Sensitivity of the Diffusion-Weighted Imaging B-value to detect hippocampal sclerosis in Temporal Lobe Epilepsy

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INTRODUCTION: Diffusion-weighted MR imaging (DWI) studies have shown that apparent diffusion coefficients of water (ADCw) are reduced during the acute seizure state in experimental temporal lobe epilepsy (TLE), and maintained or increased in later stages [1,2]. This effect may be caused by the initial cytotoxic edema induced by excitotoxicity [3]. In humans, most reports have addressed only focal DWI abnormalities in the course of the ictal state, discarding the analysis of the chronic TLE phase where there is evidence of established hippocampal sclerosis (HS). This work aims to report and discuss the DWI findings in chronic, refractory TLE patients with histological and quantitative structural MRI evidence of HS using different levels of diffusion weighting.

SUBJECTS AND METHODS: Eight age-matched controls and fifteen patients were studied with DWI, using three different weightings (b1=1000, b2=1500, b3=3000 s/mm²) obtained along identical hippocampal planes, on the coronal axis. TLE patients enrolled for amygdalo-hippocampal resection were selected from the local surgery for epilepsy program. Additionally, quantitative MR-based coronal T1 volumetry (3D) and T2 relaxometry (T2-r), and axial chemical-shift (CS) were performed prior to surgery as part of ours comprehensive multimodal epilepsy evaluation. To obtain each individual mean hippocampal isotropic diffusion map, ADCw values were averaged from four rostro-caudal orthogonal DWI partitions using ROIs of constant size (20mm²). ROIs were drawn by two observers, according to each subject’s anatomical landmarks as observed from the original T2-DWI image and the 3D data set. ADCw data was correlated with histological observations of HS and quantitative MRI.

RESULTS: In all fifteen patients, ipsilateral ADCw increased a mean of 23% (b1), 18% (b2) and 12% (b3) interictally in the ipsilateral hippocampus, where the side of seizure focus was determined electrographically and confirmed by quantitative MRI. Individually, all ipsilateral hippocampi data from b1 and b2 showed ADCw values 2.5 SD higher than controls, while 5 patients from b3 study fell below this limit. Moreover, ADCw values correlated best with both hippocampal volume decrease (r=0.75), T2-r increase (r=0.81) but not with CSI NAA/(Cho+Cre) (r=0.31) with the b1 protocol.

CONCLUSIONS: Increased ADCw can identify pathology associated with the impairment of the structural organization in sclerotic hippocampi and confirm seizure lateralization. Brain tissue with interictally increased ADCw may represent an epileptogenic region with neuronal loss, gliosis, and expanded extracellular space. Quantitative measurements of diffusion which use weighted values up to b=1500 can be used in the localization of seizure focus for pre-surgical screening of chronic TLE.

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References: