FID-based T1-Weighted UTE Imaging of Human Brain at 3T

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INTRODUCTION

T_1-weighted images of human brain are acquired using special pulse sequences such as magnetization-prepared rapid gradient-echo (MP-RAGE), spin echo (SE), or gradient echo (GE) sequence (1). These sequences produce great intensity contrast between white and gray matters in the brain. But, tissues or components of short T_2 relaxations (T_2<10ms), either intrinsic or acquired from pathological processes, are almost missed by these acquisition techniques due to long RF duration (~2.5ms) and long data acquisition delay (e.g., TE ~10ms). This study presents T_1-weighted brain images based on FID signals, instead of spin- or gradient-echoes as usually used. Compatible with ultra-short echo time (UTE<1ms), the FID acquisitions minimize the signal decays from short-T_2 tissues/components. This abstract demonstrates our initial experimental brain images of healthy volunteers and brain tumor patients acquired on a clinical 3T MRI scanner, to show some of potential benefits of the FID-based T_1-weighted UTE imaging.

METHODS AND MATERIALS

Methods: The proposed T_1-weighted 3D imaging was based on FID signals acquired immediately after short selective RF excitations without any gradient-/spin-echoes used. An ultra-short echo time was produced via variable-duration slice encodings. The T_1-weighted contrast between white/gray matters was generated through appropriate selection of flip angle, θ, at a given TR. The in-plane data acquisitions at individual slice-encodings were accelerated with multi-shot spirals. A home-developed pulse sequence named as acquisition-weighted stack of spirals (AWSOS) was used to implement the described method (2). *Experiments*: Healthy volunteers and brain tumor patients were scanned on a 3T MRI scanner (Magnetom Trio Tim 3T, Siemens Medical Solutions, Erlangen, Germany) using the standard Siemens head matrix coil. The data acquisition parameters were specified in the figures.

RESULTS AND DISCUSSION

In Figure 1 are images selected from the 3D image set of a healthy volunteer. A flat slab profile was achieved with a sinc RF excitation of duration=2ms and cycles=2.5, and a nice contrast between white/gray matters was obtained consistently from top to low brain. Figure 2 demonstrates images of a brain tumor patient. The UTE image (Fig. 2a) not only produced high intensity of the brain parenchyma, but also helped identify a potential abnormal region (yellow, hypo-intensity) from the normal background (red, hyper-intensity) in the difference image (Fig. 2c). Figure 3 shows an example of identifying a surgical region and its affected area on the normal background. The surgerical region has a hypointensity in the long-TE image (Fig. 3b) and nothing can be seen inside that region. In the UTE image (Fig. 3a), however, the skull outline and adjacent tissues were recovered. More findings were found in the difference image (Fig. 3c), such as a bright boundary line of the surgery opening, a large hypointensity region possibly affected by the surgery, and a hyperintensity (normal) caudate. More interestingly, inside the affected hypointensity region (red arrow) were some tissues recognizable, possible related to tumor recurrence. *In conclusion*, we have demonstrated an alternative way to obtain T_1-weighted brain images in which signal decays of short-T_2 tissues or components were minimized. Interesting findings were observed in these images and may be helpful in evaluation of brain tissue recovery after a surgery.

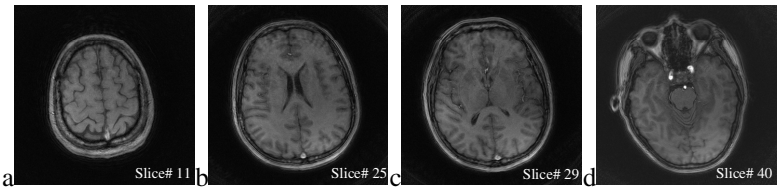

Fig. 1. FID-based T_1-weighted UTE images of a healthy volunteer acquired on a 3T scanner. A decent contrast between white/gray matters was achieved. Parameters: sinc RF of duration=2ms and cycle=2.5, FOV=220mm, matrix size=512x512, TR/TE =100/1.18ms, θ=45°, partitions=60 at 2mm in thickness, in-plane spirals=64, fat saturation, total acquisition time TA=6.4min.

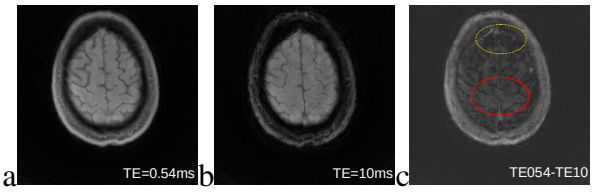

Fig. 2. FID-based T_1-weighted images of a brain tumor patient at UTE (a) and long TE (b). The difference image (c) clearly differentiates abnormal (yellow) brain parenchyma from the normal (red). Parameters: sinc RF of duration=0.8ms and cycles=1.5, FOV=220mm, matrix size=256×256, TR=100ms, θ=30°, partitions=40 at 5mm in thickness, in-plane spirals=32, fat saturation, total acquisition time TA=2.13min.

REFERENCES [1] Haacke EM, etc. John Wiley & Sons, Inc, 1999. [2] Qian Y, etc. MRM 2008; 60:135-145.

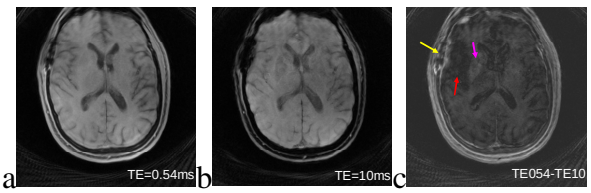

Fig. 3. FID-based T_1-weighted images of the same patient as in Fig.2, but the slice was across a surgery region left dark in (b). The difference image (c) clearly shows the boundary line (yellow), the affected brain parenchyma (red), and the normal caudate (pink). Parameters were the same as in Fig. 2: