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Clinical Research

Determining the Diagnostic Value of 18F-Fluorodeoxyglucose Positron Emission/Computed Tomography in Detecting Prosthetic Aortic Graft Infection

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Background: To determine the diagnostic value of 18F-fluorodeoxyglucose positron emission/computed tomography (FDG PET/CT) in detecting prosthetic aortic graft infection (AGI).
Methods: Twenty-one patients with prosthetic grafts for abdominal aortic aneurysms underwent FDG PET/CT scans for suspected graft infection over a 15-month period. Images were evaluated for tracer pattern and grade of FDG uptake in addition to measuring the maximal standardized uptake value (SUVmax). Two independent nuclear medicine physicians retrospectively evaluated all imaging. The images from a control group of patients with aortic grafts who underwent FDG PET/CT scans for onco-hematological indications were evaluated to establish radiological characteristics of asymptomatic grafts. Secondary parameters that are associated with graft infection such as components of the peripheral blood count were collected. Graft infection status was determined using microbiological outcomes following graft explantation or radiological drainage of perigraft collections and correlated with results of the FDG PET/CT scans to determine infective status.
Results: In the control group, the pattern of FDG uptake was homogenous and diffuse. The mean SUVmax was 3.5 (±1.3). Thirteen out of 21 grafts were confirmed as infected. Tracer uptake in infected grafts displayed an intense and focal pattern, with a median grade of uptake of 4 vs. 2 on a validated 4 point grading scale. The area under the receiver operating curve for FDG PET/CT in detecting infection was 0.85 (±0.15) $P = 0.01$. Sensitivity was 92%, specificity 63%, and positive and negative predictive values of 80% and 83%, respectively. The SUVmax was significantly higher in infected than noninfected grafts, (10.3 ± 4.2 vs. 5.4 ± 3.4) $P = 0.02$. According to the receiver operating characteristic analysis, SUVmax greater than 6.3 represented the optimal cutoff between infective and noninfective outcome. Of the secondary parameters collected, grade of uptake and SUVmax were the only significant predictors of infection (odds ratio 2.5, 1.5 respectively) $P = 0.05$. White cell count, erythrocyte sedimentation rate, and C-reactive protein demonstrated nonsignificant odds ratios of 1.4, 0.9, and 1.0, respectively.
Conclusions: FDG PET/CT is a valuable diagnostic test for identifying AGI. Infected grafts display significantly greater FDG uptake in a distinctive intense focal perigraft pattern and distribution. SUVmax greater than 6.3 is a good cutoff to determine infective status.

INTRODUCTION

Vascular grafts are used to bypass occluded or diseased aneurysmal blood vessels. Grafts can be autogenous, commonly from the long saphenous vein, or prosthetic grafts composed of Dacron or polytetrafluoroethylene. Aortic graft infection

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(AGI) is an uncommon event with an overall incidence ranging from less than 1% for endovascular procedures[1] up to 3% for open surgery[2,3]; however, it carries significant morbidity and mortality between 20% and 75% in the event of infection.[4,5] When graft infection is suspected, prompt diagnosis and treatment are vital.

Early clinical presentation of AGI can be variable and insidious with nonspecific signs such as abdominal pain, pyrexia, and general malaise. This is more so for intracavitary abdominal graft infections, which present a diagnostic challenge. Late signs of infection are more straightforward to detect as patients can present with fulminant sepsis, aorto aortic-enteric fistula, gastrointestinal hemorrage, acute limb ischemia with evidence of septic emboli, and complete wound dehiscence.[6–8] There is no gold standard for the diagnosis of vascular graft infection and no clear consensus on the optimal imaging modality used to detect AGI. Current practice focuses on clinical examination combined with laboratory tests such as white cell count (WCC), erythrocyte sedimentation rate (ESR), and C-reactive protein (CRP) and radiological imaging. Computed tomography (CT), magnetic resonance imaging (MRI), and radiolabeled white cell scanning are all accepted imaging techniques but hampered by reports of variable positive and negative predictive values.[9]

Although CT scans are the most commonly used radiological modality for AGI, they are plagued by reports of low sensitivity in detecting key diagnostic features of graft infection such as perigraft fluid, gas locules, and soft tissue swelling in up to 50% of scans.[10] Bruggink et al.[11] reported CT to have a positive predictive value (PPV) and negative predictive value (NPV) of 60% and 57%, respectively, when used to detect AGI. Furthermore, the suboptimal sensitivity of CT can be particularly problematic for early detection of graft infection or ''low-grade indolent infections'' that may result in delayed treatment and diagnosis.[12–14] Shahidi et al.[15] reported MRI to have a PPV of 95% and NPV of 80% for detecting graft infection in comparison with indium-111-labeled white blood cell scanning which had a PPV and NPV of 80% and 82%.

Fluoro-2-deoxy-D-glucose positron emission tomography (FDG PET) is a noninvasive imaging technique that provides functional information on the metabolic activity of tissues. FDG is a glucose analog that is processed at a higher rate in tissues with increased metabolic activity such as malignancy, infection, and inflammation. FDG-PET is used in conjunction with CT (FDG PET/CT) as a hybrid imaging technique that combines functional information with the added benefits of anatomical precision from morphological imaging, resulting in improved spatial resolution and image localization.[16] It is widely used in onco-hematology, to stage disease, assess response to treatment, and detect relapse. The indications for FDG PET/CT in nononcological diseases, such as infection and inflammation have rapidly expanded over the past few years,[17,18] and its role in the landscape of detecting AGI is evolving. Bruggink[19] et al. explored the diagnostic value of plain CT, FDG-PET, and fused FDG PET/CT in detecting graft infection. Hybrid imaging demonstrated the greatest diagnostic values with a sensitivity of 93%, specificity 70%, and positive and negative predictive value of 82% and 88%, in comparison with 56%, 57%, 60%, and 58% for plain CT, respectively. This was attributable to the benefits of combining metabolic data with anatomical precision of FDG PET/CT.

The primary aim of this study was to investigate the diagnostic accuracy of FDG PET/CT to detect AGI and expand our knowledge of its use for this purpose. The secondary aim was to evaluate the predictive value of specific biochemical tests and radiological markers as diagnostic variables for graft infection.

METHODS

Patient Inclusion

Test group of symptomatic patients. Between February 2013 and July 2014, 21 patients with suspected AGI at the Royal Free Hospital, London, were referred for FDG PET/CT scans. Ten patients underwent endovascular stenting, 7 had traditional open surgeries, and 4 patients had received both interventions. All patients had grafts in place for at least 6 weeks before scanning, and the longest graft was in situ for 11 years. Only, patients with prosthetic grafts were included in the study. All patients were clinically symptomatic at time of scan, with pyrexia of unknown origin, undefined malaise, and fluctuating inflammatory markers without another clear source of infection. Data on patient demographics and comorbidities were retrospectively collected and displayed in Table I.

Control group: asymptomatic patients. A control group of 7 patients with prosthetic aortic grafts were investigated to establish FDG PET/CT characteristics of noninfected grafts. These patients were undergoing FDG PET/CT scans for investigation and monitoring of onco-hematological diseases. All patients were in remission and had disease-free involvement of their graft.

FDG PET/CT analysis. Patients underwent PET/CT imaging on a Siemens Biograph PET/CT scanner