MR Imaging of a Postmortem Formalin-Fixed Human Brain of a Multiple Sclerosis Patient at 3T and 7T

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Introduction

Multiple sclerosis (MS) is a chronic, inflammatory and demyelinating disease of the central nervous system. Magnetic Resonance Imaging (MRI) of the brain and spine is used for diagnosis and monitoring of MS [1]. The use of MRI at lower field strength, typically 1.5T, to sample multiple sclerosis lesions has been demonstrated in earlier studies [2]. The purpose of this study was to explore capabilities of higher fields in visualizing MS lesions and to compare high resolution MRI of MS lesions of a postmortem formalin-fixed brain of a multiple sclerosis patient at 3T and at 7T. Cortical lesions constitute a substantial part of the total lesion load in multiple sclerosis (MS) brain but remain largely undetected with current MR imaging resolution [3]. We investigated the potential of high-resolution ultra-high-field MRI and report its enhanced ability in visualizing cortical lesion.

Material and Methods

Postmortem formalin-fixed brain slices from a MS patient were examined for cortical pathology using a 3T and a 7T whole body MR scanner (both Achieva, Philips Medical Systems, Cleveland, OH, USA). The brain slices in saline were placed in 3T and 7T transmit/receive head coils to acquire the images. Coronal spin-echo images were acquired at 3T and 7T with the following parameters: TR=2400ms, TE =45ms, slice thickness = 1 mm, FOV = 20cm, Matrix = 2048 x 2048, NEX = 5.

Results

In addition to enhanced signal to noise ratio (SNR), ultra high field MRI has different relaxation values that affect its capability to detect demyelination in MS lesions. Lesions were easily identified using gradient echo and spin echo images. Numerous MS lesions not seen by MR imaging at 3T were evident using MR imaging at 7T. Cortical MS plaques were evident on both, 3T and 7T spin echo images with a higher prevalence on the 7T images.

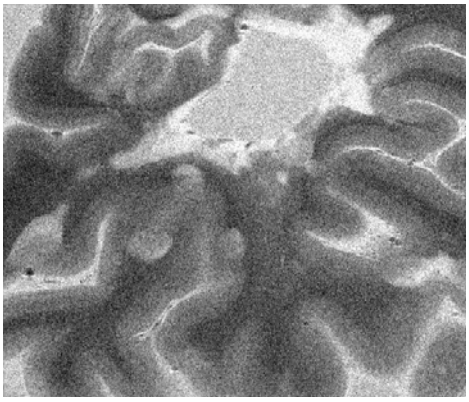

Figure 1: 3T MR image of postmortem formalin-fixed brain slices from a MS patient.

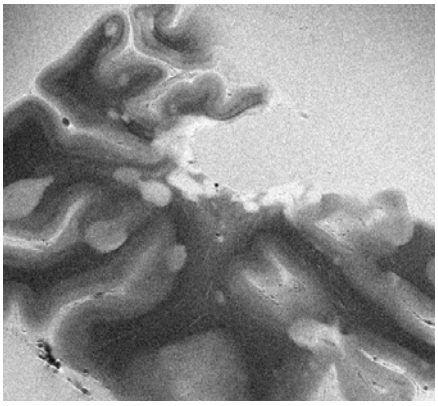

Figure 2: 7T MR image shows more MS lesions than the 3T image and a higher signal to noise ratio.

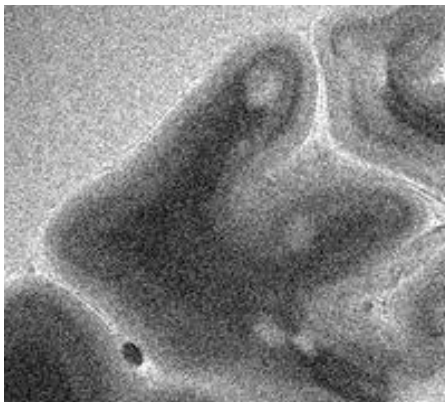

Figure 3: Zoom from the 7T MR high resolution image of Figure 2 to enhance cortical MS lesions and the line of Gennari coursing through the cortex.

Discussion

The greater sensitivity for Multiple Sclerosis lesions of 7T MRI compared to 3T does not entirely stem from higher SNR. Relaxation parameters also play an important role to enhance its ability for detection of lesions in earlier stages of the disease with ultra high field MRI. Considering that early diagnosis of MS is vital for improvement of therapeutic efficacy which can delay disease progression, the role of ultra high field MRI is highlighted in this regard. This may lead to an improved monitoring of neurological deficits in MS. Improved visualization of cortical plaques at ultra high fields could improve the investigation of clinical and neuropsychological abnormalities in patients with MS as cortical lesions are related to neuropsychological deficits, epilepsy, and depression [3].

Literature

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