FastDiagonal-SPRITE: a new method for Diagonal-SPRITE images

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Introduction

In order to expand the study of ultra-short T2 imaging (1) in biological components a novel ultra-short TE (UTE) technique was previously introduced, called Diagonal-SPRITE(2). This technique reduces acquisition time and increases the spatial resolution compared to Standard SPRITE and therefore is an improved technique for *in-vivo* MR imaging. As in all single point imaging techniques, Diagonal-SPRITE suffers from long scan times because each single point in k-space is individually acquired. In order to further improve the temporal resolution a new sequence has been created: FastDiagonal-SPRITE. FastDiagonal-SPRITE reduces the scan time a further 20% compare to Diagonal-SPRITE, without decreasing the resolution and S/N.

Method

Diagonal-SPRITE was improved by reducing the number of k-space acquisition points. While in Diagonal-SPRITE in order to acquire high resolution images the whole Cartesian k-space is collected, on our 9.4T 20G/cm Varian system using FastDiagonal-SPRITE the number of points decreases by 15% because the corners of k-space are not acquired (fig3). A water and oil phantom was imaged with FOV= 30x30x30mm, matrix size 135x160x11, Tp=0.32ms, averages=5, acquisition time = 16min, flip angle = 5 degrees. 5 averages were acquired by detecting 5 consecutive points on the FID curve.

Results

Comparing fast and normal Diagonal-SPRITE, the spatial resolution does not change because the k-space step size Δk remains the same. For the same reason the S/N is not affected. Not acquiring the corners of k-space generates two advantages: a reduction in acquisition time and a reduction in the gradients duty cycle. The two aspects are related, in fact by avoiding the k-space corners the gradients are not pushed to the maximum value (2). Therefore a reduction of 20% in temporal resolution between fast and normal Diagonal-SPRITE is achieved. Another improvement was made by increasing the number of averages by collecting 5 points on each FID in a 15μs acquisition window. The resolution difference between the first and the last point is 5% (fig 1). The disadvantage of using FastDiagonal-SPRITE rather than Diagonal-SPRITE is found in the artefacts. Rhombic artefacts are seen when FastDiagonal-SPRITE is used, due to the lack of k-space information. Especially in the central slice, the rhombic artefacts reach a high signal intensity (fig2A). Diagonal artefacts are also present in the fast as well as in the normal Diagonal-SPRITE. These artefacts are observed in the point spread function (PSF) of FastDiagonal-SPRITE. We have observed that due to the long T1's found in our samples, which mimic biological tissue, we can minimize the T1 component of the signal and reduce the diagonal artefact by using small flip angles.
For instance at 9.4T when a 5 degree flip angle is used, diagonal artefacts are significantly reduced fig2B,C,D (3).

Discussion

FastDiagonal-SPRITE has been found to be a reliable and important improvement to the SPRITE technique. It reduces the acquisition time without affecting spatial resolution and S/N. The disadvantage of using this novel implementation of Diagonal-SPRITE is a high intensity rhombic artefact which is being investigated.

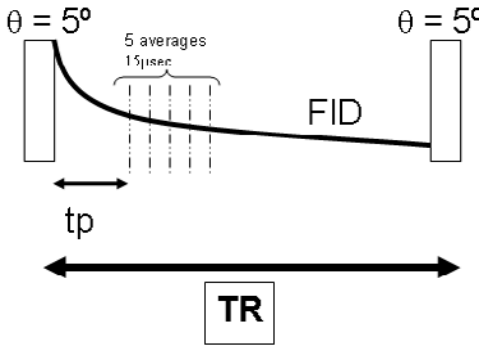

Fig 1: SPRITE sequence timing, showing 5 averages on the FID curve.

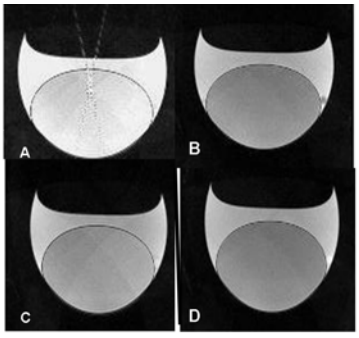

Fig 2: Water and oil phantom: central slice for A) FastDiagonal-SPRITE and for B) Diagonal-SPRITE; C) non-central slice for FastDiagonal-SPRITE D) non-central slice for Diagonal-SPRITE

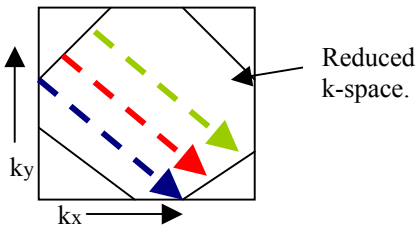

Fig 3: Reduced k-space. FastDiagonal-SPRITE does not k-space corner data, increasing the temporal resolution compare with Diagonal-SPRITE.

1. Robson MD, Gatehouse PD, Bydder M, Bydder GM. Magnetic resonance: an introduction to ultrashort TE (UTE) imaging. J Comput Assist Tomogr 2003;27(6):825-846.
2. Protti A., Herlihy A., Tessier J., Bell J. In vivo Diagonal-SPRITE imaging at 9.4T. Magnetic Resonance in Medicine (Submitted) 2005.
3. Protti A, Herlihy A, Tessier J, Bell J. DiagonalSPRITE: a new method for UTE imaging. abstract ESMRMB 2005.