

Title

Ultrasonic imaging assessment of cerebral blood flow changes during ischemia in 7-day-old rat and correlation with infarct volume

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Objectives

In the rat pup stroke model, the size of the ischemic lesion is not constant and varies without possibilities of prediction for size. Part of this variability may depend on the blood flow changes through the circle of Willis. Our aim was to quantify the cerebral blood flow changes occurring during ischemia and to correlate those data with the infarct volume.

Methods

Ischemia was induced in twenty 7-day-old rat pups by permanent electro-cauterization of the left middle cerebral artery (MCA) followed with a transient occlusion of homolateral common carotid artery (CCA). Blood flow velocities (BFV) in the basilar trunk (BT), internal carotid arteries (ICA) and anterior, middle and posterior cerebral arteries were measured with 12MHz ultrasound imaging. Ultrasound study was repeated at different times : 1) before surgery, 2) after occlusion of the left MCA and homolateral CCA, 3) after removal of the occlusion of the CCA and 4) 24h after onset. After sacrifice on day 1, infarct volume was determined by TTC-staining.

Results

Cerebral blood flow adaptation after ischemia was heterogeneous among rat pups. In our study, 12 had a large increase of BFV (>10 cm/s) in the controlateral ICA and the BT after the occlusion of the left MCA and homolateral CCA. 8 had small or no increase. Results were classified according to infarct volume. Rat pups with small size infarcts showed a great increase of BFV in the controlateral ICA (mean : 26.5 cm/s) and the BT (16.5 cm/s). Conversely, rat pups with large infarcts showed a small or no increase of the BFV (ICA : 1.5 cm/s, BT : 1,8 cm/s). The results were significant for the ICA ($p=0.022$) and the BT ($p=0.0421$).

Conclusions

Our results show 1) an heterogeneous blood flow adaptation during ischemia among rat pups and 2) the association between the changes of BFV in the controlateral ICA and the BT and the infarct volume. ICA and BT are upstream from the circle of Willis. The BFV increase in those arteries means an increase of blood flow through the circle of Willis and so, possibly a better brain perfusion during ischemia through the cortical anastomoses. We conclude that blood flow adaptation after ischemia is heterogeneous and that this variability could explain the heterogeneous size lesion. Ultrasound imaging allows the assessment of the blood flow changes. In preclinical studies, this method could help to identify what can be assigned to a neuroprotective treatment and what depends on changes in cerebral blood flow supply.