

# Additive value of positron emission tomography/computed tomography scan for detection of aortic tube graft infection: a case report

Farnoosh Larti <sup>1</sup>, Mohammad Amin Khadembashiri<sup>1</sup>, Mehrshad Abbasi <sup>2</sup>, and Alborz Sherafati <sup>1\*</sup>

<sup>1</sup>Department of Cardiology, Imam Khomeini Hospital Complex, Tehran University of Medical Sciences, Tohid Square, Tehran 1419733141, Iran; and <sup>2</sup>Department of Nuclear Medicine, Vali-asr Hospital, Tehran University of Medical Sciences, Tohid Square, Tehran:1419733141, Iran

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## Background

Diagnosis of aortic graft infection is challenging, and delayed diagnosis is associated with poor prognosis. Positron emission tomography/computed tomography (PET/CT) has improved diagnostic accuracy.

## Case summary

A patient with a history of congenital heart disease was admitted due to fever. He had a history of four cardiac surgeries, including the Bentall procedure for endocarditis. Blood cultures were negative. A semi-mobile mass was detected in the distal portion of the aortic tube graft in echocardiography. PET/CT scan was used to confirm tube graft infection and to support proceeding to cardiac surgery.

## Discussion

Using multimodality imaging, including PET/CT scan in combination with echocardiography, can improve diagnostic accuracy for the detection of aortic tube graft infection, infection of prosthetic valves, or intra-cardiac devices, especially in high-risk surgical cases.

## Keywords

Aortic tube graft infection • Infective endocarditis • Multimodality imaging • PET/CT scan • Case report

## Learning points

- Infective endocarditis and tubular graft infection can be misdiagnosed as haematologic disorders like idiopathic thrombocytopenic purpura.
- Splenic infarction and history of prolonged fever can be clues for evaluation of aortic tube infection in patients with history of Bentall procedure.
- Positron emission tomography/computed tomography scan has additive diagnostic value to echocardiography for aortic tubular graft infection especially in the setting of clinical uncertainty.

\* Corresponding author. Tel: +98 9123066025, Fax: +98 2166939537, Email: [alborz.sherafati@gmail.com](mailto:alborz.sherafati@gmail.com)

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## Introduction

Infective endocarditis (IE) can occur following prosthetic valve or tubular graft implantation surgery.<sup>1</sup> Early detection of infection and appropriate treatment can decrease complications, including mortality. Echocardiography has limited sensitivity for the detection of vegetation in the presence of prosthetic materials<sup>1,2</sup>; therefore, other imaging modalities are needed to improve the diagnostic accuracy. Positron emission tomography hybrid imaging (PET/CT) is a functional imaging modality that evaluates metabolic activity in different tissues. <sup>99m</sup>Tc-Hexamethylpropylene amine oxime (<sup>99m</sup>Tc HMPAO) labelled white blood cell (WBC) scan/single-photon emission tomography (SPECT), another functional imaging, may also assist in detection of prosthetic material infection with an acceptable specificity.<sup>3</sup> The resolution of cardiac magnetic resonance is optimal, but it is not possible to differentiate active vegetation from chronic changes in previously manipulated valves.<sup>3</sup> A combination of PET/CT scan and echocardiography can improve the sensitivity for diagnosing endocarditis and graft infection.<sup>4</sup>

abnormalities in the peripheral blood smear. Corticosteroid was initiated following the diagnosis.

The patient had a history of tetralogy of Fallot and underwent cardiac surgery four times including Blalock–Taussig shunt in 1994, tetralogy of Fallot total correction in 2001 (surgery was deferred to this time due to acceptable oxygen saturation), pulmonary valve replacement (PVR) with a bioprosthetic valve in 2010 due to the presence of severe pulmonary regurgitation, and Bentall procedure for native aortic valve endocarditis along with mechanical PVR in 2015. He was under regular cardiology follow-up since the last surgery.

As for the lab data, haemoglobin (Hb) level was 8 g/dL (13–16 g/dL), WBC count was  $19400 \times 10^9/L$  ( $4000\text{--}10\,000 \times 10^9/L$ ) with 81% polymorphonuclear leucocytes, serum creatinine was 2.1 mg/dL (0.6–1.5 mg/dL), erythrocyte sedimentation rate was 80 mm/h (0–15 mm/h), and C-reactive protein was 56 mg/L (<6 mg/L). Blood cultures were negative. Due to abdominal pain, fever, and splenomegaly, an abdominal CT scan was performed that showed splenic infarction and subcapsular haematoma, which did not require specific interventions.

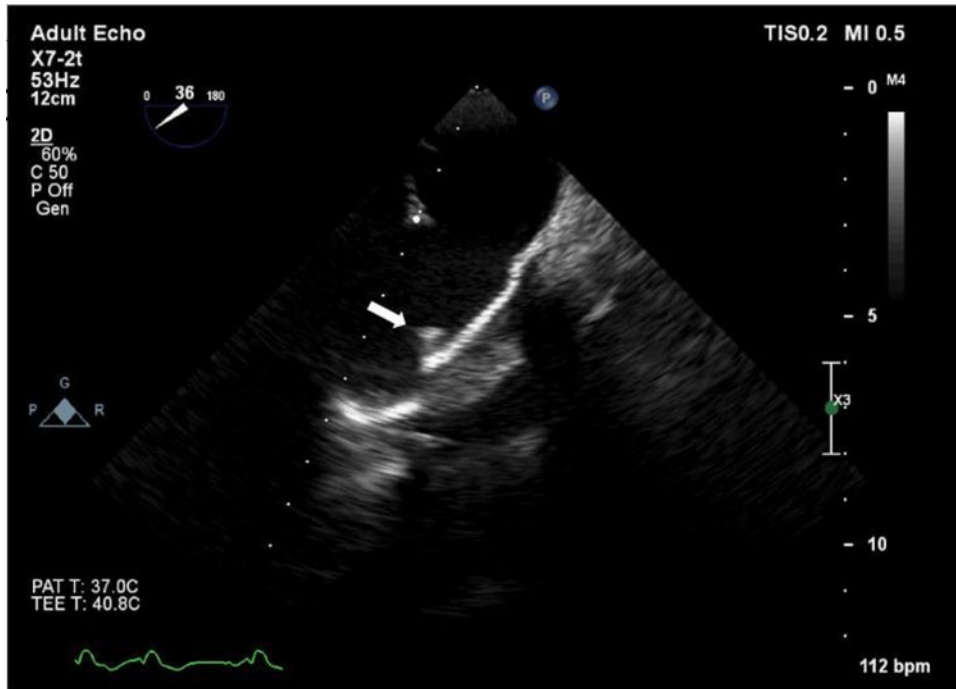
## Timeline

1991	Tetralogy of Fallot was diagnosed after birth
1994	Blalock–Taussig shunt surgery
2001	Tetralogy of Fallot total correction surgery (acceptable oxygen saturation after previous surgery had delayed total correction surgery for 7 years)
2010	Pulmonary bioprosthetic valve replacement due to severe pulmonary regurgitation
2015	Infective endocarditis of aortic valve resulting in Bentall procedure for native aortic valve along with mechanical pulmonary valve replacement
2018 (July)	Detection of splenomegaly and thrombocytopenia in follow-up visit. Corticosteroid was initiated due to diagnosis of idiopathic thrombocytopenic purpura
2018 (November)	Initiation of fever and abdominal pain. Persistence of thrombocytopenia despite corticosteroid treatment
2019 (January)	Patient was referred to our centre due to persistent fever and left upper quadrant pain. Abdominal computed tomography (CT) scan was performed due to splenomegaly, which showed splenic infarction. Blood cultures were negative. In transoesophageal echocardiography, a semi-mobile mass was detected in distal part of ascending aorta tube graft. Antibiotics were initiated, but no improvement occurred in patient's symptoms. Positron emission tomography/CT scan showed increased metabolic activity around tubular graft. Bentall homograft procedure was performed. Symptoms resolved following surgery and continued antibiotic therapy.
2020	Normal platelet count, no symptoms, normal inflammatory biomarkers

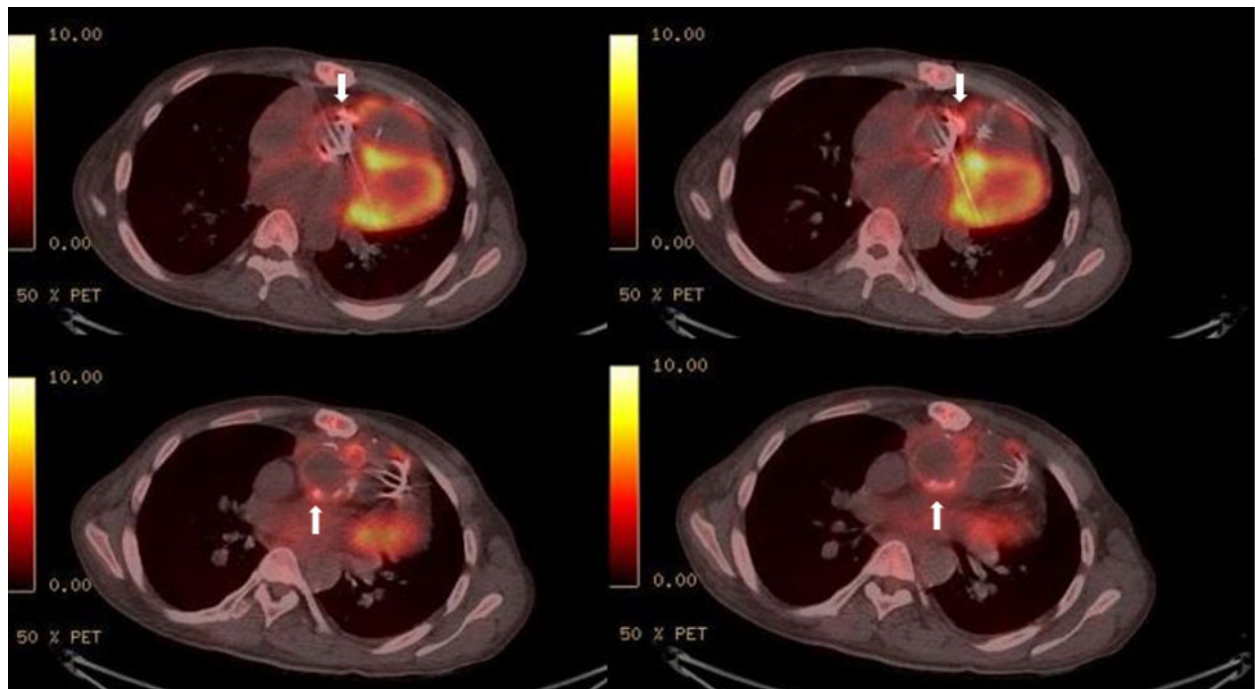
## Case presentation

A 28-year-old Caucasian man presented with a 3-month history of low-grade fever, significant weight loss, and left upper quadrant pain. On admission, he was ill and febrile, with a blood pressure of 90/65 mmHg, heart rate of 110/min, a mid-systolic murmur in the second left intercostal space, splenomegaly, and left upper quadrant tenderness. There were no other signs in favour of endocarditis. Few months before the onset of fever, thrombocytopenia and splenomegaly were detected during follow-up visits, and a diagnosis of idiopathic thrombocytopenic purpura was considered based on the absence of clinical symptoms and lack of platelet morphologic

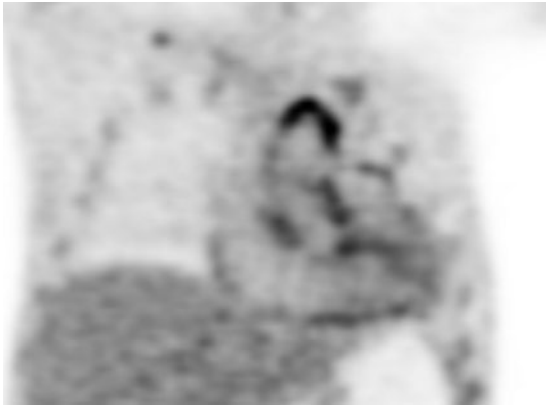
In transthoracic echocardiography (TTE), the left ventricular ejection fraction was 25%, and aortic and pulmonic prosthetic valves had normal pressure gradients with no evidence of paravalvular regurgitation or obvious vegetation. A suspicious pseudoaneurysm formation was detected in the anterior part of the aortic annulus. As prosthetic valve endocarditis (PVE) was highly probable, transoesophageal echocardiography (TOE) was performed, which showed no vegetation on native and prosthetic valves (Video 1, Video 2, Video 3). However, a 1.2 cm semi-mobile mass was detected in the distal part of the ascending aorta tube graft (Figure 1). TTE and TOE were repeated 2 weeks later, and the findings remained unchanged.



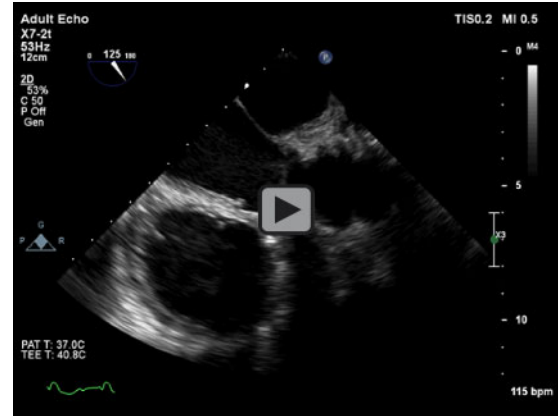
**Figure 1** Transoesophageal echocardiography demonstrated a mobile mass in the distal portion of the ascending aortic tube graft (arrow).



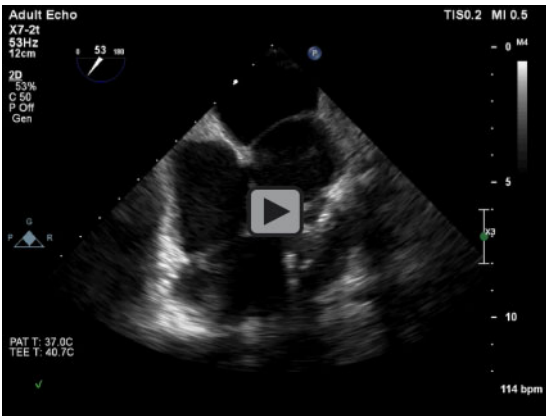
**Figure 2** Positron emission tomography/computed tomography scan showed increased metabolic activity in aortic root and around ascending aortic tubular graft indicative of abnormal hypermetabolism (arrow).



**Figure 3** Coronal view of positron emission tomography scan revealing increased metabolic activity in ascending aorta.



**Video 2** TEE midesophageal long axis view. VSD



**Video 1** TEE midesophageal short axis view. No evidence of pseudoaneurysm or abscess formation was detected.

Empiric antibiotic treatment was initiated for endocarditis after TOE. The drug regimen included ampicillin/sulbactam 3 g intravenous (IV) every 6 h, vancomycin 1 g IV twice daily, gentamycin 80 mg IV every 8 h, and rifampin 200 mg oral every 8 h. The patient remained febrile despite treatment, and no improvement was noted in symptoms. Repeated blood cultures were still negative and there was no evidence of atypical IE pathogens, including a positive culture for the HACEK group or serum antibody against *Coxiella burnetii*. Moreover, no other sources were found for embolic infarction.

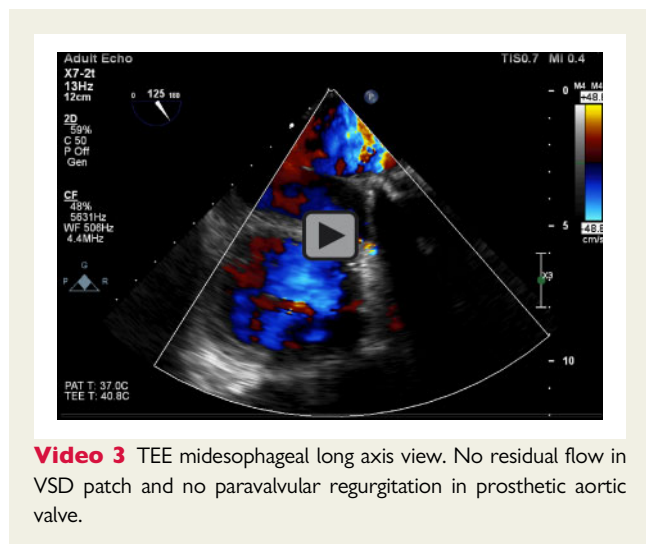
Due to persistent symptoms and the tube graft mobile mass, which did change after two weeks of treatment, the patient became a candidate for open surgery. Regarding the high surgical risk and the absence of definite echocardiographic data in favour of PVE, the surgery team refused to operate. We used a PET/CT scan, delayed up to this stage of disease against the European Society of Cardiology (ESC) 2014 guideline recommendation due to lack of insurance coverage, for detecting signs of inflammation around the prosthetic valves and tubular graft. Sixty minutes after intravenous injection of a 6.6 mCi  $^{18}\text{F}$ -fluorodeoxyglucose (FDG), whole-body scan was done using an

integrated PET/CT device (D-690, General Electric Medical Systems). There was increased metabolic activity in the aortic root up to the aortic arch with a standardized uptake value (SUV) max of 8.2. The root of the pulmonary artery also showed hypermetabolism (SUV max = 5.4). The scan was indicative of abnormal hyper-metabolism of the tubular graft due to active inflammation/infection (Figure 2 and Figure 3).

The patient was scheduled for cardiac surgery. Extensive involvement of the tubular graft was evident at the surgery with no pseudoaneurysm formation or prosthetic valve involvement. The patient underwent the Bentall homograft procedure. Antibiotic treatment with ampicillin/sulbactam, vancomycin, gentamycin, and rifampin was continued for 6 weeks at the same doses. The platelet count returned to normal, and corticosteroid was discontinued. At 1-year follow-up, the patient did well with no symptoms and normal inflammatory biomarkers. The homograft aortic valve function was normal with no evidence of infection in echocardiography.

## Discussion

Infective endocarditis occurs in about 5% of the patients with prosthetic valves,<sup>1</sup> and about 20–30% of IE patients have prosthetic valves or intra-cardiac devices.<sup>1,2</sup> On the other hand, aortic tube graft infection occurs in up to 2% of graft insertions and is associated with an increased mortality rate of as high as 25%, especially if left untreated.<sup>5,6</sup> A significant proportion of tube graft infections have late-onset manifestations,<sup>7</sup> which can be non-specific with the absence of fever,<sup>5</sup> causing a major diagnostic challenge. However, complications of infection, including septic emboli to other organs, may be present,<sup>5,7</sup> which can assist in proper diagnosis. In our patient, splenic infarction was a key finding in favour of endocarditis or graft infection. The Modified Duke criteria are used for the diagnosis of IE, which include TTE or TOE findings as a major criterion.<sup>8</sup> However, there are no specific criteria for the diagnosis of aortic graft infection, and a combination of clinical, organism culture, and imaging, similar to Duke criteria, is used for the detection of graft infection.<sup>5</sup> In our patient, due to the presence of fever, splenic infarction, and a semi-mobile mass in



**Video 3** TEE midesophageal long axis view. No residual flow in VSD patch and no paravalvular regurgitation in prosthetic aortic valve.

TOE, a diagnosis of tubular graft infection was considered, and antibiotic treatment was initiated.

TOE has some limitations for the detection of aortic graft infection: the shadow of a prosthetic valve may result in artefacts,<sup>3,7</sup> between-observer variation may occur in image analysis, and small vegetations may be missed.<sup>4</sup> Thus, using other imaging modalities can improve the diagnostic accuracy. Aortic CT angiography provides high-resolution anatomical images of the aorta and has a high sensitivity and specificity for the detection of aortic infection, especially peri-aortic complications like abscess or pseudoaneurysm formation.<sup>3</sup> However, it may have a lesser value for detecting vegetations, metallic prosthetic valves may create artefacts, and there are several limitations for performing this modality, including renal failure and allergy to contrast material.<sup>3</sup> Cardiac magnetic resonance imaging (MRI) is another option, which demonstrates anatomical details along with tissue inflammation and oedema,<sup>3</sup> but its diagnostic accuracy is not determined in trials, and there are also limitations including renal failure, claustrophobia, and presence of metallic materials including intra-cardiac devices.<sup>3</sup> In our patient, the presence of the metallic prosthetic aortic valve made CT angiography and MRI less suitable options.

Functional imaging modalities can also be used to improve the diagnostic accuracy. <sup>18</sup>F-FDG PET/CT scan, which was used in this patient, has a high sensitivity for the detection of endocarditis and aortic graft infection.<sup>3,9</sup> Some studies found that a combination of PET/CT scan with echocardiography increased the sensitivity of the diagnosis of IE and aortic graft infection and could reclassify patients with uncertain diagnoses.<sup>2,3</sup> PET/CT scan is also valuable for the detection of peripheral embolization.<sup>10</sup> However, the specificity of PET is not high and other non-infectious inflammatory processes like post-surgical inflammation, if the modality is performed within few months after cardiac surgery, may be associated with false-positive results.<sup>9,11</sup> On the other hand, small vegetations and prolonged antibiotic therapy may result in a false negative scans.<sup>9,11</sup> <sup>99m</sup>Tc HMPAO/SPECT is another functional method with a high specificity that can detect abscess formation and peripheral embolization of infection, but it has a lower sensitivity.<sup>3</sup>

The 2014, the ESC guideline on aortic diseases suggested using PET for detection of inflammatory aortic involvement including

endovascular graft infection,<sup>12</sup> and the 2015 ESC guideline on infective endocarditis recommended using PET/CT for improving the diagnostic accuracy in misdiagnosed cases with possible IE and for detecting peripheral embolic events.<sup>13</sup> Decision making for this patient was challenging. Due to the persistence of fever despite antibiotic treatment, surgery was the next therapeutic option. However, the history of previous operations increased the risk of mortality and morbidities in the upcoming surgery since bleeding, transfusion, prolonged mechanical ventilation, pneumonia or acute respiratory failure, and acute kidney injury are more common in redo operations.<sup>14</sup> Furthermore, negative blood cultures and lack of vegetation on aortic prosthetic valve made it necessary to determine the infectious nature of the tubular graft mass. A combination of PET/CT scan was applied to obtain more accurate evidence to resolve clinical uncertainty, but a major concern was the history of antibiotic treatment during admission that could negatively affect the results. Based on the ESC guidelines, our patient underwent a PET/CT scan, which showed increased metabolic activity around the aortic tubular graft despite antibiotic therapy. Increased FDG uptake in the aortic graft provided additional data for invasive management, which confirmed the presence of tubular graft infection.

## Conclusion

This case report emphasized the use of multimodality imaging including PET/CT scan in combination with echocardiography for detection of aortic tubular graft infection in high-risk surgical cases.

## Lead author biography



Farnoosh Larti is a fellowship of echocardiography with special interest in structural heart disease.

## Supplementary material

[Supplementary material](#) is available at *European Heart Journal - Case Reports* online.

**Slide sets:** A fully edited slide set detailing this case and suitable for local presentation is available online as [Supplementary data](#).

**Consent:** The authors confirm that written consent for submission and publication of this case report including images and associated text has been obtained from the patient in line with COPE guidance.

**Conflict of interest:** none declared.

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