Regional effects of type 2 diabetes mellitus on cerebral blood flow and brain anatomy using MRI and Continuous Arterial Spin Labeling MRI at 3 Tesla

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Introduction

Cerebrovascular reactivity reflects the ability of cerebral microvasculature to adapt to metabolic demands and systemic blood pressure fluctuations and to maintain steady cerebral perfusion. Continuous Arterial Spin Labeling (CASL) perfusion magnetic resonance imaging (MRI) has already proven its ability to measure cerebrovascular reserve[1]. The goal of this study was to determine the regional effects of type 2 diabetes (DM) on cerebral blood flow and on brain anatomy using CASL MRI at 3 Tesla.

Materials and method

Twenty-six healthy subjects (13 men, 13 women, mean age ± SD: 60.0 ± 8.6 years) and twenty-six subjects (13 men, 13 women, 61.5 ± 6.3 years) with type 2 DM (for 13 ± 11 years) were studied. Controls were not treated for any systemic disease; DM subjects with strokes, cardiac, renal or cotidal disease were excluded. MR imaging was performed using a whole-body 3 T MRI scanner (GE Signa Vhi) with quadrature head coil. All subjects had routine T1-weighted inversion-recovery fast gradient echo (IR-FGE) imaging. 

%BF was computed as the percent of blood flow augmentation during RB compared to blood flow reduction during HV. The percent of CO₂ change between RB and HV (%CO₂) was also computed. One-way ANOVA was used for statistical comparisons.

Results

Figure 1 presents the method that was used to define the regions and to assess the spatial distribution of WMC on a FLAIR slice. Perfusion and CO₂ were significantly different between breathing exercises (p < 0.0001), but were not between healthy subjects and DM groups. %CO₂ was not different between the groups. %BF was preserved in both sides of C and in T-R but was significantly reduced in DM compared to healthy subjects in F (L: p = 0.05, R: p = 0.03), PO (L: p = 0.05, R: p = 0.01) and T-L (p = 0.02). WMC distribution was different between the regions (p < 0.0001), but volume was not different between groups. For the DM, CSF volume was higher in all regions (p < 0.04) except in PO-R and in both C regions. For the whole brain, GM and WM volumes were lower in the DM compared to the control group (p < 0.03).

Discussion - Conclusion

Regions could be computed on all images; this approach allows spatial distribution comparisons without using any registration step, providing significant advantage for comparisons of images with low spatial resolution (i.e. for the perfusion map). Anatomical changes associated with type 2 DM are indicative of brain atrophy and may contribute to the decrease of the vascular reserve. Association between WMC and perfusion warrants further investigations.

References


Figure 1: Definition of the anatomical regions on a FLAIR slice. An ellipse is fitted on the brain ROI (A). The medial axis of the smallest rectangle including the ellipse was then computed allowing the delineation of 8 regions. In B, 6 regions were defined on the ROI: left and right sides for the frontal (the 2 darkest ones), temporal (the 2 intermediate ones) and parieto-occipital (the 2 brighter ones) regions. The WMC segmentation corresponding to slice A is shown on C. The WMC volume could be computed on each region to assess its spatial distribution. The same protocol was used for the IR-FGE and for the perfusion maps.

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