In vivo visualization of multiple sclerosis cortical lesions by high resolution MRI at 3T

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Introduction:

It is now well established that white matter (WM) pathology reflects only part of the spectrum of damage in patients with multiple sclerosis (MS); demyelination in the cortical grey matter (GM) is also a significant factor. Neocortical lesions (NL) have been extensively described in *post-mortem* studies on both MS patients [1] and animal models of MS [2]. Recently, the usage of a double inversion recovery technique has been demonstrated to be a promising tool for detecting *in vivo* NL in patients with MS [3]. *In vivo* detection of NL by means of MRI poses several problems due to their small size relative to image resolution, the partial volume effect with the cerebrospinal fluid surrounding the cortex, and the low contrast between GM lesions and the surrounding tissue. NL identification is further limited by the fact that a small amount of myelin is present in the cortex. This is responsible for the relatively small changes in T2 relaxation times of NL with respect to surrounding cortical GM. High-resolution T1 imaging allows for more clearly defined GM/WM boundaries that are not as visible with other imaging modalities, thus permitting unambiguous identification of lesion location within or in the proximity of the cortex. Here we report that the usage of a fast inversion recovery prepared 3D spoiled gradient recalled imaging (IR-FSPGR) at 3T with an 8-channel receiver head coil permitted successful detection of cortical boundaries and identification of NL in our cohort of MS patients.

Methods:

Study design

The present study was performed at the NINDS-NIH in Bethesda, MD under protocols approved by the Institutional Review Board and each subject signed an informed consent.

Twenty-three MS patients defined according to the Poser criteria were referred to the Neuroimmunology Branch (NIB) at NINDS-NIH for either immunological studies or consideration for enrollment in a therapeutic protocol. Those patients who were willing to undergo a 3T MRI as well as 19 age-gender matched healthy volunteers (HV) were consecutively enrolled.

Each subject underwent a 3T-MRI (GE Healthcare, Milwaukee, WI), using an 8 channel brain receiver array coil. High resolution IR-SPGR images were acquired with TE 2.8, slice thickness 1.0 mm, FOV 24 cm, matrix size 256*256, TI 750, BW 31.25 and FA 20 degrees, and acquisition time of 8:33 minutes. Additionally each patient underwent conventional pre/post contrast (Magnevist, Berlex Labs, Cedar Knolls, NJ at 0.1 mmol/kg) T1 and T2 weighted images.

Images analysis:

NL were defined as abnormalities visible as hypointense on IR-SPGR images. Three types of cortical lesions were identified for the purpose of this study: Type A NL were defined as those lesions entirely confined to the cortical tissue (figure 1); Type B NL were those lesions lying predominately within the cortex with some extension into WM (figure 2); Type C NL were those entirely within the WM, touching the cortical ribbon without invading the cortex (figure 3). Anatomical labels of cortical lesions in Talaraich space were derived using AFNI software [4].

Figure 1. Type A NL

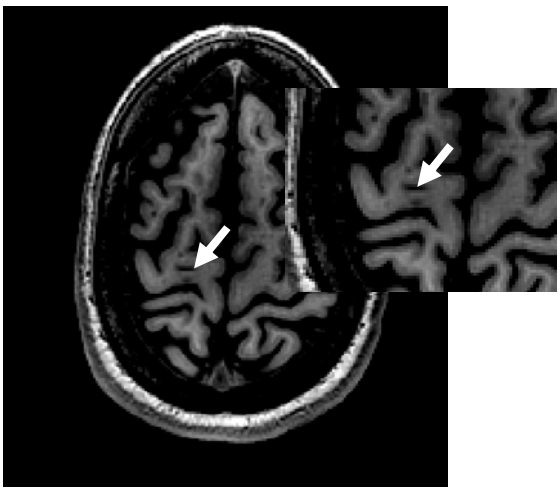


Figure 2. Type B NL

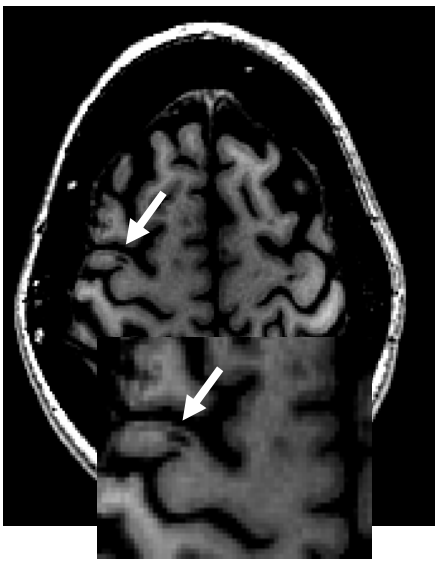
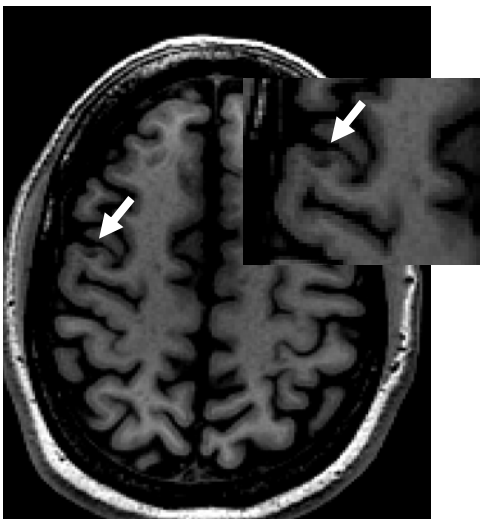


Figure 3. Type C NL



Results and Discussion:

Preliminary results are available on 8 patients (age: 24-50 years, disability scale: 1.0-6.0, 6 relapsing-remitting and 2 secondary progressive MS). No NL were identified on images of the HVs. A total of 105 NL were found on images of seven out of eight patients. Five (4.7%) NL were type A NL, 44 (42%) were type B NL and 56 (53.3%) were type C NL. Up to 70% of NL were found to be present in the frontal lobe cortical regions.

Current results indicate that high resolution T1-weighted imaging with an 8-channel receiver array coil at 3T provides adequate sensitivity in identifying cortical lesions *in vivo*. Further analyses are ongoing in the entire cohort of patients to understand the clinical relevance of the findings.

References:

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