T2 time increase as an indicator of the early ischemic edema in acute stroke

T. Kucinski[1], S. Jung[1], R. Knab[2], C. Saager[1], B. Geisler[1,2], J. Fiehler[1], J. Röther[2], H. Zeumer[1]

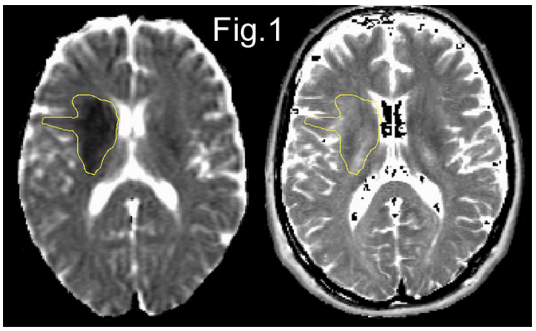
[1]Neuroradiology, University-Hospital Hamburg-Eppendorf, Hamburg, Germany, [2]Neurology, University-Hospital Hamburg-Eppendorf, Hamburg, Germany

Introduction and Purpose

The decrease of the apparent diffusion coefficient (ADC) tags tissue with severe metabolic impairment in acute ischemic stroke. Early recanalisation of the occluded artery may reverse ADC decrease and preserve tissue from final infarction. Hence, the ADC does not necessarily define the irreversibly damaged ischemic core. The early ischemic edema (EIE) is the result of tissue water increase, which is well known as early ischemic signs on computed tomography (CT) scans. These are generally not reversible and delineate the infarct core more specifically in very early stages. Measurements of the tissue T2 time are correlated with water increase (1) and thus may provide an equivalent of the early CT signs. To investigate quantity and spatial distribution of the EIE with MRI, quantitative T2 maps were calculated and compared with the ADC decrease.

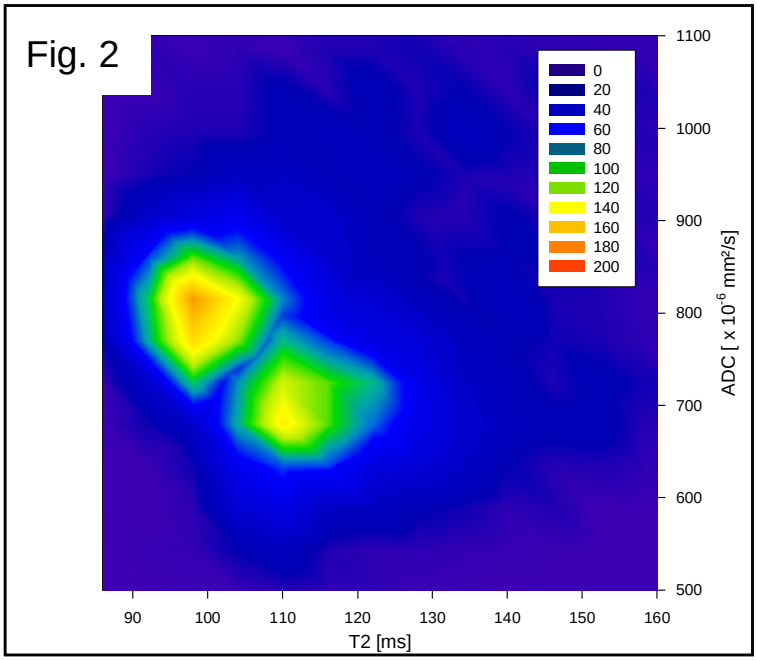
Methods

26 patients with symptoms of acute ischemic stroke of the middle cerebral artery territory were studied within 1.5 – 4.8 hours after onset (mean 3.0). The imaging protocol included diffusion weighted imaging (DWI) with b values of 0, 500 and 1000 and a triple-echo T2 turbo spin echo sequence (TE1-3 = 15,75,135; TR = 3000 ms). The ADC and quantitative T2 (qT2) maps were calculated by monoexponential fitting. Regions of interest (ROIs) with decreased ADC were surrounded and transferred onto the qT2 maps (Fig. 1), mirror ROIs of the contralateral hemisphere served as control. The decrease of ADC (mean control values minus lesion ROIs) was correlated with the increase of T2. Quantitative evaluation included mean and pixel-by-pixel correlation of ADC and T2 times.



Results

Mean ADC decrease in all patients was 170 x 10^{-6} mm²/s (lesion = 636 x 10^{-6} mm²/s, control = 806 x 10^{-6} mm²/s) and correlated (r = 0.39, p = 0.046) with a T2 increase of 5 ms (lesion = 113 ms, control = 108 ms). Compared with values from the literature, this represents about 1.3% net water increase within 3 hours (mean) and lies within the magnitude assessed by CT (2). A graphic pixel-by-pixel correlation of ADC and T2 (Fig. 2, colors = frequency of pixels) generally showed a shift from normal ADC and T2 values in unaffected control ROIs (left, upper “island”, Fig. 2) to a decrease of ADC with simultaneous increase of T2 in ischaemic regions (right, lower “island”).



Conclusions

Early T2 increase within 4.8 hours of acute ischaemic stroke can be visualized and quantified. T2 increase correlates with ADC decrease and represents a tool to investigate net water increase (EIE). Like early CT signs, distinct T2 increase may serve as an indicator of severe ischemia and irreversibly damaged brain tissue.

References

1. Boisvert DP, Handa Y, Allen PS. Proton relaxation in acute and subacute ischemic brain edema. *Adv Neurol* 1990;52:407-413.

2. Kucinski T, Vaterlein O, Glauche V, et al. Correlation of apparent diffusion coefficient and computed tomography density in acute ischemic stroke. *Stroke* 2002;33:1786-1791.