18-Fluoro-2-deoxyglucose positron emission tomography–computed tomography: an additional tool in the diagnosis of prosthetic valve endocarditis☆

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SUMMARY

Objectives: To evaluate the role of 18-fluoro-2-deoxyglucose positron emission tomography–computed tomography (^{18}F-FDG-PET–CT) in the diagnosis of infectious endocarditis (IE).
Methods: We retrospectively examined 27 consecutive patients who were admitted to the Infectious Diseases Department of Tor Vergata University Hospital between 2009 and 2013 with a suspicion of IE. The final IE diagnosis was defined according to the modified Duke criteria, and the microbiological and diagnostic results were collected for each patient.
Results: Twenty out of 27 patients had a suspected prosthetic valve endocarditis (PVE) and seven had a suspected native valve endocarditis (NVE). Twenty-five out of 27 patients (92%) had a confirmed diagnosis of IE (18/25 PVE and 7/25 NVE); 16 had a positive echocardiography evaluation and 16 had positive ^{18}F-FDG-PET–CT findings. Echocardiography showed a higher sensitivity as a diagnostic tool for the detection of IE compared to ^{18}F-FDG-PET–CT (80% vs. 55%). However, a greater number of PVE had positive ^{18}F-FDG-PET–CT results compared to those with positive echocardiography findings (11/13 vs. 9/13), and overall 89% (16/18) of confirmed PVE resulted ^{18}F-FDG-PET–CT positive. Analyzing only the cases who underwent transoesophageal echocardiography, ^{18}F-FDG-PET–CT showed a sensitivity of 85% in PVE (vs. 69% for echocardiography and 77% for the Duke criteria). All seven patients with NVE had a positive echocardiography and negative ^{18}F-FDG-PET–CT findings ($p < 0.001$).
Conclusions: The results of this study further highlight the limitations of echocardiography in the diagnosis of PVE and the potential advantages of ^{18}F-FDG-PET–CT in these cases.

1. Introduction

Infective endocarditis (IE) continues to be an important medical issue. The incidence of IE ranges from 3 to 10 episodes/100 000 person-years, and the risk of developing IE increases dramatically with age (14.5 episodes/100 000 person-years for patients aged 70–80 years).[1,2] Over the past 30 years, neither the incidence nor the associated mortality has decreased, despite major advances in both diagnostic and therapeutic procedures. New predisposing factors have been identified, such as valve prostheses, degenerative valve sclerosis, and intravenous drug abuse.[1]

Prosthetic valve endocarditis (PVE) represents an extremely serious medical condition with a potentially deleterious outcome. PVE accounts for 10–30% of all cases of IE and occurs in 1–6% of patients with valve prostheses, with an incidence of 0.3–1.2% per patient/year.[2] A definitive IE diagnosis is based on the revised Duke criteria[3] and is generally more difficult for prosthetic than native valves,[4] as transthoracic echocardiography (TTE) has limited diagnostic power on prosthetic valves. Transoesophageal echocardiography (TEE) is essential in patients suspected for PVE,

otherwise both TTE and TEE are limited by their dependence on the individual patient's morphology, instrumental settings, transducer position, operator, and artefacts from heavy valve calcifications and metallic prosthetic valves through acoustic shadowing. Therefore, if an initial echocardiography is negative, repeated TEE examinations are recommended in cases of clinical suspicion.[5,6] The question of whether performing TTE prior to TEE is necessary in the evaluation of suspected prosthetic valve vegetations is a difficult one. Guidelines provided by the American Heart Association, American College of Cardiology, and American Society of Echocardiography in 2003,[7] stated that sequential examinations starting with TTE is the preferred approach given the essential information on cardiac function and haemodynamics provided by TTE. However, particularly in the case of PVE, protocols in which TTE is ordered first may subject patients to unnecessary delays in diagnosis as well as increased overall costs, and also the results of this test are more frequently negative for PVE.[8]

18-Fluoro-2-deoxyglucose positron emission tomography–computed tomography (^{18}F-FDG-PET–CT) (fluorodeoxyglucose labelled with fluorine-18) is a well-recognized imaging tool that is most often used in oncology, but also in infectious diseases, vasculitis, cardiology, and neurology disorders;[9–12] increased levels of glucose are detected in granulocytes and monocytes. Emerging data suggest a role for ^{18}F-FDG-PET–CT in the diagnosis of endocarditis and endovascular graft and pacing system infections when conventional diagnostic tools have failed.[13–16]

The aim of this study was to evaluate the diagnostic efficacy of ^{18}F-FDG-PET–CT in native valve endocarditis (NVE) and PVE in a group of patients referred to our department with a suspicion of IE during the period 2008–2013.

2. Methods

2.1. Patients

Between January 2008 and October 2013, 27 consecutive patients were admitted to the Infectious Disease Department with a suspicion of IE. On admission, the evaluation of possible and definite IE cases was based on the clinical and/or pathological modified Duke criteria.[3] The final IE diagnosis was defined according to the modified Duke criteria and the microbiological and diagnostic results collected from each patient. The assessment of individual cases on the basis of the above criteria allowed us to confirm or reject the diagnosis of IE.

All of the patients underwent physical examinations, laboratory investigations, culture tests, and additional diagnostic procedures, including chest X-ray, abdominal ultrasound, and TTE. As a result of technical problems, intolerance, or patient refusal, TEE examination was limited to only 11 patients. All of the accepted patients underwent ^{18}F-FDG-PET–CT at admission, a median of 4 days (range 3–8 days) after the start of antibiotic therapy. ^{18}F-FDG-PET–CT was

used as an additional tool to confirm the diagnosis of IE, to evaluate peri-valve extensions and early peripheral embolisms, or to rule out other infectious foci, and was never used alone to assess the clinical management of the patients.

Late PVE was defined as an infection that presented at >12 months after heart surgery, and early PVE as an infection that presented at <12 months after surgery.

Demographic, clinical, microbiological, and treatment data were collected retrospectively. The ethics committee of Tor Vergata University Hospital approved this study.

2.2. ^{18}F-FDG-PET–CT

All patients underwent ^{18}F-FDG-PET–CT in the resting state after eating a meal rich in fat and low in carbohydrates to reduce the physiological uptake of FDG in the myocardium.[17] The test was performed after a 6-h fasting period. Glycaemia was determined to be ≤120 mg/dl at the time of the study. One hour after the intravenous injection of 4 MBq/kg ^{18}F-FDG, a low-dose whole-body CT scan from the mid-thigh to the vertex was acquired using a Discovery VCT PET/CT (GE Healthcare, Milwaukee, WI, USA). Once the CT imaging was completed, PET acquisition was performed in the three-dimensional mode, and the data were reconstructed using the iterative method (algorithm OSEM); the CT data were used for attenuation correction.

2.3. Interpretation of ^{18}F-FDG-PET–CT

The cardiac images were interpreted independently by two nuclear medicine physicians who were blinded to the clinical data and other imaging studies. In two cases where the two physicians disagreed on a diagnosis, consensus was reached via a third physician. In patients with suspected NVE, any increase in FDG uptake in or around the heart valves outside the myocardium was considered abnormal. In patients with suspected PVE, the analysis was performed on both the attenuation-corrected and non-attenuation-corrected images, and the presence of hotspots in the prosthetic and periprosthetic areas was considered abnormal (Figures 1 and 2).

2.4. Statistical analysis

This should be considered a retrospective and observational study. Continuous variables are expressed as the mean value. Categorical data are expressed as numbers with percentages. The sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) were calculated using the final diagnoses of confirmed NVE or PVE and the rejected NVE or PVE as the outcomes. The sensitivity, specificity, NPV, and PPV of the Duke criteria, echocardiography (TTE and TEE), and ^{18}F-FDG-PET–CT were calculated based on the final diagnosis of IE using SPSS
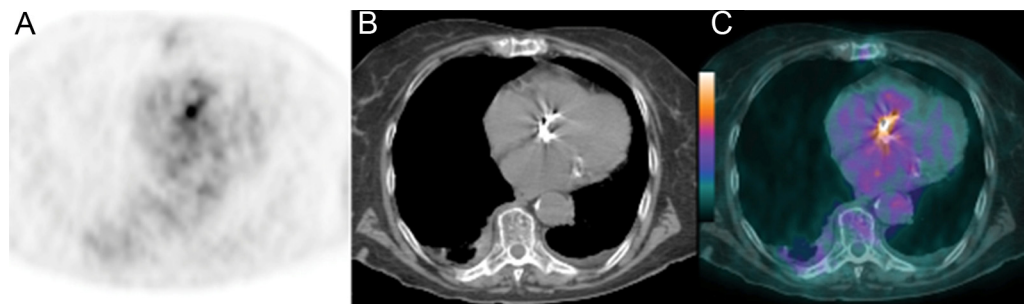

Figure 1. Transverse images from an 83-year-old woman with PVE: (A) ^{18}F-FDG-PET–CT; (B) CT; (C) integrated ^{18}F-FDG-PET–CT. High FDG uptake was observed at the level of the aortic prosthesis.