Detection of White Matter Disease in the Brain and Spine Using Double Inversion Recovery SPACE at 3 Tesla

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Introduction

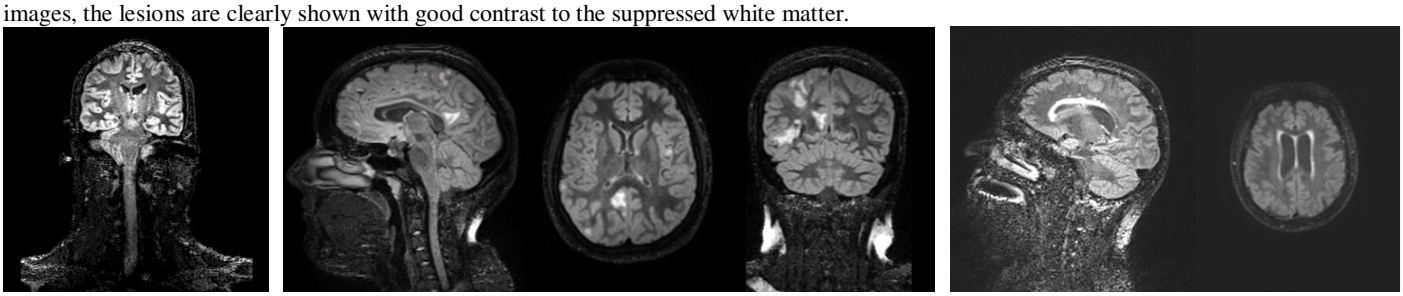
Double IR SPACE or TSE has been shown to be useful for detecting white matter diseases such as multiple sclerosis in adult brain at 1.5T [1]. Unlike conventional technique of using conventional 2D T2-weighted Dark-Fluid imaging (FLAIR), the double IR SPACE sequence provides better contrast between the white matter and the lesion because of the suppressed white matter signal. This sequence is also very potential to be used for evaluating demyelination in pediatrics and other white matter diseases. Acute Demyelination Encephalomyelitis (or ADEM) is a self-limited central nervous system inflammatory demyelinating disorders of childhood. ADEM is an acute or subacute white matter disease of brain and spinal cord that often follows a viral illness and vaccination [2]. Unlike multiple sclerosis which can be life-long condition and cause loss of disability, ADEM can be temporary and does not cause long-term illness. Because of the white matter lesions can spread to the brain and the spine, it would be desired to develop method of detecting the lesions in both brain and spine in adults, and pediatrics especially. The purpose of this study is to develop a method of detecting white matter diseases in both brain and spine in both pediatrics and adults using an optimized isotropic double inversion recovery 3D SPACE sequence at 3 Tesla.

Method

A non-selective double inversion recovery SPACE sequence was acquired at isotropic voxel that covers the whole brain and cervical spine in sagittal or coronal orientation. Imaging was performed on Siemens 3T Trio system (Siemens Medical Solutions, Inc, Malvern) with Total Imaging Matrix coils. A 12 channel head coil, neck coil, and spine coil were used for imaging of the brain and the cervical spine. The double IR pulses use a non-selective IR to null the CSF and another IR pulse to suppress the white matter. The acquisition parameters are: TE = 394 msec, TR = 6500 msec, isotropic voxel of 1.2 x1.2x1.2 mm, BW = 596 Hz/pixel, echo spacing = 3.24 msec, Fatsat, the time between inversion = 2350 msec, and the sum of the inversion time = 2700 msec, iPAT factor of 2, T2 variable flip angle, number of partitions = 140. Typical scan time is 5-6 minutes. Three volunteers and seven patients with pediatric demyelination, vascular depression, and multiple sclerosis were scanned.

Results

Figure 1shows images of the brain and cervical spine acquired with the non selective double inversion recovery SPACE on volunteers and patients with various disease conditions in pediatrics and adults. Figure 1A shows an isotropic coronal acquisition that shows the whole brain and cervical spine with the combination of head, neck and spine coil. The brain and spine images have good SNR at this 1.2 mm isotropic resolution using the combination coils. Figure 1B shows the images of the brain and spine on a patient with pediatric encephalomyelitis that shows the lesions and infarcts. Figure 1C shows the images of the brain of a patient with vascular depression showing the lesion on the ventricle periphery. As seen in these images, the lesions are clearly shown with good contrast to the suppressed white matter.



A B C

Figure 1 (A) Isotropic 1.2x1.2x1.2 mm coronal double IR SPACE at 3T showing the whole brain and cervical spine acquired with a combination of head coil, neck coil, and spine coil. (B) Multiplanar reformatted images of the brain and spine of a patient with pediatric encephalomyelitis (C) Sagittal and transversal reformatted images of the brain from an adult patient with vascular depression.

Discussion and Conclusion

As seen on the images, the double IR SPACE shows good contrast between the white matter, gray matter and the lesions at 3T. The first inversion pulse suppressed the CSF as typical FLAIR sequence, and the second inversion pulse suppresses the white matter of the brain and spine. With the suppression of the white matter, the lesions are clearly shown with good contrast to the white matter. Detecting the white matter lesions in the brain has become widely performed, but detecting the lesions in both brain and spine in a single scan has not been introduced before. This is particularly important since the white matter diseases such as multiple sclerosis lesions can spread to both brain and spine. In this paper, we have developed a method of detecting white matter diseases in both brain and spine in a single scan in pediatric and adults using an isotropic double inversion recovery SPACE at 3 Tesla using a combination of head, neck, and spine coils that gives excellent lesion contrast.

References:

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[2] Krupp, et al. Consensus definitions proposed for pediatric multiple sclerosis and related disorders. Neurology 2007; 68 (suppl 2): S7-12.