The Role of $^{18}$F-FDG PET in Aortic Dissection

A acute aortic dissection is relatively rare (approximately 3 per 100,000 person-years) but has a high mortality: between 10% and 30% at 30 d (I). Early diagnosis and treatment are essential for survival. Peak incidence occurs after the age of 60 y with other risk factors including the male sex and hypertension. A typical clinical presentation is of sudden, sharp, central chest pain. Other symptoms (syncope, stroke, myocardial infarction, heart failure) are well recognized. The underlying pathology relates to a tear in the aortic intima, through which blood passes into the media. This process may shear the intima from the media, creating a false lumen that can be localized or can propagate in both antegrade and retrograde directions. If branching arteries of the aorta arise from the false lumen, their blood flow can be compromised, leading to complications of stroke (carotid arteries) and myocardial infarction (coronary arteries). Additionally, blood can track retrogradely toward the heart and aortic valve, causing cardiac tamponade and aortic valve regurgitation, respectively. The intimal tear is frequently associated with cystic medial degeneration of the aorta and the presence of inflammatory cells (I).

Therapy for aortic dissection depends on the extent of the aortic tear. If the ascending aorta is involved (Stanford type A), the management is usually surgical repair with aortic reconstruction as necessary. In contrast, if the dissection is confined to the descending aorta (Stanford type B), the treatment strategy is medical with future surveillance by serial aortic imaging. Medical therapy is aimed at lowering blood pressure and therefore aortic wall stress. Multiple agents are usually needed, with β-blockers being universally recommended as first-line agents (2). Surgery is usually indicated only in type B dissection if there is progression of the dissection (aneurysm formation, occlusion of major aortic branches, aortic rupture) or persistent hemorrhage into the retroperitoneal or pleural space (3). Despite this strategy, medical management fails in a sizeable proportion of patients with type B dissection, and early imaging therefore plays a critical role in identifying patients who require surgery. Either CT or MRI is generally used to measure the maximum diameter of the aorta and to exclude complications. CT is preferred in the acute setting because of its short acquisition time in a potentially unstable patient group, whereas after discharge MRI may be more appropriate for concerns of nephrotoxicity and radiation burden from serial CT studies. Unfortunately, despite close follow-up to detect complications, the death rate among patients with type B dissection remains high—approximately 45% in the 10 y after diagnosis (4). As a result, better imaging methods are still needed for identifying medically treated survivors of type B aortic dissection who are at high risk of complications.

In this issue of The Journal of Nuclear Medicine, Kato et al. examine the use of $^{18}$F-FDG PET for predicting adverse outcomes in aortic dissection (5). It is believed that proteolytic and inflammatory processes are at work in the aortic wall in chronic dissection (2), and the authors hypothesized that $^{18}$F-FDG uptake by the dissected aorta might be a marker of future adverse outcomes. They prospectively recruited a group of 28 patients with aortic dissection—26 patients with Stanford type B and 2 with type A dissections who were refused surgery because of comorbid disease. Kato et al. also recruited 14 age- and sex-matched controls without known vascular disease. Patients with renal impairment, poorly controlled diabetes, collagen disorders, and traumatic aneurysms were excluded. After CT aortography, PET was performed at both 50 and 100 min after $^{18}$F-FDG injection, an average of 13 d after diagnosis. Fused PET/CT images were read for $^{18}$F-FDG uptake in 3 areas—at the point of maximal aortic diameter and both proximal and distal to it. Unfavorable patient outcomes were defined as death from cardiovascular causes, progressive aortic dissection or rupture, conversion to surgery, and occurrence of cardiovascular events during the 6-mo follow-up period.

Of the 28 subjects imaged, 8 had unfavorable outcomes and the remaining 20 had a favorable clinical course. Baseline aortic diameter at the dissection site was greater in the unfavorable group, whereas levels of circulating biomarkers such as high-sensitivity C-reactive protein were not different between the 2 groups. Compared with the controls, both groups with dissection had greater $^{18}$F-FDG uptake proximal and distal to the dissection. Significantly, $^{18}$F-FDG uptake at the point of maximal aortic diameter was higher in those patients destined for unfavorable outcomes than in those in the good prognostic group. Even within the favorable outcome group, lower $^{18}$F-FDG uptake was noted.
among those who had complete resolu-
tion of their dissection than in those
whose aortic diameter stayed un-
changed. After multiple-regression an-
alysis, 18F-FDG uptake at the maximal
area of aortic dissection 50 min after 18F-
FDG injection independently predicted
adverse outcome with an odds ratio of
7.7 (P = 0.0171), although the con-
fidence intervals were wide. The authors
established that a cutoff value of 3 for
standardized uptake value would yield
useful positive and negative predictive
values for adverse patient outcomes. 18F-
FDG uptake after 100 min did not appear
to be as discriminatory as that measured
at 50 min, perhaps because the peak 18F-
FDG uptake period had passed.

The authors conclude that 18F-FDG
PET/CT might have a role in prog-
nosticating patients with type B aortic
dissection. Additionally, 18F-FDG up-
take might be useful in selecting patients
at high risk of near-term complications
for early surgery. The study presented by
Kato et al. complements one published
by Kuehl et al. in 2008 (6). Kuehl et al.
also focused on the aorta of 33 patients
with aortic syndromes but included
subjects with proximal aneurysm as well
as dissection. Although high 18F-FDG
uptake was noted in the aorta of these
patients, the link between 18F-FDG
uptake and outcome failed to reach
significance, except when PET data
were combined with levels of inflam-
matory biomarkers. This may be be-
cause there is believed to be a greater
inflammatory signal in dissection than in
aneurysm (7).

18F-FDG PET/CT has an estab-
lished role in oncology, in which it is
used to identify metastatic disease and
track response to therapy. It has also
been suggested that 18F-FDG uptake
into atherosclerotic plaque may be a
marker of plaque instability (8), and high
levels of 18F-FDG in atheroscle-
rotic arteries have been linked to
cardiovascular risk factors (9), levels
of inflammatory biomarkers (10,11),
and degree of macrophage infiltration
of the underlying lesions (12). Arterial
18F-FDG uptake is also finding a role
in inflammatory and apoptotic processes
and as a surrogate marker of efficacy of
novel antiatherosclerosis therapies
(13), in which it has proven highly
reproducible (14–16). Most impor-
tantly, there is accumulating evidence
from cohorts of patients with cancer
that elevated 18F-FDG levels in the
arteries are linked to a future risk of
cardiovascular events (17,18).

The paper by Kato adds to several
candidate nononcology applications for
18F-FDG PET. Although the study
population was small and the follow-
up short, the authors are to be con-
gratulated in conducting this demanding
imaging study in acutely ill patients.
After confirmatory work, future, larger
studies might test the strategy of an
18F-FDG PET–guided approach to patient
selection for surgery versus current
management. Additionally, elevated
18F-FDG uptake soon after diagnosis
might help to dictate the frequency of
MRI and CT surveillance required on a
personalized patient level. Finally, the
cell type underlying 18F-FDG uptake
in aortic dissection remains unknown.
Although it seems likely that, as in
atherosclerosis, inflammatory cells are
responsible, it will be important to seek
autoradiographic confirmation of this
from patients who proceed to surgery.

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