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Case Report

FDG PET/CT in abdominal aortic graft infection: A case report and literature review ☆,☆☆

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ABSTRACT

This case report follows a 47-year-old man who had multiple grafts undergoing FDG PET/CT (positron emission tomography/computed tomography) scan to evaluate for graft infection. Initial CT showed enhancing soft tissue and fluid collection around the graft, and the subsequent FDG PET/CT showed findings concerning for graft infection. This case exemplifies that FDG PET/CT is a synergistic tool in diagnosing aortic graft infections, a rare and often fatal complication of aortic grafts.

Introduction

Aortic graft infection is an uncommon complication of aortic disease procedures, but has a high risk of morbidity and mortality (between 20% and 75%) [1–3]. FDG PET/CT is a modality that combines the use of PET and CT to maximize accuracy when diagnosing illnesses, with the modality classically being used for cancer detection due to increased glucose activity within tumors. However, the use of FDG is not limited to malignancies and can also be utilized to diagnose infection and inflammation [4,5]. The following case report discusses the use of FDG PET/CT in the diagnosis of aorto-femoral bypass graft infection.

Case report

A 47-year-old man with a past medical history of tobacco use and peripheral artery disease had an initial aorto-bifemoral bypass graft and left femoral-popliteal artery bypass in July 2018. Grafts were complicated by thrombosis secondary to left popliteal stenosis, and he underwent thrombectomy which was further complicated by wound dehiscence and infection. He then underwent left aorto-femoral bypass graft and femoral-popliteal bypass graft removal in June 2019 with subsequent axillary-femoral artery bypass graft placement. He had emboli to the axillary bypass and underwent thrombectomy. The left axillary-femoral bypass failed, and he underwent left above-knee-amputation with left axillary to popliteal bypass graft removal in July 2019. A follow-up

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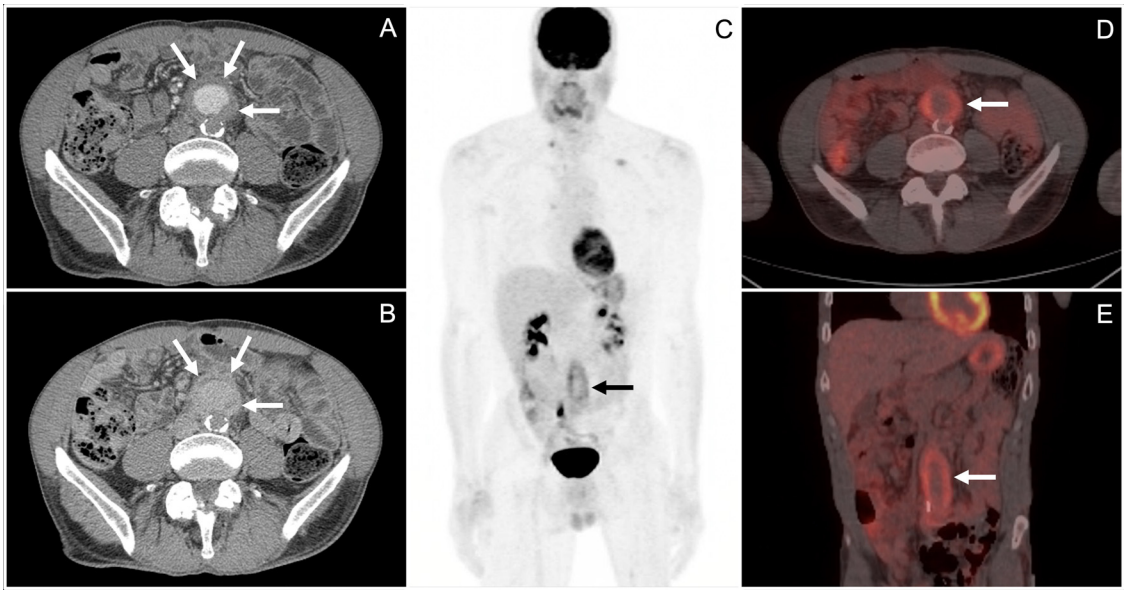

Fig. 1 – Early (A) and delayed (B) postcontrast CT images, at the level of the pelvis, show abnormal enhancing soft tissue around the aortic graft (white arrows). The native calcified and occluded aorta is seen posterior to the graft. Whole body (MIP—Maximum Intensity Projection) image from the PET/CT shows mild to moderate uptake around the aortic graft (black arrow). This is better characterized on the fused axial (D) and coronal (E) images showing uptake corresponding to the abnormal enhancing soft tissue identified earlier on the diagnostic CT. These findings are consistent with aortic graft infection.

surveillance CT showed enhancing soft tissue (Fig. 1A & B) and developing fluid collection around the aorto-femoral bypass graft. Subsequent FDG PET/CT showed persistent circumferential soft tissue thickening and fluid surrounding the aortic graft with associated FDG avidity, with maximum SUV of 5.3, extending from the aortic anastomosis distally to the level of the right common iliac artery (Fig. 1C-E). The most recent basic metabolic panel and complete blood count in July 2022 were within normal limits, and there was no evidence of bacteremia. Serial white blood cells measurements since graft placement ranged between 9.66 and 13.1 $\times$ 10^9 /L. Patient remained asymptomatic throughout this course however, the findings of abnormal enhancing soft tissue and perigraft fluid on CT, with associated avidity on FDG PET/CT were concerning for graft infection. Based on imaging findings, plans were made for excision and reconstruction of the aortic graft.

Discussion

Computed tomography (CT) was first made commercially accessible in 1972 by British engineer Godfrey Hounsfield. Since then, it has evolved into a multidisciplinary mainstay in medicine used to diagnose both simple and complex medical conditions. The same can be said for the positron emission tomography (PET) scan, with its historical origins dating back to the late 20th century. Regarding the detection of vascular graft infections, CT is the gold standard due to its high spatial resolution of the vascular and perivascular structures [6]. For CT, both specificity and sensitivity are 95% in cases with high pretest probability of graft infection [5–8]. The numbers precipitously decrease for detecting low-grade graft infections, with sensitivity at 55% and specificity at 100% [6]. To prevent mistreatment and unnecessary procedures due to possible graft infection, it is imperative to maximize the chances of a proper diagnosis through imaging. Since the late 1990s, there have been several studies that have investigated the combination CT and PET, specifically using 18-F-Fluoro-D-deoxyglucose as a marker (FDG-PET) in diagnosing graft infection [6]. Initially the Centers for Medicare and Medicaid Services approved only oncologic indications for reimbursement, but in August 2021 some barriers from the use of FDG-PET for infection and inflammation were removed.

FDG is a radiolabeled glucose analogue where its 2′ hydroxyl group has been replaced by a ^{18}F. It passes through the cellular membrane through glucose transporters (GLUT), in a manner like glucose. FDG is then phosphorylated by hexokinase to yield FDG-6-phosphate and is trapped within the cell due to its structural differences from glucose. FDG can exit the cell once dephosphorylated, but this is unlikely in cases of malignant cells as they have reduced levels of glucose-6-phosphatase. This creates a mechanism where FDG is trapped in cancer cells and can be detected [4]. Also, FDG can also be used to detect infection due to the presence of neutrophils and macrophages, which express high concentrations of GLUT [6]. This aspect of FDG usage was originally regarded as a disadvantage to the accuracy of the technique, as instead of detecting cancer, it returned a false-positive for infection. However, this has been explored further and when combined with other modalities such as CT or MR, an increase in specificity and

sensitivity for detecting cases of infection and inflammation is observed [4].

Aortic graft infection is a rare event that has been shown to have an incidence rate of less than 1% for endovascular procedures and up to 3% for open surgical procedures [3,9–11]. In terms of mortality and morbidity, the statistics are more consequential, with 20%-75% of infection cases having a poor prognosis [1–3]. Statistics regarding incidence may differ from reported numbers due to additional factors that should be considered such as time course between surgery and recognition of graft infection, differences in hospital management procedures, differences in graft sites, and original implantation indications [12]. Aortic graft infection can present in a multitude of ways, with infection more likely in patients with comorbidities such as diabetes mellitus and myelodysplastic syndromes, and in patients with corticosteroid use [13]. Early signs of graft infection include abdominal pain, fever, chills, and malaise. Prolonged infection can present with signs of sepsis, fistulas, limb ischemia, and gastrointestinal hemorrhage [1,3,7,14].

Although there are no established gold-standard criteria for diagnosis of aortic graft infection (AGI), the Management of Aortic Graft Infection Collaboration (MAGIC) is a collective of clinicians who aim to construct a consistent diagnostic standard [15]. The guideline includes 3 categories, Clinical/Surgical, Radiological, and Laboratory, which are further divided into major and minor criteria. One major as well as an additional major or minor criterion across 2 categories are required for diagnosis based on these guidelines. Major radiologic criteria include peri-graft fluid on CT scan $\geq$ 3 months after insertion, peri-graft gas on CT scan $\geq$ 7 weeks after insertion or increase in peri-graft gas demonstrated on serial imaging. Minor radiologic criteria are extensive and include other suspicious peri-graft gas/fluid/soft tissue inflammation, elevated metabolic activity on FDG PET/CT, abnormal radiolabeled leukocyte uptake.

FDG PET/CT can be a valuable tool in diagnosis of AGI as it provides information on both the anatomy and metabolism of the region of interest. Particularly, major CT criteria used alongside focal tracer uptake (versus diffuse uptake) can help determine the significance of inflammation and improve diagnostic accuracy [16,17]. FDG PET/CT uptake should be interpreted carefully however, as intensity of FDG uptake is unable to differentiate between infection and inflammation [6,15,18]. Moreover, some of the MAGIC minor radiologic criteria overlap with the natural inflammatory course following graft implantation and can make distinction from a subtle, chronic infection more ambiguous [15]. Because of this, there are recommendations to delay the use of FDG PET/CT imaging until 4-8 weeks after implantation to reduce false positives related to healing and inflammation [19,20]. When comparing the diagnostic accuracy of the MAGIC criteria versus FDG PET/CT findings alone, one study found that a combination of 2 or more FDG PET/CT metrics (ie, visual grading score, focal uptake, maximum standardized uptake values (SUVmax), target-to-background FDG ratio) can provide high concordance (91.4%) with MAGIC criteria for diagnosing AGI [21]. Currently, no cutoffs values for quantitative measure of metabolic activity are explicitly defined, though some studies have found SUVmax cutoff values between $\geq$ 3.8 and $\geq$ 8 in the perigraft areas as significant for infection [6,22].

When left untreated, AGI can result in significant morbidity and mortality. Standard treatment options include surgical removal or repair of the graft versus conservative management with antibiotics and percutaneous drainage, the latter of which is implemented in a minority of cases and usually due to poor surgical candidacy [23,24]. Regardless, mortality remains high even after surgical explantation (overall mortality of 42% based on a meta-analysis by Li et al. and 73% 1-year-survival based on a meta-analysis by Post et al.), and the search for a more effective gold-standard treatment option is still underway.

Conclusion

The poor outcomes of AGI stress the importance of early and accurate identification. As guidelines are still being curated for a gold-standard diagnostic algorithm, cases such as the one presented help contribute to the pool of data needed to support FDG PET/CT's role in AGI diagnosis.

Authorship

The authors declare that this is their original work and they all approve the content of this manuscript. They confirm that this manuscript has not been published previously, in any language, in whole or in part, and is not currently under consideration elsewhere.

Ethical clearance

This project did not involve any research and no ethical clearance was required.

Patient consent

A written informed consent was obtained from the patient for the publication of this case report.

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