

Imaging Cardiac Sarcoidosis by Cardiac Positron Emission Tomography (PET): A Local Experience Using a High-Fat, Low-to-No Carbohydrate Protocol

Dear Editor,

A 40-year-old female presented acutely with syncope and recurrent ventricular tachycardia (VT) requiring repeated cardioversion. Transthoracic echocardiogram (TTE) revealed mildly depressed systolic function of 40% to 45% with normal right ventricular size and function. Coronary angiogram revealed insignificant coronary artery disease (CAD). Biopsy of enlarged mediastinal lymph nodes revealed evidence of non-necrotising granulomatous inflammation, with no evidence of tuberculosis or fungi.

To ascertain a diagnosis of cardiac sarcoidosis, an 18F-fluorodeoxyglucose positron emission tomography/computed tomography (18F-FDG PET/CT) study was performed under strict, non-fasting, high-fat, low-carbohydrate dietary modifications. The patient was instructed to consume 2 consecutive meals containing high fat and low-to-no-carbohydrate diet the evening prior to FDG PET/CT imaging, and on the morning of the scan. She was advised to have fatty unsweetened foods such as fried chicken, fried eggs or fried bacon, without bread or rice because these are sources of carbohydrates. She was also advised not to have beverages that contain milk or sugar. On the day of the scan, the patient was injected with 10-millicuries of 18F-FDG intravenously, followed by cardiac 18F-PET/CT imaging 60 minutes later.

18F-FDG PET/CT images were compared to myocardial perfusion imaging (MPI) study by single-photon emission computed tomography (SPECT). The cardiac 18F-FDG PET/CT study revealed markedly increased myocardial FDG uptake involving the mid to basal anterior and distal to basal anteroseptal walls that corresponded to segmental perfusion defects on MPI SPECT study, as well as focal FDG uptake in the right ventricle and distal to basal inferoseptum (Figs. 1a-c). The intense areas of diffuse uptake corresponded to near-transmural enhancement in the septum and anterior myocardium on cardiac magnetic resonance imaging (MRI) (Fig. 1d). The patient was treated with steroids and given an implantable cardio-defibrillator (ICD). Repeat 18F-FDG PET/CT study performed 6 months later demonstrated reductions in FDG uptake in the anterior, anteroseptal, right ventricle and inferoseptal walls, suggesting reduction in active disease activity in the myocardium (Fig. 1e).

On the other hand, a 54-year-old woman with biopsy-proven pulmonary sarcoidosis was evaluated for sarcoid involvement of the heart by the same 18F-FDG PET/CT imaging protocol and dietary instructions. While the whole body 18F-FDG PET/CT revealed multiple hypermetabolic mediastinal and bilateral hilar lymph nodes consistent with systemic sarcoidosis, there was absent myocardial FDG uptake on the 18F-FDG PET/CT scan, suggestive of the absence of cardiac sarcoid involvement (Fig. 2).

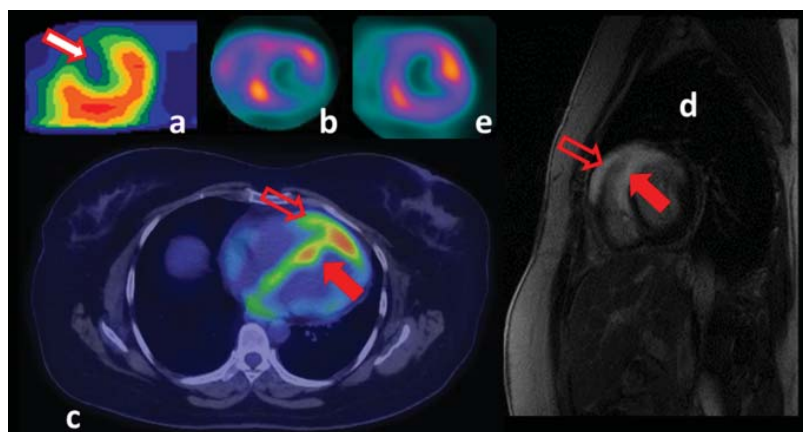


Fig. 1. 18F-FDG PET/CT scan images of 40-year-old patient. (A) Representative short-axis image of technetium-99m SPECT showing resting perfusion defect in the basal anteroseptum (arrow), with a corresponding mismatch on the (B) short-axis 18F-FDG PET/CT images, demonstrating FDG uptake in the anteroseptum, together with an area of abnormal uptake in the anterior and inferoseptum. Regions of the myocardium with normal perfusion in (A) (lateral and inferior walls) show no 18F-FDG uptake consistent with excellent suppression of myocardial glucose utilisation by the normal myocardium. (C) Axial fused 18F-FDG PET/CT image demonstrates intense focal FDG uptake in the interventricular septum (solid arrow) and right ventricle (empty arrow). (D) Late post gadolinium enhancement cardiac MRI image in short-axis acquisition showing myocardial thickening and near transmural enhancement in basal right (empty arrow) and left ventricular anterior walls as well as in septum (solid arrow). (E) Repeat short-axis 18F-FDG PET/CT study performed 6 months later demonstrating reductions in FDG uptake in the anterior, anteroseptal, right ventricle and inferoseptal walls, suggesting reduction in active disease activity in the myocardium.



Fig. 2. Representative axial fused 18F-FDG PET/CT scan image of a 54-year-old patient, demonstrating no myocardial FDG uptake (only blood pool activity, indicated by the arrow), consistent with excellent suppression of myocardial glucose utilisation by the normal myocardium with no evidence of cardiac sarcoidosis.

Discussion

At present, there is no standardised approach for the diagnosis of cardiac sarcoidosis. The diagnosis of cardiac sarcoidosis is often difficult to make with precision, and is largely corroborated by a host of several, sometimes non-specific findings, including cardiac conduction abnormalities and abnormal ventricular function or motion.^{1,2} While endomyocardial biopsy may provide added specificity, the technique is invasive and has poor sensitivity with limited clinical utility due to the patterns of patchy involvement. 18F-FDG PET/CT and cardiac MRI are currently used to aid in the diagnosis of cardiac sarcoidosis;^{3,4} both techniques have been shown to have improved sensitivity and specificity compared to other traditional nuclear imaging techniques such as Gallium-67 scintigraphy or technetium-99m pyrophosphate.⁵

Adoption of a non-fasting, high-fat, low-to-no carbohydrate diet protocol prior to 18F-FDG PET/CT in our local population appears feasible.⁶ Cardiac sarcoidosis clinical manifestations relate primarily to the location and inflammatory effects of the granulomas. Since normal myocytes utilise glucose as one of their main energy sources, techniques are required to suppress physiological 18F-FDG uptake in the myocardium. By shifting myocardial metabolism to fatty acid and suppressing glucose utilisation by normal myocardium, dietary modifications with a high-fat, low-carbohydrate diet have been shown to reduce glucose uptake by normal myocardium.⁷ In abnormal myocardium with inflammatory cell infiltrates as it is in the case of cardiac sarcoidosis, 18F-FDG accumulates in lesions where inflammatory cells utilise glucose as an energy source. These active inflammatory cardiac sarcoid lesions are identified by abnormal, focal-to-diffuse 18F-FDG uptake on PET/CT imaging, depending on different stages of the disease.⁴

The revised Japanese Ministry Guidelines are currently the official published diagnostic guide used by many practitioners as an aid to identify patients with cardiac sarcoid involvement.⁸ While neither 18F-FDG PET/CT nor cardiac MRI has been included in international guidelines, there is growing data to support the role of 18F-FDG PET/CT as a sensitive technique for the diagnosis of cardiac sarcoidosis.^{3,4,9} As shown in our first case, 18F-FDG PET/CT can both identify disease and demonstrate response to therapy through serial temporal changes.¹⁰

In this era of multimodality cardiovascular imaging, imaging cardiac sarcoidosis by 18F-FDG PET/CT adds to the armamentarium of tools, apart from echocardiography, traditional nuclear imaging techniques and cardiac MRI.^{11,12} Apart from accumulating data that support the role of 18F-FDG PET/CT as an accurate technique, 18F-FDG PET/CT has been shown to be equally, if not more sensitive, than delayed enhancement (DE) cardiac MRI in detecting cardiac sarcoidosis.³ Practically, 18F-FDG PET/CT can be used in patients in whom cardiac MRI is contraindicated, such as in patients with renal dysfunction or implanted metallic devices. The ability of 18F-FDG PET/CT to assess disease activity based on quantitative information and standardised uptake value (SUV) is also an advantage over cardiac MRI.⁵ Furthermore, in the early diagnostic phase, whole-body 18F-FDG PET/CT imaging enables clinicians to evaluate the extent of systemic disease beyond the myocardium thus improving overall diagnostic confidence.¹³ Besides, the combined use of FDG PET/CT with cardiac MRI may provide detection of active granulomatous inflammation (both FDG PET/CT and MRI DE positive) from purely fibrotic disease (FDG PET/CT negative, MRI DE positive),^{14,15} with resulting improvements in diagnostic accuracy and confidence.¹⁶

Conclusion

18F-FDG PET/CT appears to be a useful, non-invasive diagnostic imaging test for cardiac sarcoidosis. We were able to institute a dietary and imaging protocol that was instituted on ambulatory outpatients, with satisfactory clinical results.

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