

## Correlation between inflammation as assessed with $^{18}\text{F}$ -FDG PET and microvasculature as assessed with Dynamic Contrast-Enhanced MRI in carotid atherosclerotic plaques

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**Purpose:** Identifying vulnerable atherosclerotic plaques in symptomatic patients with moderate (30-69%) carotid artery stenosis can contribute to clinical decision making. According to the current guidelines, most patients in this category are not operated. One of the hallmarks of plaque vulnerability is inflammation which can induce hypoxia and, subsequently, increased plaque microvessel density which is considered as another hallmark of plaque vulnerability. Inflammation can be assessed with  $^{18}\text{F}$  FDG PET, while plaque microvasculature can be quantified with dynamic contrast-enhanced (DCE)-MRI. Our main objective was to investigate whether there is a correlation between inflammation as assessed by  $^{18}\text{F}$ -FDG PET imaging and neovascularisation as assessed by DCE-MRI.

**Methods:** Fifty-eight patients with a transient ischemic attack (TIA) or minor stroke in the carotid territory and ipsilateral carotid plaque causing a moderate stenosis as assessed by ultrasound were included. All patients underwent a multi-sequence MRI protocol on a 1.5T MR scanner equipped with a dedicated 47-mm-diameter surface RF coil. T1-weighted fast field echo DCE-MRI (TR/TE = 12/3 ms, flip angle 35°, FOV 100x100 mm, matrix size 256x256, acquired in-plane resolution 0,39mm) was performed by acquiring 10 transverse over-contiguous slices for 16 time frames with a typical separation of 25 seconds (depending on gate width) between frames during ~ 7 minutes. At the beginning of the 3<sup>rd</sup> time frame, 0.1 mmol/kg body weight of gadopentate dimeglumine (Magnevist, Bayer Schering Pharma) was injected. To analyse the DCE-MRI images, lumen contours were manually drawn on 3D TOF images of type III-VIII plaques (1), using dedicated software (VesselMASS, LUMC, the Netherlands). For outer vessel wall, contours were manually drawn using a combination of 3D T1w TFE, multislice T2w TSE and pre- and post-contrast 2D T1w TSE images. Both contours were copied to the DCE-MRI images (figure 1). These images were shifted manually to correct for small patient movement and, if necessary, contours were slightly adapted. Quantification of neovascularisation was done by using a custom-made Matlab program which calculates  $K^{\text{trans}}$  using the Patlak model (2). A 3D PET-CT scan was performed on all patients one hour after injection of 2.75 MBq/kg body weight of  $^{18}\text{F}$ -FDG as described by Kwee et al. (3). Mean time interval between  $^{18}\text{F}$ -FDG PET and MRI was 5.7±3.7 days. After the PET scan, contrast-enhanced CT images were obtained using 90 mL of iobitridol (Xenetix 350; Guerbet). Regions-of-interest encompassing the vessel wall, were manually drawn on the CT images and were transferred onto the co-registered PET images. Dedicated fusion software was used to calculate mean  $^{18}\text{F}$ -FDG standard uptake values (SUV) of the plaque, which were normalised for blood  $^{18}\text{F}$ -FDG activity by dividing them through the mean blood SUV.

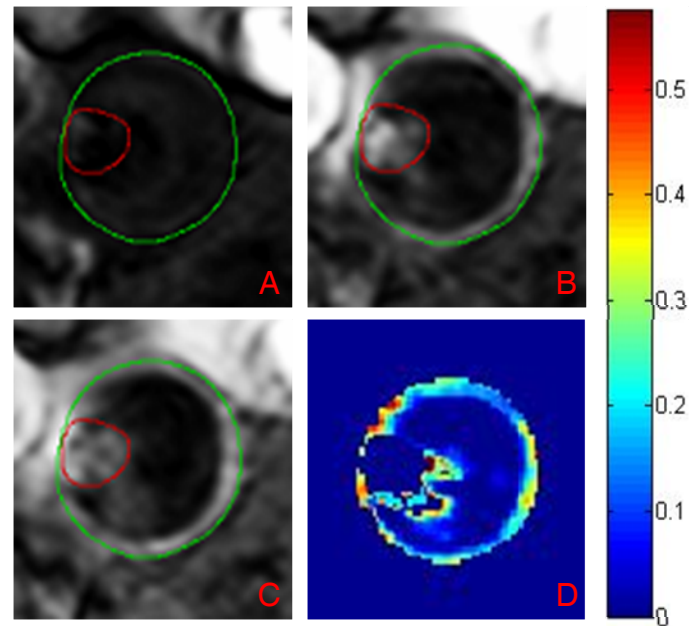
**Results:** Of the 58 patients, 9 were excluded due to poor image quality of the DCE-MRI, leaving 49 patients for further analysis. The mean  $K^{\text{trans}}$  was 0.110 (± 0.027) min<sup>-1</sup>, the 75 percentile  $K^{\text{trans}}$  was 0.146 (± 0.042) min<sup>-1</sup>. The mean normalised SUV was 1.446 (± 0.255). We found a weak but significant positive correlation between the mean SUV and the mean  $K^{\text{trans}}$  (Spearman's  $r=0.302$ ,  $p=0.035$ ). A similar Spearman correlation ( $r=0.294$ ,  $p=0.041$ ) was found using the 75 percentile.

**Discussion:** There is a weak but significant positive correlation between  $K^{\text{trans}}$ , which is a marker for neovascularisation, evaluated by DCE-MRI, and inflammation as assessed by  $^{18}\text{F}$ -FDG PET.  $^{18}\text{F}$ -FDG PET and DCE-MRI are therefore not interchangeable.

**Conclusion:** Future studies are warranted to investigate whether DCE-MRI and/or  $^{18}\text{F}$ -FDG PET can be used to predict cerebrovascular events.

**References:** 1) Cai JM, Hatsukami TS, Ferguson MS, et al. Classification of human carotid atherosclerotic lesions with in vivo multicontrast magnetic resonance imaging. *Circulation*. 2002;106(11):1368-73, 2) Gaens ME, et al. *Proceedings ISMRM 2011*:1229, 3) Kwee RM, Truijman MT, Mess WH, et al. Potential of integrated [ $^{18}\text{F}$ ] fluorodeoxyglucose positron-emission tomography/CT in identifying vulnerable carotid plaques. *AJRN*. 2011;32(5):950-4

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**Figure 1** DCE-MRI slice on different time points before (A) during (B) and after (C) contrast injection with matching  $K^{\text{trans}}$  map (D)