First Experience of Imaging Large Vessel Vasculitis With Fully Integrated Positron Emission Tomography/MRI

Ingo Einspieler, MD; Klaus Thürmel, MD; Matthias Eiber, MD; Markus Essler, MD

A 58-year-old woman with a history of infrarenal large vessel vasculitis (LVV) was admitted to our hospital with pain in the lower left abdomen. Considering the history of vasculitis, clinical symptoms, and slightly elevated parameters of inflammation (CRP: 0.5 mg/dL; norm, <0.5 mg/dL; blood sedimentation rate: 39 mm/hour; norm, <30 mm/hour), a $^{18}$F-fluoro-deoxyglucose (FDG) positron emission tomography/MRI (PET/MR) scan was performed to identify suspected recurrent vasculitis.

A whole-body integrated PET/MR system (Biograph mMR) was used combining MRI and PET into 1 imaging modality. This allows truly simultaneous acquisition and thus facilitates highly accurate spatial coregistration of PET and MRI data. The combined PET/MR acquisition was performed 140 minutes after injection of 417 MBq $^{18}$F-FDG. A coronal T2w short $\tau$ inversion recovery sequence was performed to outline the extent of potential edema in the vessel wall. Whole-body contrast-enhanced magnetic resonance angiography (MRA) was performed to identify potential arterial stenosis or occlusions and to monitor a previously diagnosed aneurysm of the ascending aorta. The extent of the potential aortic inflammatory process was studied using an axial T1w fat-suppressed dark blood sequence before and after contrast media application.

PET/MR revealed an extensive active inflammation of the infrarenal aortic wall, including the aortic bifurcation (Figures 1–3; Movie I in the online-only Data Supplement). Furthermore, contrast-enhanced MRA showed a previously known aneurysm of the ascending aorta of 5 cm in diameter (Figure 4), which was stable in follow-up. Because of the high inflammatory activity seen on PET/MR images along with the clinical presentation, a therapy with glucocorticoids and methotrexate was started. A few weeks later, pain in the lower left abdomen and slightly elevated inflammation values disappeared (CRP: 0.2 mg/dL; norm, <0.5 mg/dL; blood sedimentation rate: 12 mm/hour; norm, <30 mm/hour). In addition, follow-up an ultrasound examination showed a reduction of the diameter of inflamed aortic wall of 0.5 cm matching the clinical improvement.

The most commonly used imaging modalities for LVV, such as giant cell arteritis or Takayasu arteritis, are CT (computed tomography), CTA (computed tomography angiography), MRI, MRA, and ultrasound. Furthermore, $^{18}$F-FDG-PET has emerged as a powerful tool for the assessment of disease activity in initial diagnosis and therapy monitoring. Although PET is highly sensitive in detection of inflammatory activity, morphological assessment is limited because of the relatively low spatial resolution. Therefore, a combination with CT in terms of PET/CT is routinely used. However, with regard to soft-tissue contrast, CT is clearly inferior to MRI. The latter has shown the ability to allow assessment of inflammation in early and late stages of LVV in addition to detailed morphological information, whereas $^{18}$F-FDG-PET was proved to be superior to MRI in determining the extent of vasculitis. Therefore, the combination of $^{18}$F-FDG-PET and MRI has the potential to offer not only sensitive estimation of inflammatory processes in large vessels, but also detailed morphological analysis, which enables exact coregistration and differential diagnosis to other inflammatory aortic diseases such as inflammatory abdominal aortic aneurysm or retroperitoneal fibrosis. To date, only a few preliminary reports deal with the combined use of PET and MRI in the evaluation of LVV as separate procedures. To our knowledge, our report is the first describing the application of fully integrated PET/MR in vasculitis. Usually, LVV is diagnosed by the existing professional diagnostic criteria (eg, the American College of Rheumatology [ACR] criteria), which are not fulfilled in this case. Regarding the ACR criteria, for instance, the erythrocyte sedimentation rate has to be $\geq$50 mm/hour. However, it is well known that, in contrast to the early stages of LVV, laboratory inflammatory parameters are of limited value in the estimation of disease activity in later disease stages. Nevertheless, this important fact is unfortunately not taken into account in the ACR criteria. In this case, the erythrocyte sedimentation rate was only slightly elevated (39 mm/hour; norm, <30 mm/hour), which did not fit the ACR criteria, although vasculitis was present, which was shown clearly by PET/MR. Thus, the existing diagnostic criteria are useful but limited. Therefore, an imaging modality such as PET/MR would be crucial for disease classification. Furthermore, PET/MR
probably raises sensitivity in the detection of inflammation and allows exact morphological allocation of the PET data, which might be superior to $[^{18}\text{F}]$-FDG-PET/CT and the merging of nonsimultaneously acquired PET and MRI. Moreover, in contrast to CT or PET/CT, PET/MR is associated with less exposure to radiation, which might be a good point given the relatively young age of vasculitis patients. In the future, PET/MR may become standard of care in the evaluation of LVV.

Disclosures

None.

References


Key Words: positron-emission tomography • magnetic resonance imaging • vasculitis

Figure 1. Coronal slices of positron emission tomography (PET; A), T2w short tau inversion recovery (STIR; B), and fused PET/MRI images (C) show an intense radiotracer uptake in the infrarenal aortic wall (red arrow) as well as wall thickening and edema (white arrow) over ≈7 cm. The fused data set showed a perfect coregistration and excellent concordance of PET and T2w STIR images (C), which was visually ascertained by 2 experienced readers (1 nuclear medicine physician and 1 radiologist).

Figure 2. Axial T1-weighted fat-suppressed dark blood images (top) show thickening of the aortic wall (red arrow) with infiltration of the surrounding mesenterium before (A) and after (C) application of contrast media, as well as significant contrast enhancement of the infrarenal aortic wall indicating active inflammation (C). The corresponding axial positron emission tomogram (bottom) with pathological $[^{18}\text{F}]$-fluoro-deoxyglucose accumulation in the center (B), which exactly projects onto the thickened wall seen on MRI (D).
Figure 3. Three-dimensional fusion of maximum intensity projection–contrast-enhanced magnetic resonance angiography and positron emission tomography (PET) demonstrates normal contrast enhancement in the vessels but intense and extensive accumulation of [18F]-fluoro-deoxyglucose surrounding the infrarenal aorta including the aortic bifurcation (white arrow), corresponding to the inflamed aortic wall seen. PET shows that no other vessel segment is involved. High uptake in projection on the renal pelvis and bladder is related to physiological excretion.

Figure 4. Multiplanar reconstruction–contrast-enhanced magnetic resonance angiography in sagittal (A), axial (B), and coronal (C) view shows aneurysmatic dilatation of the ascending aorta (red arrows) with ≈5 cm in diameter.
First Experience of Imaging Large Vessel Vasculitis With Fully Integrated Positron Emission Tomography/MRI
Ingo Einspieler, Klaus Thürmel, Matthias Eiber and Markus Essler

doi: 10.1161/CIRCIMAGING.113.000778

The online version of this article, along with updated information and services, is located on the World Wide Web at:
http://circimaging.ahajournals.org/content/6/6/1117

Permissions: Requests for permissions to reproduce figures, tables, or portions of articles originally published in Circulation: Cardiovascular Imaging can be obtained via RightsLink, a service of the Copyright Clearance Center, not the Editorial Office. Once the online version of the published article for which permission is being requested is located, click Request Permissions in the middle column of the Web page under Services. Further information about this process is available in the Permissions and Rights Question and Answer document.

Reprints: Information about reprints can be found online at:
http://www.lww.com/reprints

Subscriptions: Information about subscribing to Circulation: Cardiovascular Imaging is online at:
http://circimaging.ahajournals.org//subscriptions/