Diffusion- and Perfusion-Weighted Imaging in Acute Stroke: How Well Do Diffusion Restricted, Perfusion-Diffusion Mismatch Ratios and Hypoperfused Volumes Correlate with Clinical Outcomes?

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Purpose:

Treatment decisions in patients with acute stroke often are made based upon imaging findings at MR imaging (MRI) including diffusion (DWI) and perfusion (PWI) sequences. The role of "penumbra" imaging, however, is still not established in clinical practice. Our aim is to correlate stroke outcome with DWI restricted lesion volume and volume of hypoperfused brain tissue.

Materials and Methods:

We obtained IRB approval for this retrospective study. We did a search for MRI performed with PWI for evaluation of acute stroke. Our search returned 197 patients. Thirteen patients were excluded from the final analysis (12 had no PWI performed and 1 PWI study was performed for evaluation of brain tumor, not stroke). On a Vitrea workstation, we utilized OLEA software for postprocessing of PWI and DWI studies. The arterial input function was selected automatically by the software. The following perfusion parameters were obtained: mean transit time (MTT), cerebral blood flow (CBF), cerebral blood volume (CBV) and Tmax. The DWI lesion volume was calculated by setting an ADC value threshold level to match the DWI abnormality. The volume of hypoperfused brain tissue was calculated using the Tmax, with threshold level typically set at six seconds. Finally, we performed a chart review to correlate the clinical outcomes with the DWI restricted volumes and volumes of hypoperfused brain tissue. In our initial evaluation, we assessed the first 35 patients. Treatment outcomes were defined as the change in NIH Stroke scale value (NIHSS) between admission and discharge. A poor clinical outcome was defined as a decrease in NIHSS less than four. We performed a statistical analysis utilizing the SPSS Statistics Data Editing software. We performed a Pearson correlation in order to identify how well hypoperfused volume, DWI restricted lesion volumes and PWI-DWI Mismatch Ratios correlated with NIHSS values at admission and discharge.

Results:

There were 35 patients in our initial evaluation with average age 69 years (range 40-92 years). There were 15 males and 20 females. Eight patients were excluded from our final analysis due to the absence of either an admission or discharge NIHSS value. The range of diffusion restricted lesion volumes included in the initial evaluation was 2.3-153 mL. The range of hypoperfused volumes included in the initial evaluation was 0.46-243 mL. Fourteen patients had a poor clinical outcome as defined by our study. The mean of DWI restricted lesion volumes in this subset of patients was 48.6 mL [standard deviation (std. dev.) 43.6]. The mean of hypoperfused volumes in this subset of patients was 92.5 mL (std. dev. 53.5). Thirteen patients had a good clinical outcome as defined by our study. The mean of DWI restricted lesion volumes in this subset of patients 35.2

mL (std. dev. 36.7). The mean of hypoperfused volumes in this subset was 61.9 mL (std. dev. 55.5). No significant difference in DWI restricted lesion volumes or hypoperfused volumes between our two subsets of patients was seen. A statistically significant correlation was detected between hypoperfused volumes and DWI restricted volumes ($r=0.753$, $p<0.001$), NIHSS at admission ($r=0.700$, $p<0.001$), and NIHSS at discharge ($r=0.748$, $p<0.001$). The DWI restricted lesion volumes also correlated significantly with the NIHSS values at admission ($r=0.535$, $p=0.004$) and discharge ($r=0.507$, $p=0.01$), although to a lesser degree. The PWI-DWI mismatch ratios showed no significant correlation to either NIHSS value at admission or discharge. A partial correlation of hypoperfused volumes and NIHSS values was performed, controlling for age, sex and DWI restricted volume. This showed that hypoperfused volume has a statistically significant correlation with NIHSS values at admission ($r=0.592$, $p=0.004$) and discharge ($r=0.662$, $p=0.001$), independently of the other variables.

Conclusions:

In our initial assessment of 35 patients, those with poor outcomes tended to have higher DWI restricted volumes and hypoperfused volumes relative to those who had good clinical outcomes, although this did not reach statistical significance. We were able to show that there is a statistically significant correlation between hypoperfused volumes and NIHSS values at admission and discharge. A significant correlation also is seen between DWI restricted volumes and NIHSS values, although to a lesser degree. The correlation of hypoperfused volumes with NIHSS values was independent of DWI restricted lesion volume, age and sex. No significant correlation is seen with PWI-DWI mismatch ratios and NIHSS values at admission or discharge, emphasizing that mismatch ratios must be interpreted in the context of DWI restricted lesion and hypoperfused volumes. We believe that a further analysis of the remaining patients in our study will allow us to better delineate the relative importance of DWI restricted lesion and hypoperfused volumes in stratifying patients for potential treatment.

Adult Brain:

Stroke

Adult Brain - Secondary:

Functional Imaging (fMRI, MEG, MRS, PET, DTI, SPECT, connectivity studies)

Keywords:

Diffusion-Perfusion Mismatch

Diffusion-Weighted Imaging

Stroke

Reference One:

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