Peripheral Nerve Imaging with 3D Gradient Recalled Echo-Selective Species Imaging Sequence at 3.0T: A Preliminary Study

H. Shen[1], G. Cao[2], X. Lou[3], A. Zhang[3], J. Li[3], Z. Xiao[1], Q. Jiang[4], and A. T. Vu[5]

[1]Global Applied Science Laboratory, GE Healthcare, Beijing, Beijing, China, People's Republic of, [2]Global Applied Science Laboratory, GE Healthcare, Hong Kong, China, People's Republic of, [3]Department of Radiology, Chinese PLA General Hospital, Beijing, Beijing, China, People's Republic of, [4]MR Modality, GE Healthcare, Shanghai, Shanghai, China, People's Republic of, [5]MR PSD/Applications Engineering, GE Healthcare, Waukesha, Wisconsin, United States

Introduction

Magnetic resonance (MR) nerve imaging is a useful technique with which to evaluate abnormal conditions of entire nerves and nerve bundles, and it has been used successfully in patients with tumors, trauma, and neuritis of the brachial plexus. Conventionally, two-dimensional (2D) fat-suppressed (FS) T2 weighted (T2W) fast spin-echo (FSE) sequence with chemical shift selective saturation or short inversion-time inversion recovery is playing an important role in MR nerve imaging. Recently, diffusion weighted (DW) imaging was used because the sequence could suppress background signal and depict the long trajectory of the brachial plexus on soap-bubble reconstructed images [1]; DW steady-state free precession (SSFP) were also reported with the advantage of three-dimensional (3D) high resolution [2], however, SSFP is subject to airtifacts cased by off-resonance frequency, especially on 3T In this study, we applied 3D Gradient Recalled Echo – Selective Species Imaging (GRE-SSI) sequence to image the lumbosacral plexus and compared it with the DW imaging sequence.

Methods

In 3D GRE-SSI sequence, a 2D spatial-spectral (SPSP) radiofrequency (RF) pulse took the place of conventional excitation pulse (Fig 1), to achieve spatial selection in one dimension and water spectral selection in the other dimension. To minimize the scan time, we employed only three sub-pulses under the envelope of a spectrally-selective RF pulse to achieve minimum TE/TR. The total width of the SPSP pulse was 2.88ms, and the spectral bandwidth was 0.52kHz. The duration and bandwidth of each sub-pulse was 0.576ms and 16.95kHz.

All experiments were performed on a 3.0T MR scanner (EXCITE HD, GE Healthcare, Milwaukee, WI, USA) with a phased array spine coil. For GRE-SSI scan, the parameters were: TE = 4.4ms, TR = 8.8ms, Flip angle = 30, receiver bandwidth = ±31.2kHz, NEX = 1, FOV = 40cm x 40cm, matrix = 256 x 256, slice thickness = 1.6mm, reconstructed voxel size = 0.78 x 0.78 x 0.8 mm3. 90 coronal slices were acquired in 202s. For 2D DW scan, the parameters were: TE = 66.9ms, TR = 5000ms, b-value = 800s/mm2, receiver bandwidth = ±250kHz, NEX = 8, FOV = 38cm x 19cm, matrix = 160 x 80, EPI factor = 56, slice thickness = 5mm, slice overlap = 1mm, reconstructed voxel size = 1.48 x 1.48 x 4 mm3. 44 slices were acquired in 320s for one section. Two sections were scanned for covering the lumbosacral plexus. Curved maximum projection reconstruction (MPR) was used for both GRE-SSI and DWI for the visualization.

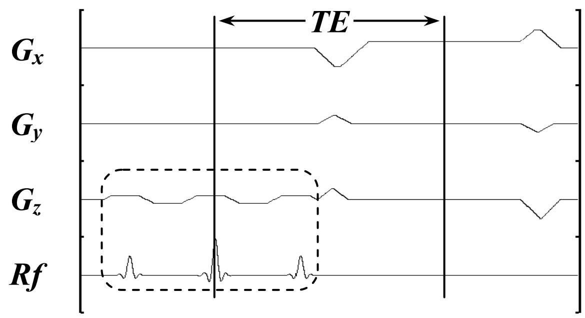

Fig 1: Diagram of one shot of GRE-SSI sequence. The dashed round rectangle contains the 2D SPSP pulse with three sub-pulses.

Results and Discussion

GRE-SSI and DWI images from a neurofibromatosis patient were collocated in Fig 2. In GRE-SSI, the fat was not excited by the SPSP pulse, and the nerve showed hyperintensities compared to the background tissues.

Both GRE-SSI and DWI had the capability of demonstrating the nerve nodes and diseases. DWI was also good at showing the nerve localized next to muscle (red arrows in Fig 2b) because of the good background suppression, which was not easy to be recognized in GRE-SSI because of similar contrast between the nerve and the muscle (red arrows in Fig 2a). GRE-SSI has the advantage of high resolution to clarify the adjacent relation between the nerves and the surround tissues. The intestinal motion could cause motion blurring in GRE-SSI and signal drop-off in DWI. DWI suffered from the field inhomogeneity. There were shape distortions (green arrows in Fig 2d) in DWI even though techniques of partial fourier and asymmetric FOV were taken to shorten the EPI factor. DWI was only applicable in axial acquisition because there would be more severe distortions in sagittal or coronal acquisition. At the scan time point, GRE-SSI was more efficient than DWI.

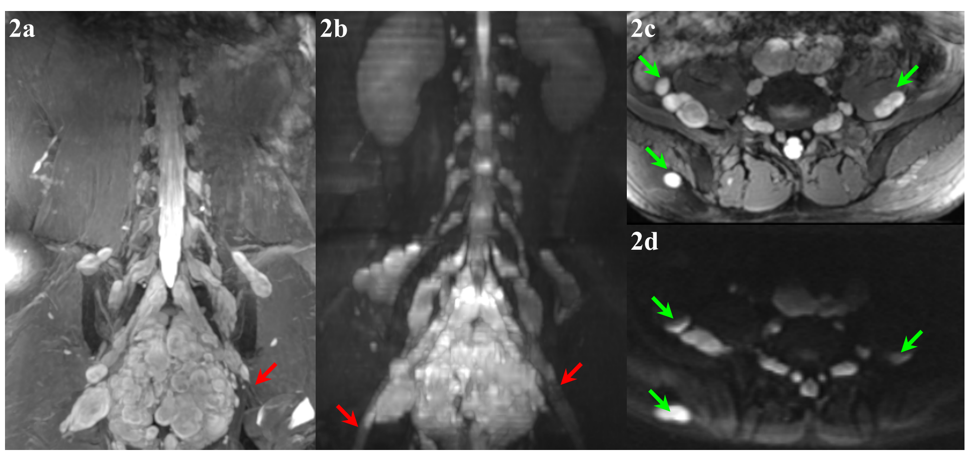

Fig 2: GRE-SSI and DWI images from a neurofibromatosis patient. 2a: Curved MPR image of GRE-SSI; 2b: Curved MPR of DWI; 2c: Reformatted axial GRE-SSI image; 2d: Original axial DWI image.

References

[1] Takahara T. et al. Radiology 2008, 249(2): 653-60 [2] Zhang Z.W. et al. AJNR 2008, 29(6): 1092-4