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MRI for estimating the microglia activity in ICH stroke

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Background and Purpose: During intracerebral hemorrhage (ICH), blood is released from the vasculature into the brain matter. Erythrocytes (red blood cells) are cleared from the parenchyma by microglia/macrophages. During this process heme is metabolized by hemeoxygenase (HO; primarily, HO-1) to biliverdin, carbon monoxide (CO), and pro-oxidative iron[1, 2]. Oxidative stress appears to play a prominent role in ICH pathogenesis. Direct evidence for the causal relationship between free radicals and ICH injury was by demonstrating the efficacy of antioxidants as therapeutic agents[1, 2]. Specifically, the free radical scavengers, such as dimethylthiourea, α-phenyl-N-tert-butyl nitrone, NXY-059 (a sulfonyl derivative of α-phenyl-N-tert-butyl nitrone) or deferoxamine, a drug chelating pro-oxidative iron, significantly reduced brain injury in animal models of ICH[1].

Non-invasive monitoring of microglia/macro phages activity will definitely help the clinicians who are treating the ICH stroke patient. Here we are presenting a simple reliable technique which can compare the microglia activity using MRI.

Methods: Patient exams were performed under an IRB-approved protocol. MR images of 6 ICH patients were used for this study at two different time intervals from the occurrence of the stroke. Isotropic T1/T2 with 3 mm^3 spatial resolution were used for this work. Clinical exams were acquired on 3.0 T scanners (GE, DVMR 20.1IB, Milwaukee, WI).

Data analysis: The hematoma region was segmented and reconstructed for high resolution isotropic volume through cubic spleen interpolation to extract the inner details from the isotropic T2W volumetric images of these stroke patients using 3D Volumetric analysis tool combined with other modules of Analyze 11.0 software (Analyze 11.0; Biomedical Imaging Resource, Mayo Clinic, Rochester, MN).

Results: Figure 1 shows the schematic representation of high resolution segmented hematoma region at day 3 & day 18 for two age & sex matched ICH stroke patients with different size of hematoma at 3 ± 1 days from the onset and 18 ± 2 days from the onset. We can see the black patched/dotted regions in all time periods and are increasing as time of occurrence increasing from the onset of stroke. The black patched/dotted regions may be attributed to the trapped CO gas in the hematoma during the process of microglia activity/ formation of ferritin from hemoglobin. Few of them we observed (figure not shown) decreasing of this activity after about a month.

Conclusion: On the long run, this technique will help the ICH stroke treating physician if the drug that he/she is using is working or not. More work towards the development and validation of this technique is under progress.

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