Tailored single voxel Short TE MR spectroscopy in temporal lobe epilepsy - absolute quantification with partial volume correction for cerebrospinal fluid

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Introduction
Single voxel proton magnetic resonance spectroscopy (1H MRS) has shown abnormalities in patients with temporal lobe epilepsy (TLE), but has been performed with long echo times (TE) and large voxels (1).

Partial volume effects from cerebrospinal fluid (CSF) contained in the spectroscopy voxel can not easily be excluded, especially in the presence of atrophy, which is the main feature of hippocampal sclerosis (HS), a very common pathology underlying TLE. The increasing use of absolute quantitation in 1H MRS makes it necessary to minimize the diluting influence of partial volume effects. We tailored the size of the voxel to the size of the individual hippocampus (HC), quantified N-acetyl aspartate (NAA), creatine (Cr), choline (Cho), glutamate (Glu) and inositol (Ins) from short TE spectra and corrected these concentrations with a measure of CSF partial volume in the voxel, in controls and patients with HS.

Methods
15 healthy controls (7 women, 8 men; median age 30 years, range 21 - 60 years) and 10 patients with clinically unilateral TLE and HS (5 women, 5 men; median age 26.5 years, range 20 - 36 years) were investigated using a 1.5 T GE Signa scanner and a standard head coil (GE, Milwaukee). The diagnosis of unilateral HS was based on qualitative and quantitative assessment of hippocampal atrophy and high signal on T2 weighted images.

1H MRS voxels were positioned on axial T1 weighted images of the HC along the long axis of the HC. Voxel size was tailored to the size of the HC. 1H MRS was performed using the following parameters: PRESS, TR 3000 msec, TE 30 msec, 256 - 384 averages. The quantitation was performed using a frequency domain fitting program (LCModel (2)) and a calibration factor estimated from an external phantom containing a 50 mmol solution of NAA (3). T1 and T2 corrections were applied (3). A normal range of metabolite concentrations was defined as the mean ±3 SD.

The amount of CSF in the spectroscopic voxel was segmented on contiguous coronal T1 weighted images with a slice thickness of 1.5 mm by drawing around the CSF manually in an area representing the voxel's rectangle inplane and expressed as percentage of the prescribed voxel.

The correction for CSF dilution used the formula Cm = (Cmea x100)/(100-CSF); Cmea is the measured concentration and CSF the percentage of CSF in the voxel.

Results
In controls, the absolute concentration of all metabolites did not correlate with the fraction of CSF (Fig.1). Therefore, the correction for CSF dilution did not improve the coefficient of variation for these values (tabl. 1). There was no difference in the mean fraction of CSF between controls and patients.

Before partial volume correction, six out of ten HS patients had abnormally low NAA concentrations on the side of pathology, of whom two also had abnormal NAA values on the contralateral side, although less marked. After partial volume correction, four out of ten HS patients were abnormal ipsilaterally and none bilaterally.

Before and after partial volume correction, Ins was abnormal ipsilaterally to HS in three patients. The concentrations of Cr and Cho did not differ between control and patient group. All in all, six out of ten patients were abnormal on quantitation of NAA and Ins both, before and after partial volume correction.

Discussion
Exploiting the increased information content of short TE 1H MRS, we identified low concentrations of NAA and high concentrations of Ins in individual patients with TLE and HS, possibly representing neuronal loss and gliosis. Although Glu was detectable, there was no significant difference between patients and controls.

Tailoring the size of the single voxel to the size of the HC, leads to a similar fraction of CSF in controls and patients. After partial volume correction for CSF, however, the method gained lateralizing specificity.

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References