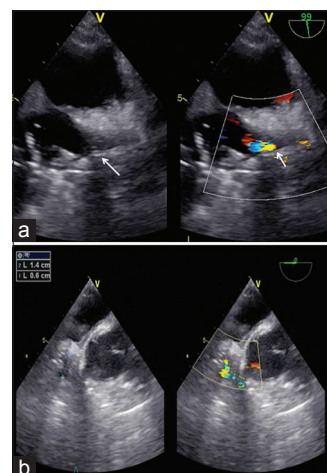


Figure 3: (a) Mid esophageal bicaval view showing thrombus and turbulent flow on colour Doppler in the superior vena cava. (b) Upper esophageal ascending aortic short axis view showing thrombus and turbulent flow in the superior vena cava

gives us functional information and the CT, anatomical data.^[5] The ability of FDG PET/CT to actively incorporate

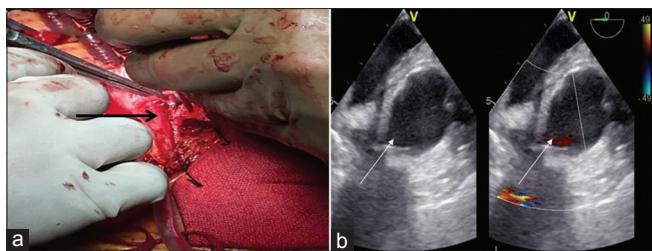


Figure 4: Patch augmentation of superior vena cava (a) Upper esophageal ascending aortic short axis view after removal of vegetations, showing superior vena cava free of echogenic mass (b)

activated leukocytes, macrophages, and CD4 - positive T cells present at the sites of infection makes it a useful diagnostic tool in a suspected case of LE.^[6] It is useful in detecting LE located on both intracardiac and extracardiac portions of the leads and may be highly beneficial when vegetations are not detected on TEE.^[7] The European Society of Cardiology guidelines (2015), has included FDG PET/CT in the major diagnostic criteria for the diagnosis of prosthetic valve endocarditis and also in the diagnostic algorithm for the detection of embolic events for both native valve and prosthetic valve endocarditis.^[8] It has been shown to be more useful in the diagnosis of skin and pocket infection than the lead or device-related infective endocarditis.^[9]

Impact of previous antimicrobial therapy on the accuracy of FDG PET/CT in identifying lead endocarditis is debatable. Granados *et al.* found no significant difference between false negative and true-positive cases with antibiotic therapy.^[10] However, usually on the clinical suspicion of IE, antimicrobial treatment is started before 18F-FDG PET/CT imaging. This may reduce inflammation and resulting poor FDG up-take, finally leading to about 80% false-negative results.^[10]

Misregistration artefact is another unique challenge in FDG PET/CT scanning due to difference in breathing pattern during CT and PET acquisition periods. CT thorax examination is usually performed during breath-hold; however, PET images are captured during tidal breathing, and this can contribute significantly to misregistration of vegetation foci on fused FDG PET/CT images.^[11] The metal implants in the body causes streak artefacts on CT imaging and degrades image quality. When CT images are used for attenuation correction, the presence of metal produces over attenuation of PET activity in that region and may result in erroneous hot spots.^[12]

TEE is more sensitive (73%) than FDG-PET/CT (63%) for identification of cardiac device-related infective endocarditis,^[13] both of them provide complementary diagnostic information and have their own benefits and limitations. TEE, is an invasive procedure, provides real-time feedback of interventions. It is devoid of radiation exposure and more economical (INR 100/- vs INR 3000/- at PGIMER, Chandigarh). On the contrary, despite of high

spatial resolution, the success of FDG PET/CT depends upon optimization, patient preparation and scan acquisition.

However, when FDG-PET/CT is used synergistically with TEE, the sensitivity of detecting LE increases significantly.^[14] In the index case FDG PET/CT study showed increased focal tracer uptake along the pacemaker lead in the right atrium suggesting localized infection in the right atrium. TEE was instrumental in detecting vegetation in the SVC and resulting anatomic narrowing of its lumen. The misregistration and streak artefacts may be the probable causes of faulty localization of infective foci by FDG PET/CT in our case.

Conclusion

TEE may be complementary to FDG PET/CT for the diagnosis and localization vegetation over pacemaker leads. In addition, pre-operative TEE may help in anticipation of difficulty in SVC cannulation and devising an alternative approach.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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