

# Successful treatment of graft-duodenal fistula after renovisceral debranching thoracic endovascular aortic repair with limited graft resection based on <sup>18</sup>F-fluorodeoxyglucose positron emission tomography with computed tomography

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## ABSTRACT

We present the case of a patient with a graft-duodenal fistula after renovisceral debranching thoracic endovascular aortic repair. <sup>18</sup>F-fluorodeoxyglucose positron emission tomography with computed tomography showed that the infection was localized to the renovisceral bypass grafts and the right kidney. Based on the preoperative imaging findings, a limited surgery with resection was performed in the fistula, right kidney, and fluorodeoxyglucose-positive bypass grafts, while preserving the fluorodeoxyglucose-negative grafts. No signs of reinfection were reported 2 years after the surgery. Accurate assessment of infection with <sup>18</sup>F-fluorodeoxyglucose positron emission tomography with computed tomography may be useful for performing adequate excision of infected lesions. (J Vasc Surg Cases and Innovative Techniques 2021;7:286-90.)

**Keywords:** Prosthesis-related infections; positron emission tomography computed tomography; fluorodeoxyglucose F18; device removal; vascular surgical procedures

Graft-duodenal fistula (GDF) is a clinical manifestation of vascular graft infection (VGI) after surgical or endovascular aortic repair. It is a rare and life-threatening complication that requires intensive multidisciplinary treatment. Surgical treatment is lifesaving; however, the extent of excision is difficult to determine, particularly in patients who have undergone extended aortic repair. Selection of appropriate imaging technology is essential for identifying the extent of infection and determining the treatment strategy.

<sup>18</sup>F-fluorodeoxyglucose positron emission tomography combined with computed tomography (FDG-PET/CT) has been traditionally used for oncologic and inflammatory diseases; however, several recent reports have suggested its use for VGIs.

This study described the successful treatment of a patient who developed GDF after extended aortic repair

by applying FDG-PET/CT and limiting the extent of excision. The patient consented to the publication of details and images related to the case.

## CASE REPORT

A 47-year-old man with Marfan syndrome presented with fever and chills. The patient underwent several surgical and endovascular surgeries for aortic dissection, including aortic arch repair for acute type B aortic dissection 14 years ago, thoracic endovascular aortic repair for the descending thoracic aorta 12 years ago, and a hybrid repair with renovisceral debranching and thoracic endovascular aortic repair for thoracoabdominal dissecting aortic aneurysm 2 years ago. As shown in Fig 1, the abdominal aorta was replaced with a Dacron bifurcated graft, and the bilateral renal arteries (RAs) and superior mesenteric artery (SMA) were rerouted by bypass grafting using a cross-shaped graft from the right limb of the abdominal aortic graft (AG). The celiac artery was rerouted from the trunk of the abdominal AG. The endografts were placed from the descending thoracic aorta to the abdominal AG.

Investigations upon presentation showed an elevated number of leukocytes (18,000/ $\mu$ L) and C-reactive protein level (13 mg/dL). *Streptococcus anginosus* was isolated from blood cultures. CT angiography showed fluid collection around the cross-shaped bypass graft and AG, with occlusion of the graft to the right RA with right kidney infarction. VGI was suspected; however, the extent of infection was unclear. Therefore, FDG-PET/CT was performed to identify the exact site of infection.

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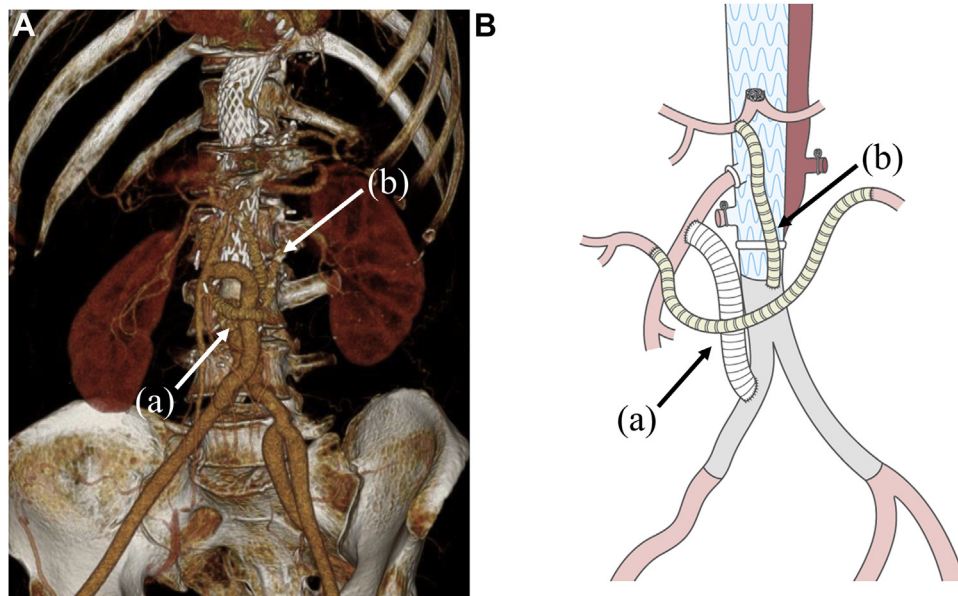
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**Fig 1. A,** Preoperative computed tomography (CT) angiography and **(B)** a schematic presentation. The abdominal aorta is replaced with a Dacron bifurcated graft. The bilateral renal arteries (RAs) and the superior mesenteric artery (SMA) are rerouted by bypass grafting using a cross-shaped graft from the right limb of the abdominal aortic graft (AG) (a). The celiac artery is rerouted from the trunk of the AG (b). The endografts are placed from the descending thoracic aorta to the AG.

FDG-PET/CT showed focal and heterogeneous uptake of FDG localized to the cross-shaped bypass graft; however, no significant uptake was found around other AGs (Fig 2). Consequently, we performed limited surgery, that is, resection of the cross-shaped bypass graft with in situ reconstruction using autologous grafts, right nephrectomy, infected tissue debridement, and omental flap transposition.

#### OPERATIVE FINDINGS AND TECHNIQUES

1. Through a median laparotomy, we dissected the retroperitoneal space along the cross-shaped bypass graft. The fistula between the graft and the third portion of the duodenum was identified (Figs 3 and 4, A), and segmental duodenal resection was performed. Gastrostomy and jejunostomy were also performed.
2. As per the FDG-PET/CT findings, the infection was macroscopically localized to the cross-shaped bypass graft. The abdominal AG and bypass graft to the celiac artery were encapsulated by fibrous scar tissue.
3. The right kidney was infarcted and a right nephrectomy was performed.
4. To revascularize the left RA and SMA with autologous grafts, we harvested the greater saphenous vein and right external iliac artery (EIA). The EIA was replaced with an expanded polytetrafluoroethylene graft. The left RA and SMA were reconstructed with greater saphenous vein and free EIA grafts, respectively (Fig 4, B).

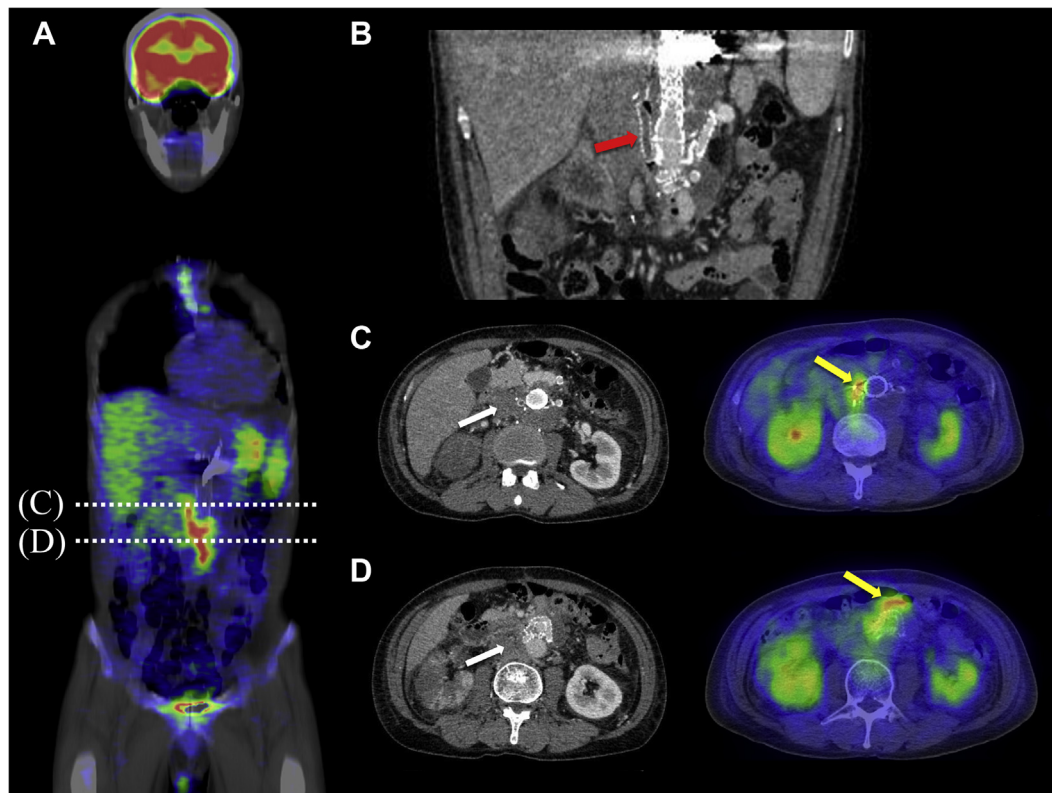
5. The tissues around the infected graft were meticulously debrided and irrigated. The operative field was covered with an omental flap.

*S anginosus* was isolated from all explanted grafts and tissues. Ampicillin/sulbactam was administered at the time of presentation and continued postoperatively. Gastrojejunostomy was performed 10 weeks later, and the patient was discharged after 16 weeks. Oral amoxicillin administration was continued after discharge. The patient has been well with no signs of reinfection for 2 years.

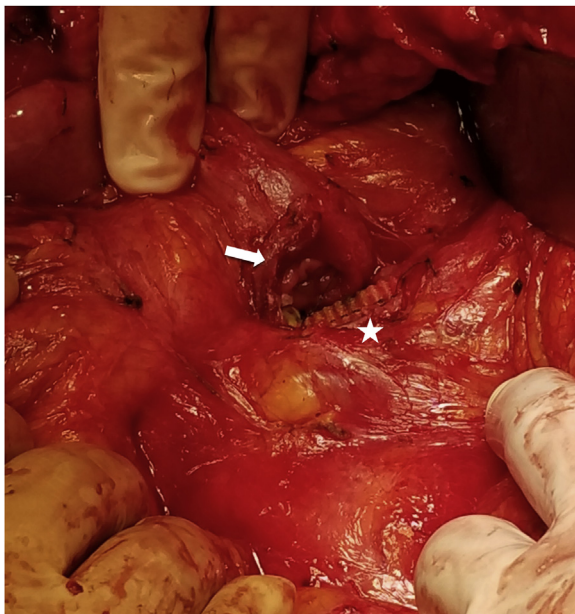
#### DISCUSSION

GDF is a presentation of the VGI after surgical and endovascular aortic repair. It is lethal if untreated and surgical treatment is indispensable; however, there is no consensus regarding surgical treatment of GDF.<sup>1,2</sup> Generally, radical fistulectomy with total excision of the vascular graft or endograft is recommended in suitable patients.<sup>3</sup> However, radical excision is often highly invasive and technically difficult in patients who have undergone extended aortic repair, resulting in high mortality and morbidity. Alternatively, partial excision limited to infected grafts, with preservation of uninfected grafts, may be considered in localized infections.<sup>4</sup> Therefore, the precise distinction between infected and uninfected lesions is essential for successful partial excision.

Various imaging modalities are used for diagnosis of VGIs. CT angiography has been the gold standard modality for VGI; however, its diagnostic accuracy is suboptimal,



**Fig 2.** Preoperative  $^{18}\text{F}$ -fluorodeoxyglucose positron emission tomography combined with computed tomography (FDG-PET/CT) and CT angiography. **A**, Coronal view of FDG-PET/CT. **B**, Coronal view of CT angiography. **C**, Axial view at the level of the graft to the right renal artery (RA). **D**, Axial view at the level of the graft to the superior mesenteric artery (SMA). CT angiography shows fluid collection around the cross-shaped bypass grafts and abdominal aortic graft (AG) (white arrows), with occlusion of the graft to the right RA (red arrows). FDG-PET/CT showed the focal and heterogenous uptake of FDG localized to the cross-shaped bypass graft (yellow arrows); however, no significant uptake was found around the other AGs.

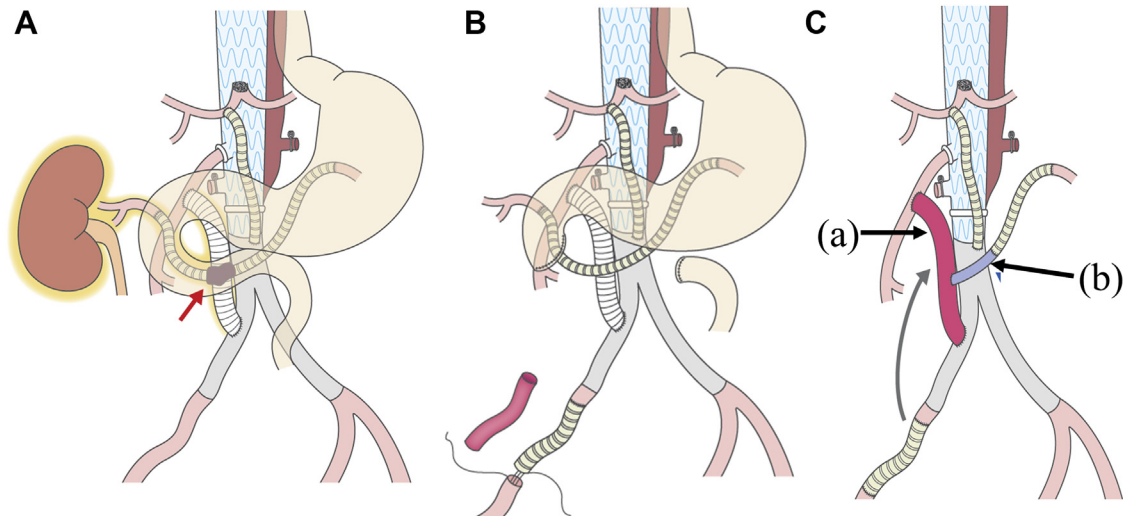


**Fig 3.** An operative photograph of the fistula between the third portion of the duodenum (white arrow) and the bypass graft to the superior mesenteric artery (SMA) (☆).

with 0.67 sensitivity and 0.63 specificity.<sup>5</sup> Additionally, it cannot show the localization of infection. Recently, FDG-PET/CT has been used in infective conditions, including VGI and GDF.<sup>6-9</sup> A meta-analysis by Reinders Folmer et al<sup>5</sup> reported high accuracy of FDG-PET/CT for VGI, with 0.95 sensitivity and 0.80 specificity.

A concern with FDG-PET/CT is whether FDG-negative lesions are uninfected and if they can be preserved. Reinders Folmer et al<sup>5</sup> reported high negative-predictive value as well as high sensitivity, which suggests that FDG-negative lesions have a low possibility of infection. Tokuda et al<sup>9</sup> reported two cases of intrathoracic VGI using FDG-PET/CT. These patients also had abdominal AGs; however, FDG uptake was not observed. They explanted only the FDG-positive thoracic AGs and preserved the abdominal AGs; hence, there was no recurrence of infection. Goto et al<sup>10</sup> also reported a complex case of intrathoracic VGI complicated by an aorto-esophageal fistula. They performed a successful limited surgery based on FDG-PET/CT findings. These reports imply that FDG-negative lesions can be preserved and support our strategy to limit surgery. In the current case, CT angiography





**Fig 4.** Schematic presentations of operative findings and procedures. **A**, The fistula between the cross-shaped bypass graft and the third portion of the duodenum is identified intraoperatively (red arrow). The infection is macroscopically limited to the cross-shaped bypass graft and the right kidney, as expected from the  $^{18}\text{F}$ -fluorodeoxyglucose positron emission tomography combined with computed tomography (FDG-PET/CT) findings (shown in yellow). **B**, Segmental duodenectomy is performed to resect the fistula. A right nephrectomy is also performed. The right external iliac artery (EIA) is harvested and replaced. **C**, The cross-shaped bypass graft is resected, and the SMA is reconstructed with the right EIA (a) and the left RA with the greater saphenous vein (b). The other vascular grafts are preserved.

showed fluid collection apparently involved the abdominal AG; however, FDG-PET/CT showed no significant FDG uptake (Fig 3, C, D). This preoperative finding was consistent with the intraoperative findings, and we were positive in preserving the FDG-negative grafts. Nevertheless, rigorous follow-up is mandatory if some grafts remain. Based on this finding, the long-term suppressive antibiotics was continued, despite the risks of antibiotic resistance and a delay in recognition of recurrence of infection.

Another issue is the choice of graft material for reconstruction. Options in infective condition are venous and arterial autografts, cryopreserved and fresh arterial allografts, or rifampicin-bonded synthetic grafts<sup>11-14</sup>; however, graft choice is virtually limited because cryopreserved or fresh arterial allografts are almost unavailable in our country. The reinfection rate of rifampicin-bonded synthetic graft was higher than that of allografts and autografts, and we avoided placing this graft in the “ground zero” of infection. We believe that autografts are the best choice in this case. We hesitated to use a venous autograft (ie, the femoral vein) or the superficial femoral artery in this urgent setting owing to the longer operation time needed and invasiveness. Moreover, harvesting the femoral vein is associated with venous complications, including venous hypertension and compartment syndrome.<sup>15,16</sup> Thus, the EIA was selected. The potential risks are infection of the prosthetic graft and aneurysmal deterioration of the autograft, particularly in patients with connective tissue diseases. Therefore, close surveillance is required.

## CONCLUSIONS

We described the successful treatment of a patient with GDF after extended aortic repair by partial excision limited to infected lesions based on FDG-PET/CT findings. FDG-PET/CT was helpful in performing an adequate excision of the infected lesions.

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## REFERENCES

1. Chakfé N, Diener H, Lejay A, Assadian O, Berard X, Caillon J, et al. Editor's choice - European Society for Vascular Surgery (ESVS) 2020 Clinical practice guidelines on the management of vascular graft and endograft infections. *Eur J Vasc Endovasc Surg* 2020;59:339-84.
2. Wilson WR, Bower TC, Creager MA, Amin-Hanjani S, O'Gara PT, Lockhart PB, et al. Vascular graft infections, mycotic aneurysms, and endovascular infections: a scientific statement from the American Heart Association. *Circulation* 2016;134:e412-60.
3. Batt M, Feugier P, Camou F, Coffy A, Senneville E, Caillon J, et al. A meta-analysis of outcomes after in situ reconstructions for aortic graft infection. *Angiology* 2018;69:370-9.
4. Hart JP, Eginton MT, Brown KR, Seabrook GR, Lewis BD, Edmiston CE Jr, et al. Operative strategies in aortic graft infections: is complete graft excision always necessary? *Ann Vasc Surg* 2005;19:154-60.
5. Reinders Folmer EI, Von Meijenfildt GCI, Van der Laan MJ, Claudemans AWJM, Slart RHJA, Saleem BR, et al. Diagnostic imaging in vascular graft infection: a systematic review and meta-analysis. *Eur J Vasc Endovasc Surg* 2018;56:719-29.
6. Bruggink JLM, Claudemans AWJM, Saleem BR, Meerwaldt R, Alkefaji H, Prins TR, et al. Accuracy of FDG-PET-CT in the diagnostic work-up of vascular prosthetic graft infection. *Eur J Vasc Endovasc Surg* 2010;40:348-54.
7. Sah BR, Husmann L, Mayer D, Scherrer A, Rancic Z, Puipe G, et al. Diagnostic performance of  $^{18}\text{F}$ -FDG-PET/CT in vascular graft infections. *Eur J Vasc Endovasc Surg* 2015;49:455-64.

8. Saleem BR, Berger P, Vaartjes I, de Keizer B, Vonken EJPA, Slart RHJA, et al. Modest utility of quantitative measures in (18)F-fluorodeoxyglucose positron emission tomography scanning for the diagnosis of aortic prosthetic graft infection. *J Vasc Surg* 2015;61:965-71.
9. Tokuda Y, Oshima H, Araki Y, Narita Y, Mutsuga M, Kato K, et al. Detection of thoracic aortic prosthetic graft infection with 18F-fluorodeoxyglucose positron emission tomography/computed tomography. *Eur J Cardiothorac Surg* 2013;43:1183-7.
10. Goto T, Shimamura K, Kuratani T, Kin K, Shijo T, Masada K, et al. Successful surgery localized to the infected lesion as diagnosed by <sup>18</sup>F-fluorodeoxyglucose positron emission tomography/computed tomography for extended-aortic prosthetic graft infection. *Int J Surg Case Rep* 2019;59:76-9.
11. O'Connor S, Andrew P, Batt M, Becquemin JP. A systematic review and meta-analysis of treatments for aortic graft infection. *J Vasc Surg* 2006;44:38-45.
12. Fields CE, Bower TC. Use of superficial femoral artery to treat an infected great vessel prosthetic graft. *J Vasc Surg* 2004;40:559-63.
13. Chiesa R, Astore D, Melissano C, Jannello A, Frigerio D, Agrifoglio G, et al. Fresh and cryopreserved arterial homografts in the treatment of prosthetic graft infections: experience of the Italian Collaborative Vascular Homograft Group. *Ann Vasc Surg* 1998;12:457-62.
14. Oderich GS, Bower TC, Hofer J, Kalra M, Duncan AA, Wilson JW, et al. In situ rifampin-soaked grafts with omental coverage and antibiotic suppression are durable with low reinfection rates in patients with aortic graft enteric erosion or fistula. *J Vasc Surg* 2011;53:99-107.e7.
15. Clagett GP, Valentine RJ, Hagino RT. Autogenous aortoiliac/femoral reconstruction from superficial femoral-popliteal veins: feasibility and durability. *J Vasc Surg* 1997;25:255-66.
16. Heinola I, Kantonen I, Jaroma M, Albäck A, Vikatmaa P, Aho P, et al. Editor's choice e treatment of aortic prosthesis infections by graft removal and in situ replacement with autologous femoral veins and fascial strengthening. *Eur J Vasc Endovasc Surg* 2016;51:232e9.

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