THE VALUE OF DIFFUSION AND PERFUSION MRI OF THE BRAIN IN COMATOSE PATIENTS TREATED WITH MILD HYPOTHERMIA AFTER CARDIAC ARREST

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Background: The incidence of in-hospital cardiac arrest (IHCA) ranges between 1-5 events per 1,000 hospital admissions or 0.175 events pr. bed annually. Brain damage is the most common cause of death among these patients. Approximately 15-20 % of the patients survive. It has been shown that mild therapeutic hypothermia (32 – 34 °C during 12-24 h) is effective as post-arrest treatment to decrease the harmful effects on the brain.

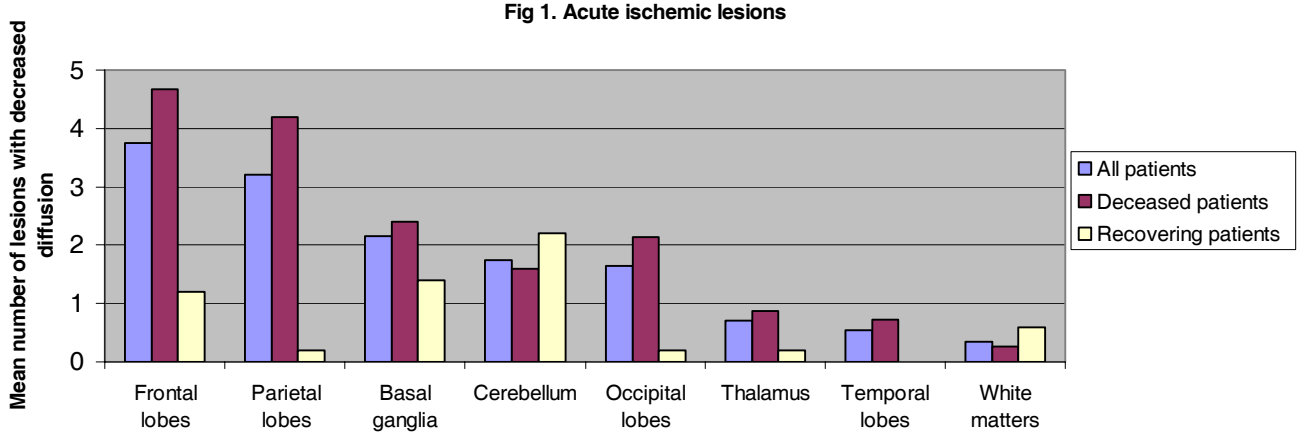
Purpose: To obtain increased knowledge about cerebral diffusion and perfusion MR-findings after a cardiac arrest in patients treated with mild hypothermia. This may enhance the possibility to predict the outcome and adapt further treatment.

Patients: Prospective study from 2003 to 2006 of 20 patients (11 men and 9 women, mean age 57.8, range 14-81) who all underwent therapeutic mild hypothermia as a neuroprotective maneuver after either in-hospital or out-of-hospital cardiac arrest. Patients, who did not regain consciousness after normalized body temperature, were examined with MRI and included in this study. The study was approved by the local ethics committee.

Methods: 12 patients had undergone a clinical acute CT examination after the cardiac arrest to exclude hemorrhage. MRI was performed at 3T (Siemens Allegra Head scanner or Philips Intera) 39-334 hours (median approximately 5 days) after cardiac arrest. In addition to conventional morphological MRI sequences, diffusion weighted imaging (DWI) was performed in all patients using a spin echo EPI sequence. Perfusion weighted imaging (PWI) was performed in 7 patients using a gradient echo EPI sequence. Mean ADC-values were measured in a 1cm^2 region of interest (ROI) in the cerebellum, basal ganglia, thalamus, centrum semiovale and pons. Lesions with decreased diffusion, as seen in acute ischemic lesions, outside these ROIs were counted. Perfusion maps including rCBF were calculated using an in-house developed analysis program (LuPE). The arterial concentration time integral was scaled by a venous output function to improve absolute quantification. rCBF maps were compared with a group of normal volunteers. Autopsy was performed on two patients.

Results: Five out of the 20 patients survived their cardiac arrest. Old age was associated with poor outcome. Initial CT scan showed no acute pathology in any of the patients. The ADC values were lowest in the cerebellum (mean 0.72 x10^{-3} mm^2/s).The number and locations of acute ischemic lesions are shown in Fig 1. The patients who died had the largest number of such lesions. Watershed lesions were common in all patients. Perfusion changes (>2 SD compared with the normal material) were found in 6 patients. Four of them had increased perfusion in one or several regions, whereas two of them had decreased perfusion. Histopathology at autopsy showed cortical, cerebellar and hippocampal neuron death, as well as ischemic white matter pathology in one of the patients, corresopnding to the pathology seen on MRI. The other autopsy confirmed acute ischemic necrosis in the cortex and brain edema, as predicted in vivo on DWI.

Fig 1. Acute ischemic lesions



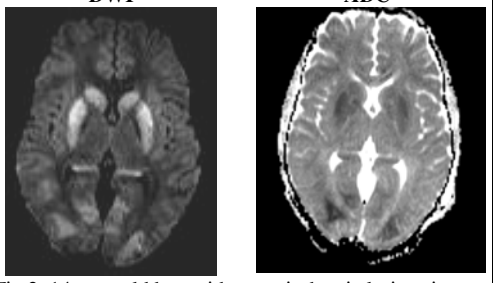


Fig 2: 14-year-old boy with acute ischemic lesions in the basal ganglia and cortex (hyperintense on DWI-left image, hypointense on ADC-map-right image).

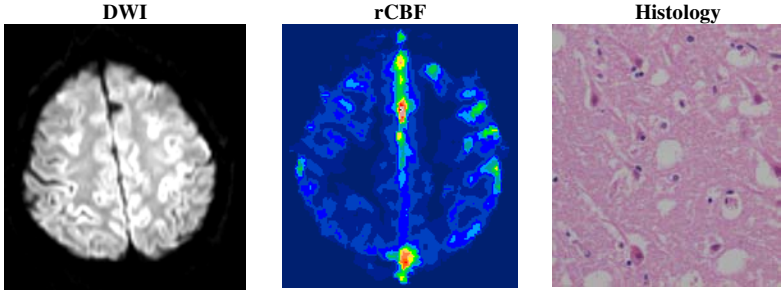


Fig. 3: 81-year-old man with acute ischemic lesions in the cortex. rCBF- map shows decreased perfusion in the corresponding areas. Histology from autopsy reveals neuron death with eosinophilic shrinkage and vacuolization in the cortex.

Conclusions: Cerebellum had the lowest mean diffusion. The largest number of acute ischemic lesions on DWI was found in the frontal and parietal lobes. The greatest difference in incidence of acute ischemic lesions, between the patients who died and the ones who survived, was found in the parietal lobe. Among the survivors, no lesions with decreased diffusion were found in the temporal lobes. Hyperperfusion was seen more often than hypoperfusion in the six patients with abnormal perfusion. There was a good agreement between the autopsy findings and the DWI appeareance. MRI with DWI and PWI is a potentially helpful tool for evaluation of prognosis and for treatment decisions in comatose patients treated with mild therapeutic hypothermia after cardiac arrest.