High resolution 3D MRI of cortical lesions in multiple sclerosis

A. H. Poonawalla[1], S. Datta[1], F. Nelson[2], J. Wolinsky[2], and P. A. Narayana[1]

[1]Department of Diagnostic & Interventional Imaging, The University of Texas Medical School at Houston, Houston, TX, United States, [2]Department of Neurology, The University of Texas Medical School at Houston, Houston, TX, United States

INTRODUCTION. Cortical lesions in multiple sclerosis (MS) are typically small and/or located near the white-gray matter junction, eluding detection by conventional MRI methods (1). Double-inversion recovery (DIR) methods have been shown to be highly sensitive to cortical lesions (2), but their intrinsically low SNR requires slice thicknesses of 2-3 mm. At such coarse spatial resolution, partial-volume averaging effects impede accurate classification of cortical lesions as purely intracortical or otherwise. A possible answer is three-dimensional magnetization-prepared rapid acquisition gradient echo (3D MP-RAGE) (3), which features high SNR and excellent gray-white matter contrast. MP-RAGE with isotropic spatial resolution of 1.0 mm^3 was previously shown to improve detection of small enhancing lesions and black holes in MS (4,5). Since then, high-field scanners and parallel imaging have made substantially higher spatial resolutions possible within clinically feasible scan times. In this work, we implement an advanced 3D MP-RAGE protocol on a 3T scanner and assess its potential for cortical lesion imaging in MS.

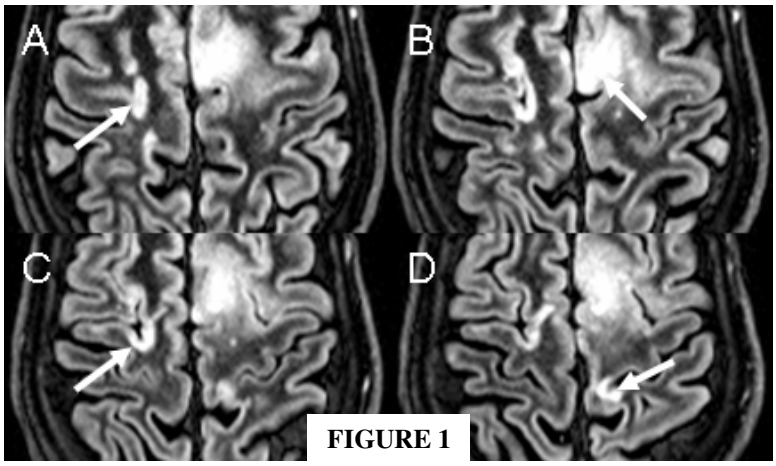

FIGURE 1

METHODS. MRI was performed on MS subjects using a Philips 3T Intera scanner with Quasar Plus gradient systems and a SENSE-compatible head coil. The scan protocol included axial DIR with 0.94 mm^2 in-plane resolution and 3.0 mm slice thickness, and coronal 3D MP-RAGE with isotropic voxel size of 0.5 mm^3, reformatted to the axial plane. SENSE encoding was used along the A/P direction for DIR (R = 2.0) and along R/L and A/P for MP-RAGE (R = 2.0 and 2.5, respectively). Scan times were 6:30 minutes for DIR and 7:38 for MP-RAGE.

RESULTS. Figure 1 shows four adjacent slices from DIR, with corresponding (non-adjacent) slices from MP-RAGE in Figure 2. Overall, DIR is suitable for identifying suspected cortical lesions but cannot provide enough information for accurate classification. MP-RAGE provides a much clearer delineation of the lesion boundaries, and position relative to the white-gray matter junction. Arrows show examples of lesions that appear on DIR as (a) mixed white-gray matter, (b) diffuse, and (c,d) cortical. On MP-RAGE, the lesion in (a) is seen to be largely confined to the cortex, whereas the diffuse lesion in (b) is less homogenous with a well-defined focal spot. The lesions in (c) and (d) are seen to only partially occupy the cortical ribbon on MP-RAGE whereas on DIR the lesions occlude the entire structure.

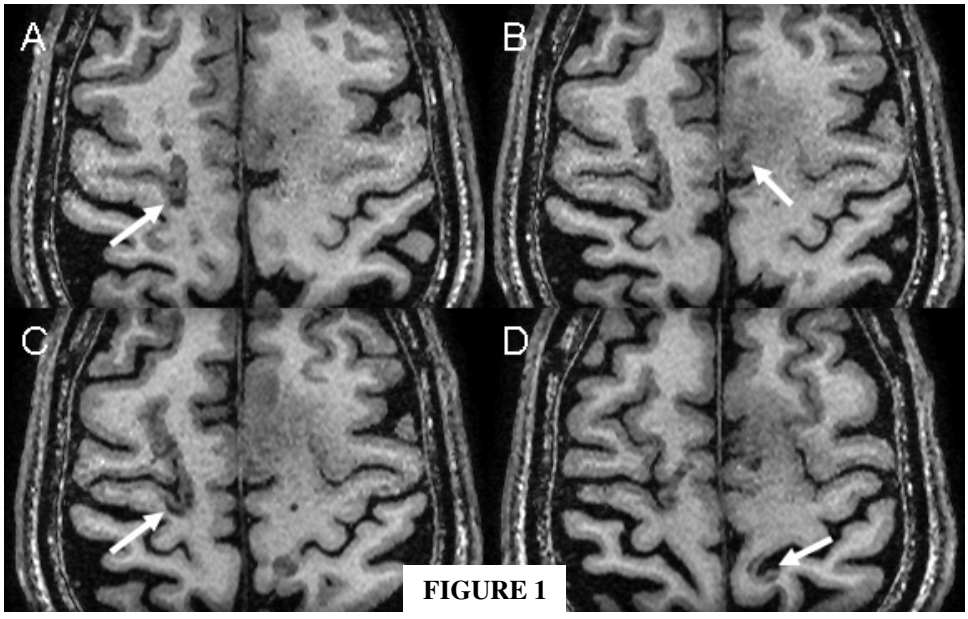

FIGURE 1

CONCLUSIONS. MP-RAGE at 3T with 0.5 mm^3 isotropic resolution delivers unparalleled detail of the white-gray matter junction. The spatial resolution and tissue contrast is superior to DIR for identification and localization of cortical gray matter lesions in MS. The combined use of high-resolution MP-RAGE and DIR in MS imaging protocols is therefore recommended for maximum efficacy in cortical lesion detection.

REFERENCES. [1] Geurts JJ, et al. AJNR Am J Neuroradiol 2005;26:572. [2] Geurts JJ, et al. Radiology 2005;236:254. [3] Mugler JP, et al. Magn Reson Med 1990;15:152. [4] Filippi M, et al. Ann Neurol 1996;40:901. [5] Filippi M, et al. AJNR Am J Neuroradiol 1998;19:235.