Global Cerebral Edema in Patients with Subarachnoid Hemorrhage: Correlation with Blood-Brain Barrier Permeability

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Purpose:

Global cerebral edema (GCE) in aneurysmal subarachnoid hemorrhage (SAH) is an important predictor of morbidity and mortality. Early detection of GCE remains challenging. Perfusion deficits in SAH patients who develop GCE are thought to be related to impaired autoregulation and blood-brain barrier permeability (BBBP) dysfunction. Computed tomography perfusion (CTP) with full pass technique allows measurement of BBBP in the clinical setting. We assessed whether alterations in BBBP correlate with GCE by studying PS (permeability surface area product), K-trans (flow rate constant from blood plasma to the extravascular extracellular space (EES)), Kep (flow rate constant from EES to blood plasma), and F (blood flow per unit volume of tissue).

Materials and Methods:

IRB approval was obtained. Thirty-three SAH patients underwent CTP on admission and at subsequent time points in the early (days 0-3) and delayed phases (days 4-16). Patients were stratified into three outcome groups as GCE, non-GCE and indeterminate based on their admission noncontrast CT using established criteria via blinded consensus reading from two board-certified neuroradiologists. Computed tomography perfusion data were postprocessed into BBBP quantitative maps of PS, K-trans, Kep and Flow using Olea Sphere software (Olea Medical, LaCiotat, France). A total of 2401 ROIs were obtained from the 31 patients included in the analysis. Unpaired t-Tests were performed. In the primary analysis comparing the GCE and non-GCE groups, the indeterminate patients were excluded. A secondary analysis was performed to include indeterminate patients with the GCE group and then the non-GCE group, separately.

Results:

A total of 31 patients were included in the statistical analysis; 48.4% (15/31) were classified as GCE, 31.9 % (13/31) as non-GCE and 9.7% (3/31) as indeterminate. The primary analysis revealed that PS, K-trans and F were decreased significantly in GCE compared to non-GCE both in the early and late phases. However, Kep was elevated significantly in GCE compared to non-GCE in both the early and late phases. The secondary analysis demonstrated that the results from the primary analysis are not altered when Indeterminate patients are added to the GCE or non-GCE groups (Figure 1).

Conclusions:

Our findings support the hypothesis that altered BBBP function occurs early and remains altered in GCE after SAH. Patients with GCE have significantly decreased PS and Ktrans and significantly elevated KEP, likely due to predominance of flow in the EES to plasma direction given the high volume in the EES. These findings further contribute to our understanding of the pathophysiologic mechanisms underlying GCE.

Adult Brain:

New Techniques/Postprocessing

Adult Brain - Secondary:

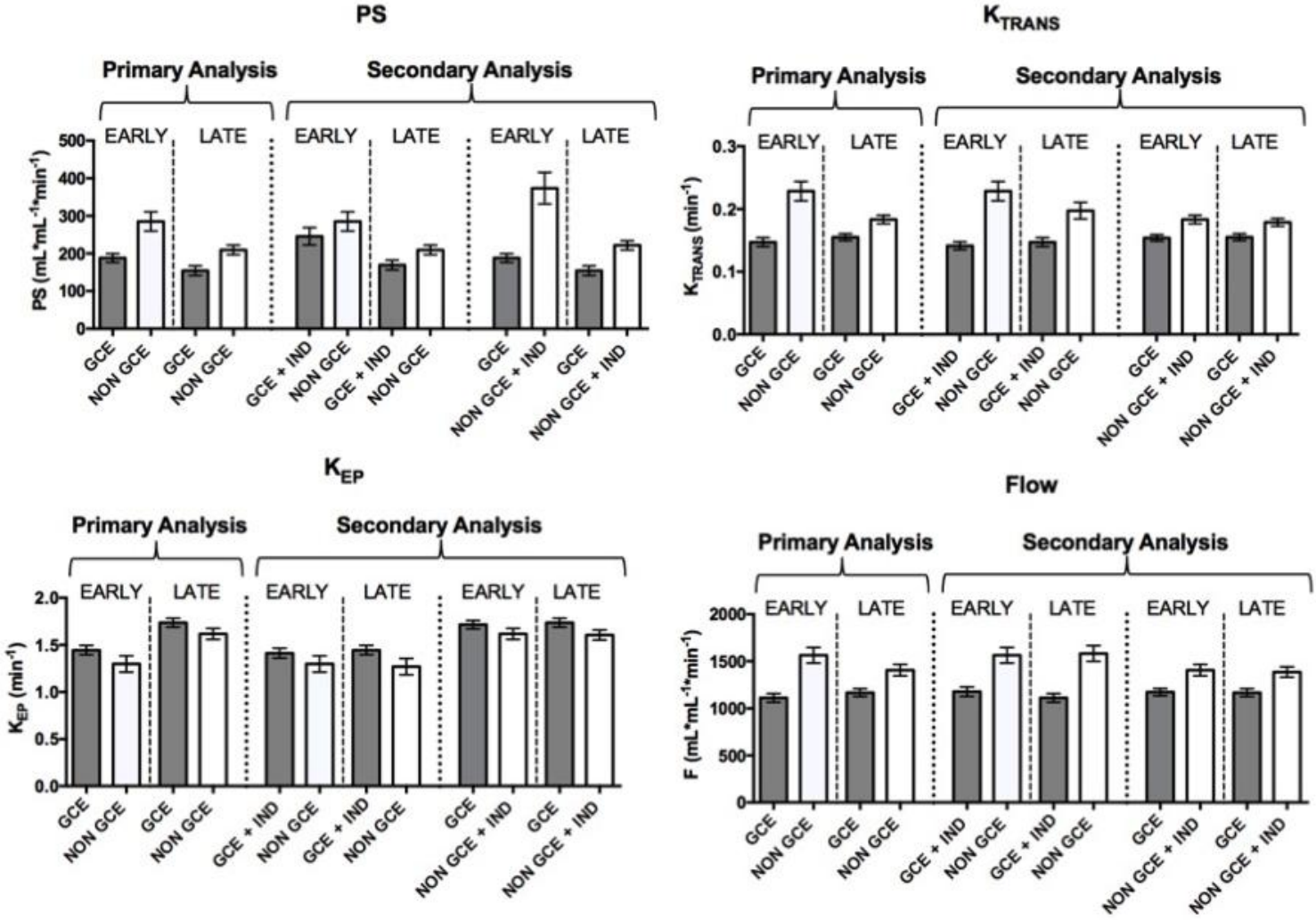
Aneurysms, diagnosis

Keywords:

Aneurysmal Subarachnoid Hemorrhage

Cerebral Edema

CT Perfusion



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