

Quantitative dynamic contrast-enhanced MRI: a potential tool for guiding treatment decisions in acute ischemic stroke

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Introduction: Increased risk of intracranial hemorrhage limits the general use of tissue plasminogen activators (t-PA) in acute ischemic stroke (AIS). Although t-PA represents an important step forward in AIS management, there is a clear need to make this treatment available to a higher number of patients while reducing the risk of hemorrhagic transformation (HT). Thus, a method that identifies patients at higher risk of HT is mandated for a successful application of t-PA. The purpose of this study was to detect and quantify BBB defects shortly after onset of ischemic injury (within a few hours) and to examine whether these defects are larger in patients being treated with t-PA.

Materials and Methods: Thirty three patients (16 females, 17 males, age range 38-80years) with acute ischemic stroke were examined within 5 hours of symptom onset. 14 out of 33 patients received t-PA. MR imaging was performed after admission CT and included anatomical, diffusion and perfusion imaging, as well as contrast-enhanced MRA. In addition, a 3D gradient-echo (GRE) dynamic contrast-enhanced (DCE) MRI exam was performed to assess permeability/BBB integrity. All imaging was performed on a 1.5T GE Signa MR system (GE Healthcare, Milwaukee, USA) equipped with echospeed gradients and a standard neurovascular head coil. Imaging parameters for the dynamic 3D GRE acquisition were as follows: FOV 240mm, 128 x 128 matrix, FA=20 deg, slice thickness 7mm, TR=5.9ms, TE=1.5ms. Total acquisition time was 4:48 min for a collection of 31 volumes. Contrast media (Omniscan, GE Healthcare, USA; total volume of 15cc Gd-DTPA) was injected as a bolus 30 seconds following the start of the 3D acquisition. Data was transferred to an independent workstation for quantitative analysis. Parametric maps of permeability (KPS) were calculated as described previously by Roberts et al [1]. Two ROIs were selected - with one placed on the core region of the diffusion abnormality or if present on the permeability abnormality (which was always within the diffusion abnormality). The second was placed on the homologous location in the contra-lateral normal hemisphere. Mean and SEM were recorded and examined for statistical significance using linear and multiple regression, respectively.

Results: Nine cases (5 received t-PA, 4 did not) showed progressive enhancement associated with increased permeability in the acute phase. All 9 went on to hemorrhage at 48 hrs post symptom onset. KPS in the lesion of these cases was significantly elevated compared to the contralateral normal hemisphere ($p < 0.01$). All other cases showed no significant increase in permeability ($p = 0.2$). Comparison of KPS in the lesion between the 2 groups (HT and non-HT) resulted in a significant difference ($p < 0.0001$) shown in figure 1. The differential effect of t-PA in those who did and did not hemorrhage was also significant ($p = 0.0153$). ADC was reduced in all cases within the infarct zone but not significantly different between those who hemorrhaged and those who did not ($p < 0.50$).

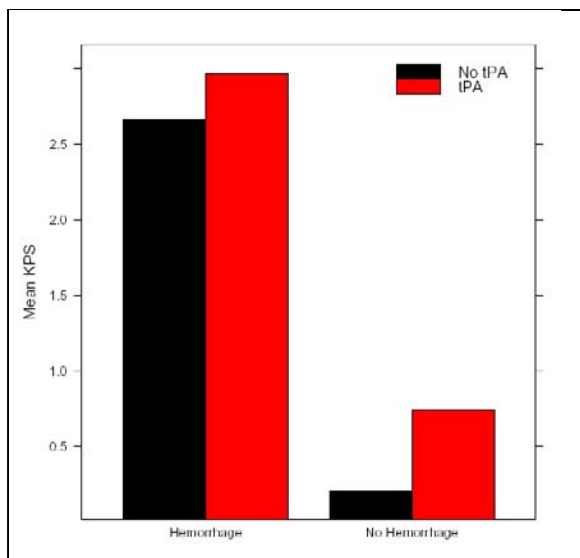


Figure 1: KPS in HT vs non-HT patients

Discussion: This study shows that early BBB defects in AIS can be assessed using quantitative DCE MRI. Significantly increased permeability was found in 9 cases which later on hemorrhaged. The highest KPS values were found in the t-PA group. This method indicates the potential to identify patients at higher risk of HT and may allow to use physiological imaging rather than time from onset of symptoms to guide the decision to treat with t-PA. This could lead to an extension of the treatment window beyond current time constraints in those patients who have a stable BBB.

References: 1. HC Roberts et al.; AJNR 21(5):891-9, 2001