Multi-slice echo planar spectroscopic imaging measures pathology in cerebral cortex in multiple sclerosis

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Introduction: Conventional MRI, although essential in multiple sclerosis (MS), provides no or very little information on cortical pathology. It is well known from post-mortem studies that cortical lesions exist in MS, and the lacking assessment of these lesions might explain some of discrepancies between conventional MRI and the clinical status of the patients. N-acetyl-aspartate (NAA) provides information on cortical neuronal loss or dysfunction, and choline (Cho) provides information on membrane turnover. We present echo planar spectroscopic imaging (EPSI) as a promising technique to measure metabolic changes in cerebral cortex in a reproducible way.

Subjects and Methods: The multi-slice EPSI sequence described in [1] was applied to 18 patients with early relapsing-remitting MS and 18 healthy control persons. Sequence parameters: TE/TR = 144/3360 ms. Matrix 32 x 32. Inversion recovery provided lipid signal nulling, and water suppression was obtained using a 32 ms chemical shift selective radiofrequency pulse. A water reference measurement served as a line shape model. Eight 10 mm slices covered most of the cerebrum with 1 cm^3 isotropic voxels. A conventional MRI (FLAIR) was performed to improve the anatomical information. A border of approximately 1 cm was semi-automatically selected at the surface of the brain for spectroscopic evaluation (fig. 1). Areas known to degrade spectral quality because of susceptibility problems (e.g. frontal cortex) or surrounding lipids were excluded. The study was performed on a Siemens Vision 1.5 T whole-body scanner using a standard CP head coil. The total scan time was 35 minutes. Finally, seven healthy controls were rescanned within a week for validation purposes.

Results: Spectra and metabolites (Cho, creatine (Cr), NAA) were measured in the selected regions of interest (ROIs). The spectra were mostly of good quality (fig. 1). Data from 3 patients and 3 controls were excluded based on reduced spectral quality. The metabolites were calculated as ratios to correct for CSF content, coil sensitivity variation and oedema. The within-subject variation for the seven rescanned controls was smaller than the variation between subjects. The intra-class correlation coefficient (ICC) for NAA/Cr was 0.56, and 0.76 for Cho/Cr (fig.2). No significant differences in cortical NAA/Cr between the MS patients and the controls were found. Cho/Cr, however, were found to be lower in the MS group compared to the healthy controls (5.7 % reduction, p=0.05) (fig. 3).

Discussion/Conclusion: From post-mortem studies it is well known that MS lesions exist in cerebral cortex. Information on cortical pathology is wanted in MS, since conventional MR techniques reveal no or very few lesions in this region. Measuring cortical pathology might improve the correlation between MRI and disability and thereby the estimations of the prognosis of the disease. In this case FLAIR was used to select ROIs containing mostly cerebral cortex in a simple reproducible way. It is known that the concentrations of NAA, Cr and Cho differ between grey and white matter, and that these concentrations change differently with age in healthy people. Furthermore, different changes in the total volume of grey and white matter, and CSF are seen with normal ageing [2]. This complicates the interpretation of the data, which may reflect changes in metabolite concentrations or relaxation times as well as atrophy.
Multi-slice echo planar spectroscopic imaging is shown to measure cortical metabolite ratios in a simple and reproducible way in MS and this technique is suggested to evaluate metabolic changes in the cortex in longitudinal studies correlating these changes to clinical data.

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References: [1] Hanson LG et al. Magn Reson Med 2000;44:412-417. [2] Pfefferbaum et al. Magn Reson Med 1999;41:276-284.

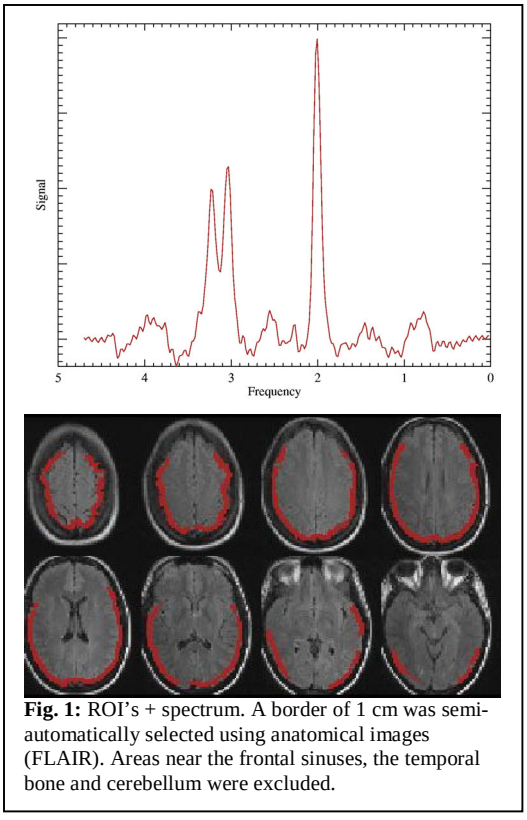

Fig. 1: ROI's + spectrum. A border of 1 cm was semi-automatically selected using anatomical images (FLAIR). Areas near the frontal sinuses, the temporal bone and cerebellum were excluded.

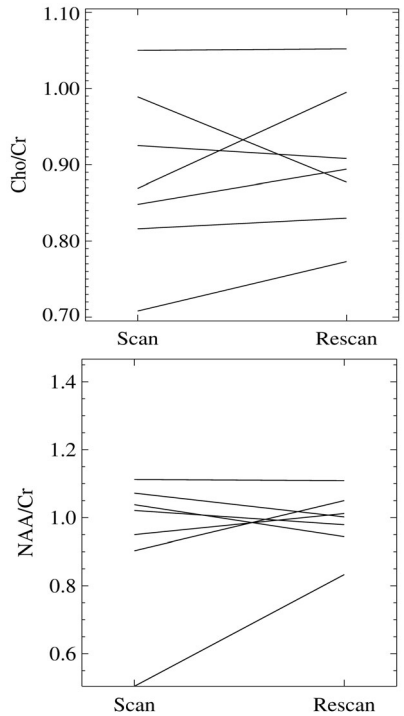

Fig. 2: Reproducibility study. Seven healthy control persons were rescanned within a week. ICC(Cho/Cr)=0.76. ICC(NAA/Cr)=0.56.

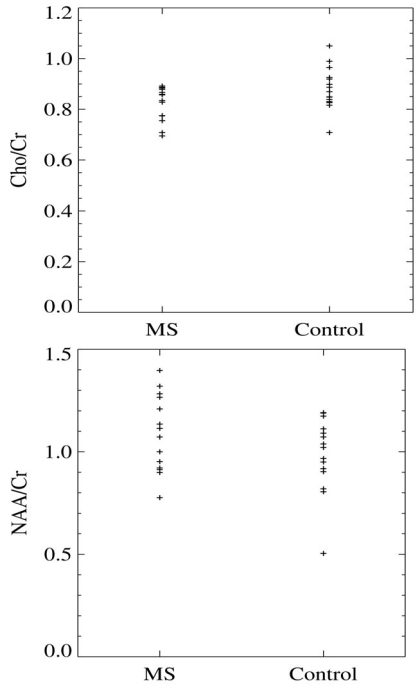

Fig. 3: Cortical Cho/Cr is significant lower in the MS patients compared to the controls. 5.7 % reduction, p=0.05. No significant differences in NAA/Cr in the two groups.