Diagnosis of Graft Infection Using FDG PET-CT

Hunbo Shim, M.D., Kiick Sung, M.D., Wook Sung Kim, M.D., Young Tak Lee, M.D.,
Pyo Won Park, M.D., Dong Seop Jeong, M.D.

Graft infections after aortic replacement are a rare, but severe complication. Because surgical removal of the infection source is essential, an accurate diagnosis is required to prevent unnecessary treatment. Both of the patients described herein were diagnosed with graft infections using dual-modality positron emission tomography-computed tomography; one patient was a false-positive, and the other was confirmed with an infection.

Key words: 1. Aorta, surgery
2. Infection
3. Graft
4. Positron-emission tomography

CASE REPORTS

1) Case 1

A 40-year-old man diagnosed with Marfan syndrome had undergone mitral valve replacement seven years earlier for mitral regurgitation. Five years later, aortic replacement was performed from just below the left subclavian artery to the origin of the renal arteries to treat an aortic aneurysm caused by chronic dissection. One year after the second surgery, he exhibited fever and myalgia. Laboratory tests revealed leukocytosis and an elevated C-reactive protein level. *Pseudomonas aeruginosa* was detected in his blood, and antibiotics were initiated. Vegetations on the mitral valve were detected by transesophageal echocardiography. In addition, a chest computed tomography (CT) showed a fluid collection around the prosthetic graft (Fig. 1A). Positron emission tomography-computed tomography (PET-CT) showed significant fluorodeoxyglucose (FDG) uptake; the standard uptake value (SUV)=6.8,

which meant there was a graft infection (Fig. 1B). The graft infection was regarded as a source of infective endocarditis. To prevent embolism, the mitral valve was replaced with a prosthetic valve (mechanical heart valve 31 mm; St. Jude Medical Inc., St. Paul, MN, USA) via median sternotomy. Ascending aorta replacement (Intergard woven graft 32 mm; InterVascular Inc., Mahwah, NJ, USA) and aortic hemi-arch replacement (Intergard woven arch graft 24 mm, InterVascular Inc.) were performed for the dilated aortic root at that time. After 29 days of antibiotic therapy, the exploration for the suspected graft infection site was performed through a left lateral thoracotomy and no purulent material was identified. The granulation tissue around the prosthetic graft was cultured and showed no evidence of infection. After several more days of antibiotic treatment, the patient was discharged and showed no further complications during a 29 month follow-up period.
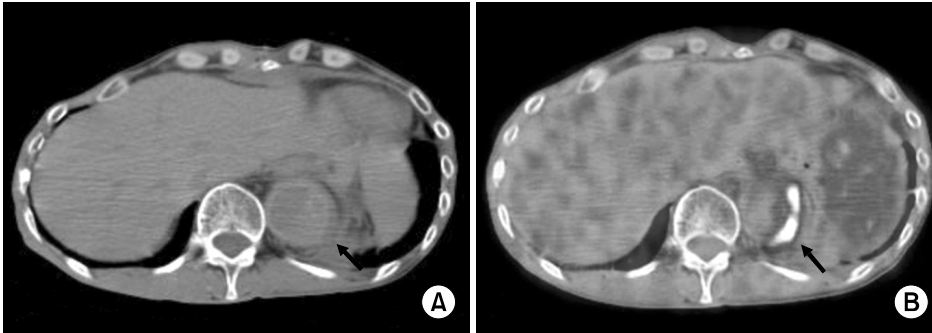
Fig. 1. (A) Computed tomography (CT) shows a fluid collection suspected of infection around the vascular graft and (B) positron emission tomography-CT shows intense fluorodeoxyglucose uptake at the same site. This finding was concluded to be a false-positive.
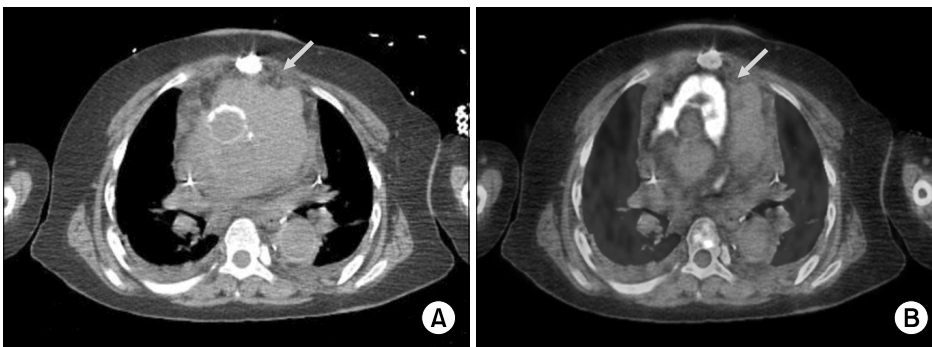

Fig. 2. (A) Computed tomography (CT) shows a hematoma shadow including air bubbles and (B) positron emission tomography-CT demonstrates high fluorodeoxyglucose uptake around the vascular graft. This patient was diagnosed with a culture negative infection.

2) Case 2

A 12-year-old male had been diagnosed with Marfan syndrome and had undergone an aortic valve sparing root replacement, mitral valve annuloplasty, and tricuspid valve repair for annuloaortic ectasia with severe aortic regurgitation, and severe mitral regurgitation (MR) and tricuspid regurgitation seven years earlier. One year after surgery, the Bentall operation was repeated for relapsed aortic regurgitation. Four years later, CT angiography showed an aortic aneurysm of the remaining thoracic aorta. The aorta was replaced from the root to the proximal descending thoracic aorta via a sternotomy. Afterwards, with a staged plan, the descending thoracic aorta was replaced using a left posterolateral thoracotomy. Incidentally, a splenectomy was performed due to an intra-operative spleen injury. After two years, the patient was admitted to the emergency room with a high fever, myalgia, and low blood pressure; antibiotic treatment was started. The echocardiography showed moderate MR and vegetations on the mitral valve. No organisms were cultured from the blood. A hematoma shadow including air bubbles around the vascular graft was detected on CT (Fig. 2A). PET-CT demonstrated high FDG uptake; SUV=8.6 around the

aortic graft (Fig. 2B). An operation was performed for a presumptive prosthetic graft infection based on the PET-CT findings. A hematoma and pus filled the space around the annulus of the aortic valve and aortic graft. A Bentall operation was performed with a 24 mm homograft via median sternotomy. Four days later, after a redo of the Bentall operation, the remainder of the aorta was replaced using a rifampin-soaked graft (Gelweave Siena collared 4 branch plexus; Vascutek, Renfrewshire, UK) via median laparotomy extended from median sternotomy. There was no microorganism isolated in the eliminated materials. Antibiotics were used for two more months following the surgery. The patient showed no further complications during a 15 month follow-up period.

DISCUSSION

The treatment of choice for graft infections is surgical removal; thus an accurate diagnosis is important to avoid unnecessary surgery. CT has been used as a complementary imaging approach for the assessment of graft infections because of its high spatial resolution. Perigraft air, perigraft fluid collections, enhanced perigraft soft tissues, and pseudoa-

neurysm formation should be considered highly suspicious for infection [1]. CT has a sensitivity of 94% and a specificity of 85% when the above-mentioned criteria for signs of graft infection are used [2]. In advanced graft infections, CT is accurate for diagnosis, but not in low-grade infections, with an overall sensitivity of only 55.5% [3].

In the early 1990s, magnetic resonance imaging (MRI) was suggested for the diagnosis of graft infections. Its positive predictive value (PPV) is 95% and negative predictive value is 80%. Additionally, a white blood cell (WBC) scan was used to detect a graft infection with a PPV of only 80%. MRI and WBC scans have a low significance as diagnostic tools for graft infection [4]. Recently, FDG-PET has received proper attention as a diagnostic tool for graft infection. Activated inflammatory cells show increased FDG uptake, which makes the FDG-PET a very sensitive imaging modality for the diagnosis of infections. Keidar et al. [5] reported a sensitivity of 93%, specificity of 91%, positive predictive value of 88%, and negative predictive value of 96% in FDG-PET for graft infection. Originally, PET was a well accepted clinical tool for the routine assessment of cancer. FDG is a marker of increased intracellular glucose metabolism and is therefore taken up by malignant as well as infectious and inflammatory processes. As a result, FDG uptake is increased not only in the infection, but also in many other conditions. Therefore, in the process of using FDG uptake to diagnose an infection, the risk of a false-positive always exists. Wasselius et al. [6] reported that FDG uptake in vascular grafts was found in the vast majority of patients without graft infections. High FDG uptake was found in 10 of 12 grafts in patients who underwent open surgery and in 1 of 4 grafts in patients who underwent endovascular aneurysm repair. On the basis of biochemical and clinical data, it was concluded that 1 in 16 grafts had an infection at the time of the investigation. This was due to an absence of guidelines to diagnose an infection using the FDG uptake value. Spacek et al. [7] reported the ratio between FDG uptake in the graft and a reference blood background in the graft, and a reference blood background showed a final sensitivity of 74.5% and specificity of 82.9%, which means that semiquantitative evaluation is not acceptable for diagnosing graft infections. Advances in fusion technology of FDG-PET and CT make the possibility of using FDG-PET/CT as a diagnostic modality combining the FDG uptake value, pattern, and morphologic appearance. According to Spacek's study, the focal FDG uptake and irregular graft boundary appearance in the CT image were significant independent factors for predicting graft infections. Subjective evaluation of the intense focal FDG uptake was specific for graft infections in 92.7% of prostheses. This is linked with a very high positive predictive value of 93.5% for predicting graft infections. In contrast, a low rate of false-negative PET findings in prostheses with no focal FDG uptake (1.8%) excluded graft infections with a very high probability of 96.6%. In our cases, the possibility of graft infections using FDG-PET/CT was determined only by SUV. More attention must be paid to other parameters such as the focal FDG uptake and graft boundary shape in CT for evaluating graft infections using FDG-PET/CT. To establish the criteria for diagnosing graft infections using FDG-PET/CT, other parameters must be combined with the currently used parameters. This will prevent unnecessary treatment or misdiagnosis that can lead to fatal complications from graft infections.

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