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Comparison of Perfusion Magnetic Resonance Imaging with Single Photon Emmission Computed Tomography in Patients with Ischemic Cerebrovascular Disease

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Stroke and cerebrovascular disease are the third leading cause of death in the Western world after cardiovascular disease and malignancies. In order to improve the outcome of stroke and thereby lessen the consequences of stroke on the individual and society, early therapy of acute stroke is mandatory. New appropriate and prompt therapeutic measures, like intravenous thrombolysis, should be guided by accurate and fast diagnosis for which a suitable method is missing from the present clinical routine.
A new, fast, accurate, non-invasive diagnostic method for the assessment of cerebral hemodynamics, perfusion magnetic resonance imaging (perfusion MRI), is evaluated through a comparison with single photon emission computed tomography (SPECT). Perfusion MRI and SPECT were performed within in 40 patients with cerebral infarction and/or carotid artery stenosis within one week. Perfusion MRI is based on the susceptibility effect of an intravascular contrast agent, resulting in local megnetic field inhomogeneity and signal intensity decrease in dynamic T2*-weighted images. A fast low angle shot (FLASH) sequence was used to acquire the T2*-weighted images for one slice containing the suspected lesion after bolus application of the contrast agent. A SPECT scan was obtained with the lipophilic perfusion tracer 99mTc-ECD whose retention in the brain parenchyma is linked to stereospecific enzymatic deesterification to acid derivatives. The corresponding slices and regions of interest in perfusion MRI and SPECT images were selected utilizing a computerized surface matching method. The size of the infarcted area and semiquantitative perfusion parameters--maximal signal intensity decrease (MSID), relative regional cerebral blood volume (rrCBV), normalized first moment (NFM) in perfusion MRI, and photon count in SPECT--were measured in the whole hemisphere, in white matter, and in the ischemic region both on the healthy and on the ischemic side. A subset of patients with relatively hyperperfused infarcts was detected by visual analysis of the perfusion MRI images.
The comparison between perfusion MRI and SPECT suffers two major drawbacks. First, the lower spatial resolution of SPECT makes the delineation between ventricle and the adjoining white matter, the detection of small lesions, and the matching of images difficult or inaccurate. Second, the lack of imaging relative hyperperfusion with 99mTc-ECD results in disconcordant measurements in patients with relatively hyperperfused

infarctions. Despite the problem associated with the comparison, 99mTc-ECD was chosen for the study due to its better availability and stability compared to other tracers. Additionally, a high rrCBV value in the perfusion MRI measurement could be a result of high blood flow or of autoregulatory vasodilation with low blood flow, while SPECT activity is-although curvilinearly- proportional to blood flow, being another possible cause of discrepancy between the measurements.

The ischemic area could be detected in 21 patients with SPECT and in 22 patients with perfusion MRI. The measured area was comparable between both methods (difference ≤ 20% or ≤ 1 cm2) in 12 of 22 patients. The rrCBV ratio and the SPECT count ratio of the ischemic and healthy hemisphere was correlating (difference ≤ 0.2) in 77.5% of patients in the hemisphere, in 60% in white matter, and in 52% in the region of interest. The highest correlation was found in the stenosis group (85.7% in the hemisphere and white matter) and in the infarction group in the hemisphere (86.6%). In the infarction group 60% of patients had correlating measurements in white matter and in the ischemic region, while in the stenosis and infarction group 66.6%, 50% and 46.6% in the hemisphere, white matter, and the ischemic region, respectively. Disregarding patients with relative hyperperfusion there is a substantially higher proportion of correlating measurements. Equivalence testing did not reveal any significant difference between perfusion MRI and SPECT.

The applied perfusion MRI technique is a reliable method for the assessment of cerebral perfusion, that can be used on conventional MRI scanners without hardware modification, adds only a few minutes to the MRI examination and does not expose the patients to ionizing radiation. With standard scanners, however, only one slice can be imaged with the required spatial and temporal resolution. Echo planar imaging (EPI), a new fast technique using strong gradients, allows multislice imaging and quantification of cerebral blood flow, although requires relatively expensive specific hardware.

Perfusion MRI can guide treatment of acute stroke and monitoring of therapeutic responses, as well as aid in evaluation of cerebral hemodynamic status in carotid artery stenosis, indicating stroke prophylaxis therapy. The role of perfusion MRI in the assessment of other intracranial disorders needs to be investigated.

Although the comparison with 99mTcECD is controversial and necessitates further comparative studies, perfusion MRI proved to be an effective method for evaluating cerebral hemodynamics.