Glucose Metabolism in the Vessel Wall Correlates With Mechanical Instability and Inflammatory Changes in a Patient With a Growing Aneurysm of the Abdominal Aorta

Christian Reeps, MD; Michael W. Gee, PhD; A. Maier; Jaroslav Pelisek, PhD; Manuela Gurdan, MD; Wolfgang Wall, PhD; Jan Mariss, MD; Hans-Henning Eckstein, MD; Markus Essler, MD

It has been shown by our group and by others that increased glucose metabolism in the aortic wall of patients with aneurysms of the abdominal aorta (AAA) can be visualized in vivo by $^{18}$F-fluorodeoxyglucose positron emission tomography (FDG-PET). Interestingly, an increased glucose metabolism in AAA wall was strongly associated with rapid progression or acute symptoms and therefore increased rupture risk. Moreover, the PET signal was correlated with histopathological changes such as activation of MMP-9, collagen, and elastic fibers as well as macrophage infiltration in the AAA wall. (It is well documented by preclinical studies that increased activity of MMP9 facilitates aneurysm rupture). However, the true prognostic value of increased FDG uptake for AAA progression and rupture risk.

Figure 1. Coronal and axial CT sections of the aneurysm in the baseline (A and C) and in the follow-up scans (B and D). Red arrow indicates the area with the maximum glycolytic activity. E. Three-dimensional reconstruction with aneurysm wall displacement of the initially small (right) and later large aneurysm (left). Color scale indicates high (red) or low (blue) wall displacement to stress.

From Klinik und Poliklinik für Gefäßchirurgie (C.R., J.P., M.G., H.-H.E.), Nuklearmedizinische Poliklinik (M.E.), and Institut für Radiologische Diagnostik (J.M.), Klinikum-rechts-der-Isar, München, Germany; and Lehrstuhl für Numerische Mechanik (W.W.), München, Germany.

Correspondence to Markus Essler, MD, Nuklearmedizinische Poliklinik, Klinikum-rechts-der-Isar, Ismaningerstr 22, 81675 München, Germany. E-mail Markus.Essler@gmx.de

© 2009 American Heart Association, Inc.

Circ Cardiovasc Imaging is available at http://circimaging.ahajournals.org

DOI: 10.1161/CIRCIMAGING.109.858712
still remains uncertain. To provide clear evidence, surveillance of small AAA by multiple PET scans would be necessary over a long period. However, PET studies are not routinely performed in patients with AAA for practical and ethical reasons and therefore an increase in glucose metabolism in AAA wall was not directly observed until now. Further, it is not clear whether biomechanical conditions of AAA such as peak wall stress or wall displacement are relevant for FDG uptake.

In this report, we describe a patient with a malignant melanoma with coincident and initially small infrarenal AAA who was examined by PET/computed tomography (CT) for staging and follow-up. During surveillance, the AAA showed rapid progression associated with strongly increased glucose metabolism. The AAA was repaired and histopathological as well as computed biomechanical properties were analyzed.

**Case Presentation**

A 55-year-old patient with a malignant melanoma of the left upper neck, infiltrating the skull base, was referred to PET/CT for exclusion of distant metastases. PET revealed intensive FDG uptake in the primary tumor but not metastases. On diagnostic CT scans, a concomitant small AAA was detected. The maximal diameter of the aneurysm was 46 mm and the length was 70 mm. The renal arteries were not included in the aneurysm. The glycolytic activity in the AAA wall was normal without accentuation (Figure 1B and 1D). The patient was presented to the tumor board and the vascular board of our hospital. It was decided to treat the tumor by radiochemotherapy (Dacarbazine and 60 Gy); regarding the AAA, recommendation for surveillance was given. Six months later, the patient was referred to PET/CT for restaging after radiochemotherapy. PET/CT imaging revealed total local and systemic tumor control by the radiochemotherapy. In contrast, the AAA showed rapid expansion to 60 mm maximum diameter with focally intensified aortic FDG uptake (SUVmax, 6.1; SUVmean, 4.8) at the bottom of the AAA sack on PET but without clinical symptoms (Figure 1B and 1D). The case was discussed again by the vascular board, and prophylactic AAA repair was recommended. During open surgery, samples of AAA wall at areas with low and highly increased FDG uptake were operatively retrieved. Wall samples were immunohistologically processed and evaluated for inflammation, elastin, and collagen fiber degradation and the expression of MMP2 and MMP9 by semiquantitative analyses (Figure 2).

**Discussion**

The patient had rapid progressive infrarenal AAA within 6 months and markedly increased glucose metabolism at the AAA sack in parallel. Moreover, compared with the baseline...
study, increased glycolytic activity correlated well to biomechanical calculated increase of AAA wall displacement. Furthermore, changes in glycolytic activity and AAA wall displacement were associated with inflammation, macrophage infiltration, and MMP2 and MMP9 activity, suggesting a causal relationship of AAA biomechanics with underlying histopathological changes detected by FDG-PET/CT. Further studies about these correlations and their predictive role for AAA progression or AAA rupture risk are needed to establish glycolytic activity as a novel biomarker in risk stratification of such patients.

Disclosures

None.

References


Glucose Metabolism in the Vessel Wall Correlates With Mechanical Instability and Inflammatory Changes in a Patient With a Growing Aneurysm of the Abdominal Aorta

Christian Reeps, Michael W. Gee, A. Maier, Jaroslav Pelisek, Manuela Gurdan, Wolfgang Wall, Jan Mariss, Hans-Henning Eckstein and Markus Essler

doi: 10.1161/CIRCIMAGING.109.858712

_Circulation: Cardiovascular Imaging_ is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 75231
Copyright © 2009 American Heart Association, Inc. All rights reserved.
Print ISSN: 1941-9651. Online ISSN: 1942-0080

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/2/6/507

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/