

Imaging with ^{18}F -FDG-PET in infective endocarditis: promising role in difficult diagnosis and treatment monitoring

Siamak Moghadam-Kia¹,
 Asad Nawaz¹,
 B. Cherie Millar²,
 John E. Moore²,
 Susan E Wieggers³,
 Drew A. Torigian¹,
 Sandip Basu¹,
 Abass Alavi¹,

1. Department of Radiology,
 Hospital of the University of
 Pennsylvania, School of
 Medicine, Philadelphia, PA, USA.

2. Northern Ireland Public
 Health Laboratory, Department
 of Bacteriology, Belfast City
 Hospital, Lisburn Road, Belfast,
 BT9 7AD, Northern Ireland, UK.

3. Division of Cardiovascular
 Medicine, Hospital of the
 University of Pennsylvania,
 School of Medicine,
 Philadelphia, PA, USA.

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Correspondence address:

Abass Alavi, MD, PhD (Hon),
 DSc (Hon)
 Division of Nuclear Medicine,
 Department of Radiology,
 Hospital of the University
 of Pennsylvania,
 110 Donner Building,
 3400 Spruce Street,
 Philadelphia, PA 19104, USA
 Email: abass.alavi@uphs.upenn.edu

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Abstract

Echocardiography (EC) plays a major role in diagnosing and monitoring the therapeutic response in infective endocarditis (IE) in routine practice. However in the setting of prosthetic valves or indwelling pacemakers, the EC findings are equivocal necessitating search for other diagnostic modalities. In these patients, ^{18}F -FDG/PET imaging may prove invaluable as evidenced by the presented case. We herein report a case of an 82 years old male with a mechanical aortic valve prosthesis who presented with a 10 days history of fever and malaise. Optimal interpretation of the EC results was difficult due to the presence of the prosthetic valve. However, ^{18}F -FDG-PET imaging findings were quite distinctive and revealed abnormally increased metabolic activity represented by two foci of increased ^{18}F -FDG uptake in the right and left borders of the heart that corresponded to areas of IE.

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Introduction

In the recent years, the medical community has witnessed a promising and revolutionary role for fluorine-18-fluorodeoxyglucose-positron emission tomography (^{18}F -FDG-PET) imaging in the diagnosis and management of a multitude of infectious and inflammatory disorders [1-3].

In this report, we highlight this novel role for ^{18}F -FDG-PET imaging in the diagnosis of infective endocarditis (IE), which presents a significant diagnostic challenge to the attending physicians.

Case report

An 82 years old male, with a mechanical aortic valve prosthesis presented with a 10 days history of fever and malaise. In the first two days of fever, 3 out of 4 blood cultures were positive for streptococci *viridans*, and all subsequent blood cultures were negative. Trans-thoracic and trans-esophageal EC were performed using a standard protocol. Findings on the trans-esophageal EC were suspicious for prosthetic aortic valve endocarditis including mild aortic regurgitation and new aortic leaflet thickening with a more discrete 5mm area of thickening at the tip of the leaflet seen in systole. Two weeks later, a repeat trans-thoracic EC suggested a clinical diagnosis of possible aortic valve IE with a worsening diastolic murmur. Slight worsening of aortic regurgitation was noted without any clear vegetations (Fig. 1). One day later, the patient presented with leg pain and weakness and underwent ^{18}F -FDG-PET imaging as a part of the work-up to assess for potential spinal discitis, osteomyelitis, and/or abscess. ^{18}F -FDG-PET revealed abnormally increased ^{18}F -FDG uptake in the inferior endplate of the L3 vertebra and in the superior endplate of the L4 vertebra with a maximum standardized uptake value (SUVmax) of 2.8, in keeping with spinal discitis/osteomyelitis (Fig. 2). In addition, abnormally increased metabolic activity represented by two foci of increased ^{18}F -FDG uptake were detected along the right lateral wall of the right atrium and in the region of the left atrial appendage or pulmonary outflow tract, that was consistent with inflammatory activity of IE. No findings of thrombus were seen on EC in these locations. Following administration of antibiotic treatment by penicillin G, 3 million units every 4h for 4 weeks and gentamycin 60mg i.v. every 12h for 4 weeks, the patient's clinical status improved, and ultimately the patient had an uneventful recovery.

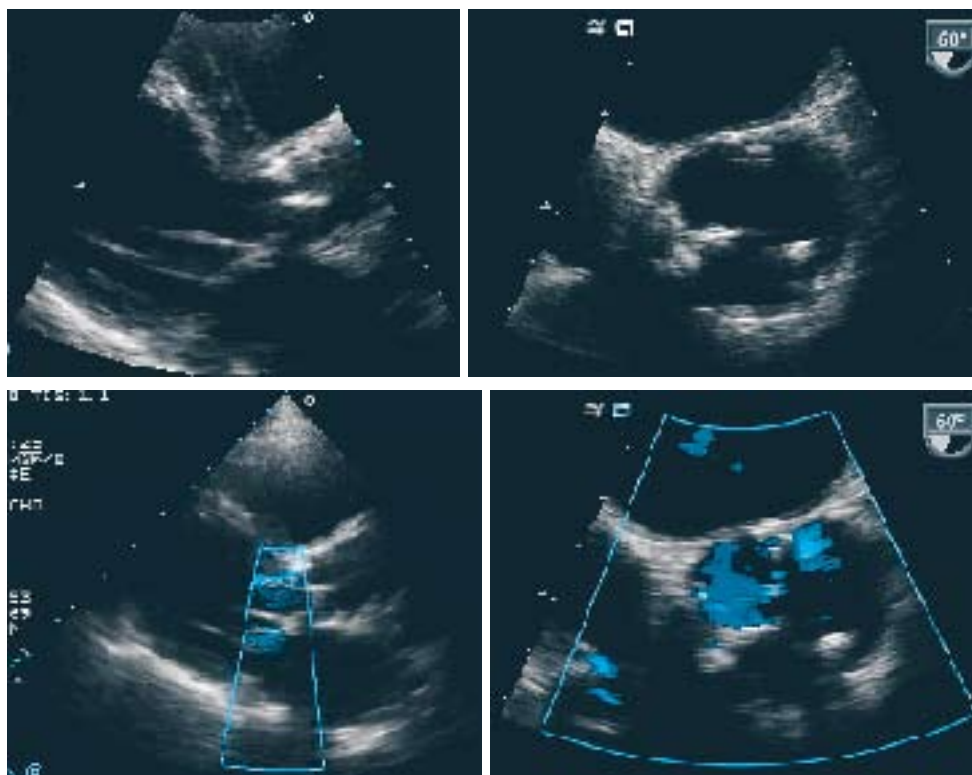


Figure 1. Echocardiography videos demonstrating slight worsening of aortic regurgitation. Optimal interpretation of echocardiographic results was difficult due to presence of prosthetic valve, and no clear vegetation was visualized.

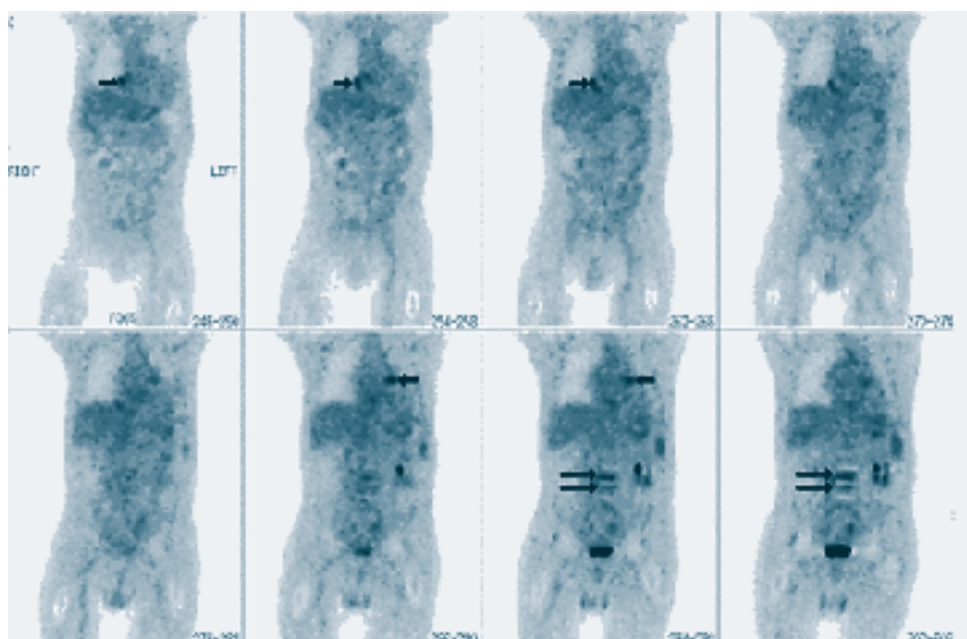


Figure 2. Coronal ¹⁸F-FDG-PET images showing abnormally increased ¹⁸F-FDG uptake in inferior endplate of L3 vertebra and in superior endplate of L4 vertebra (long arrows) with SUVmax of 2.8, in keeping with spinal discitis/osteomyelitis. In addition, abnormally increased metabolic activity represented by two foci of increased ¹⁸F-FDG uptake were detected in right and left borders of the heart (short arrows) consistent with infective endocarditis. The rest of the whole body survey was within normal limits.

Discussion

Infective endocarditis represents a serious infection and is associated with increased morbidity and mortality. EC has made important advances in the diagnosis of this entity [4-8], although at times EC fails to identify vegetations on heart valves, leading to delay in the clinical diagnosis. In certain clinical settings like in the presence of prosthetic valves, EC images may be difficult to interpret due to increased echogenicity and posterior acoustic shadowing of the prosthetic material [9]. Furthermore, vegetations revealed by EC may not neces-

sarily be actively infected [7]. Anatomical imaging in general has had limited success in the assessment of patients with infective endocarditis and endarteritis [10-11]. Conventional scintigraphic procedures have not gained acceptance in this setting due to limitations in spatial resolution and the time-consuming nature of these procedures.

Recent years have witnessed increasing evidence for the clinical utility of ¹⁸F-FDG-PET in the assessment of patients with a multitude of infectious and non-infectious inflamma-

tory disorders [1, 2]. Overexpression of glucose transporters in the cell membranes of stimulated macrophages, neutrophils, and lymphocytes is considered the most likely underlying molecular mechanism responsible for ^{18}F -FDG uptake in inflammatory cells [12, 13]. Infective endocarditis involves the endocardial surface of the heart and is usually characterized by vegetations that are composed of platelets, fibrins, microorganisms, and inflammatory cells. The current literature on the role of ^{18}F -FDG-PET imaging in the diagnosis of IE is limited, but one study by Yen et al. (2004) has shown that ^{18}F -FDG-PET can diagnose IE confirmed by positive blood cultures [14]. In addition, the potential utility of ^{18}F -FDG-PET in the diagnosis of IE has been shown in patients with normal EC imaging findings [15], small vegetations, prosthetic valves, or indwelling pacemakers [16]. In our patient with mechanical aortic valve prosthesis, no clear vegetations were identified on EC because of the intense echoes generated by the prosthesis. However, we identified two foci of increased ^{18}F -FDG uptake in the heart that were consistent with IE, as well as an associated source of lumbar spine discitis/osteomyelitis.

Microbiological diagnostic workup of IE includes microscopy, blood culture, serologic, and molecular biologic analyses. There are occasions, however, when false negative results for the diagnosis of IE occur with a microbiological approach [17]. Microbiological findings and EC may sometimes fail to provide a certain diagnosis of IE, as was the case at first in our patient. On such difficult situations, when there is a high clinical suspicion for IE despite negative EC and microbiological results, ^{18}F -FDG-PET or ^{18}F -FDG-PET/CT can potentially help to make the diagnosis [18]. We believe that further research regarding the complementary role of ^{18}F -FDG-PET and ^{18}F -FDG-PET/CT for the non-invasive quantitative imaging for assessment of patients with suspected IE should be performed prospectively in the future, as this approach has the potential to improve the diagnosis and management of patients with this serious medical condition.

Bibliography

- Zhuang H, You JQ, Alavi A. Applications of fluorodeoxyglucose-PET imaging in the detection of infection and inflammation and other benign disorders. *Radiol Clin North Am* 2005; 43: 121-134.
- Zhuang H, Alavi A. 18-fluorodeoxyglucose positron emission tomographic imaging in the detection and monitoring of infection and inflammation. *Semin Nucl Med* 2002; 32: 47-59.
- Spyridonidis T, Markou P. Current trends in infection imaging. *Hell J Nucl Med* 2005; 8: 12-18.
- Mylonakis E, Calderwood SB. Infective endocarditis in adults. *N Engl J Med* 2001; 345: 1318-1330.
- Dillon JC, Feigenbaum H, Konecke LL et al. Echocardiographic manifestations of valvular vegetations. *Am Heart J* 1973; 86: 698-704.
- Yvorchuk KJ, Chan KL. Application of transthoracic and transesophageal echocardiography in the diagnosis and management of infective endocarditis. *J Am Soc Echocardiogr* 1994; 7: 294-308.
- Mathew J, Anand A, Addai T, Freels S. Value of echocardiographic findings in predicting cardiovascular complications in infective endocarditis. *Angiology* 2001; 52: 801-809.
- Sachdev M, Peterson GE, Jollis JG. Imaging techniques for diagnosis of infective endocarditis. *Infect Dis Clin N Am* 2002; 16: 319-337.
- Cowgill LD, Addonizio VP, Hopeman AR, Harken AH. A practical approach to prosthetic valve endocarditis. *Ann Thorac Surg* 1987; 43: 450-457.
- Cowan JC, Patrick D, Reid DS. Aortic root abscess complicating bacterial endocarditis demonstration by computed tomography. *Br Heart J* 1984; 52: 591-593.
- Jeang MK, Fuentes F, Gately A et al. Aortic root abscess. Initial experience using magnetic resonance imaging. *Chest* 1986; 89: 613-615.
- Fu Y, Maianu L, Melbert BR, Garvey WT. Facilitative glucose transporter gene expression in human lymphocytes, monocytes, and macrophages: a role for GLUT isoforms 1, 3, and 5 in the immune response and foam cell formation. *Blood Cells Mol Dis* 2004; 32: 182-190.
- Zhao S, Kuge Y, Tsukamoto E et al. Fluorodeoxyglucose uptake and glucose transporter expression in experimental inflammatory lesions and malignant tumours: effects of insulin and glucose loading. *Nucl Med Commun* 2002. 23: 545-550.
- Yen RF, Chen YC, Wu YW et al. Using 18-fluoro-2-deoxyglucose positron emission tomography in detecting infective endocarditis/endarteritis: a preliminary report. *Acad Radiol* 2004; 11: 316-321.
- Obermeier F, Herold T, Schönberger J et al. Vasculitis of the aortic arch and cardiac valves as the cause of relapsing fever of unknown origin in an elderly, white man. *Clin Rheumatol* 2006; 25: 923-925.
- Vos FJ, Bleeker-Rovers CP, van Dijk AP, Oyen WJ. Detection of pacemaker and lead infection with FDG-PET. *Eur J Nucl Med Mol Imaging* 2006; 33: 1245.
- Dumarey N, Egrise D, Blocklet D et al. Imaging infection with ^{18}F -FDG-labeled leukocyte PET/CT: initial experience in 21 patients. *J Nucl Med* 2006; 47: 625-632.
- Millar BC, Prendergast BD, Alavi A, Moore JE. Positron Emission Tomography (PET): a new tool in the diagnosis of endocarditis? *Heart* 2009; 95: 332-333.

