23Na SPRITE in vivo Human Brain Tumour Imaging

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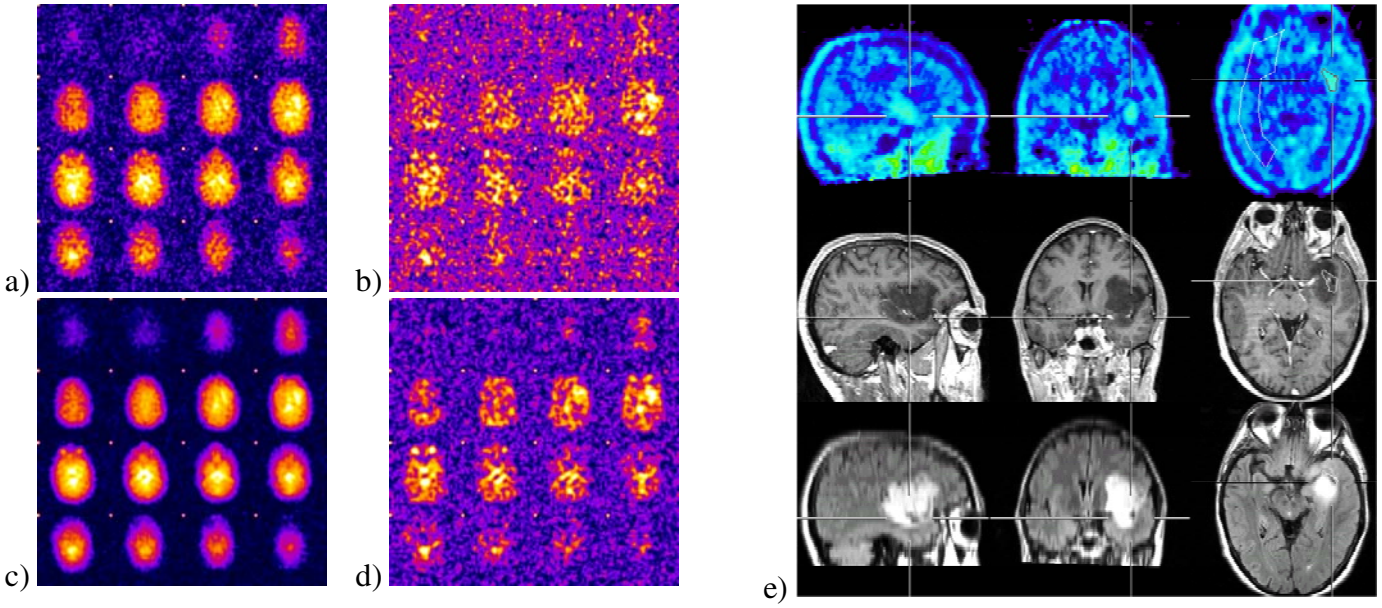
Introduction

Sodium is the most abundant MR-active nucleus in biological tissue after protons. Its very highly regulated concentration in biological tissue, combined with its large variations between healthy and diseased states, make it a very attractive nucleus to image. The development of SPRITE imaging [1] has progressed rapidly in the past few years and much of this work has been driven by the requirements of non-biological imaging [2,3]. Several extensions of the SPRITE sequence have been developed to improve the sequence for *in vivo* applications. These include Cartesian sampling with spiral and conical k-space trajectories [4], acquisition of multiple FID points [5], dynamic variation of repetition time and flip angle for acquisition time and SAR reduction [14-15] and, finally, a phase cycling filter for suppression of artefacts caused by residual magnetisation [16]. For image reconstruction, an algorithm has been developed for resolution enhancement of FOV scaled images [13]. In this work, an *in vivo* application – imaging of a human brain tumour *in vivo* - is presented.

Methods

In vivo Conical SPRITE ^{23}Na imaging was performed on an informed patient with a WHO Grade II astrocytoma. Two groups of N FID points were acquired in two successive measurements in the interval [0.1-0.5] ms and [0.5 and 2.5] ms, respectively. A matrix size of 32x32x16 and a FOV of 256x256x256mm^3 were used . The corresponding voxel volume was 8×8×16mm^3. The scans were phase cycled in order to filter residual signal artefacts. The filter bandwidth was set according to the smallest acquisition matrix size of 16 to achieve a square root of two higher SNR. Repetition time as well as flip angle reduction were used to achieve shorter acquisition times and a reduced SAR. Each scan was averaged NEX =64 times for final acquisition times of 9min 20sec and 19min, respectively. Image reconstruction was performed with the chirp z-transform [6,12] and resolution enhanced by regaining higher frequency information in early images (with high scaling factor) from later images (with low scaling factor). Positron emission tomography (PET) using the amino acid O-(2-[^{18}F]Fluorethyl)-L-Tyrosin (FET)[1] radiotracer [17,18] as well as ^{1}H fluid-attenuated inversion recovery (FLAIR) [19] and contrast agent (Gd-DTPA) enhanced [20] T_1-weighted MRI were performed as state-of-the-art tumour imaging methods.



Results

The sodium imaging results are presented in Figures a) to d). Composite images corresponding to the first and last encoding time points (0.1ms and 0.5ms) of the first measurement are shown in a) and b). Images of the second measurement with encoding time 0.5ms and 2.5ms are shown in c) and d). In both cases the first encoding time point had a scaling factor of 5:1. Despite the fact that the signal is higher for short encoding times, the SNR in the first measurement (0.1-0.5ms) is much lower than for the second one (0.5-2.5ms) due to the larger filter bandwidth which has to be utilised for short encoding times. The SNR decrease between encoding times is not only due to T_2^* relaxation but also due to the image resolution scaling. Relaxation time and spin density mapping were, therefore, problematic [7,8,9,10,11] and did not produce satisfactory results. However, the images clearly show a hyperintense sodium signal in the tumour region. In Figure e) FET-PET as well as contrast agent enhanced, T_1-weighted ^{1}H MRI and FLAIR images are shown from top to bottom for comparison. Whereas the ^{1}H MRI results show a good contrast for the tumour, the PET images show a poor contrast compared to the sodium SPRITE imaging results.

Conclusions

SPRITE imaging was shown to be applicable for *in vivo* tumour imaging. The technique has the future potential to be used for relaxation time and spin density mapping of sodium. SPRITE sodium imaging can be used within nearly clinically relevant measurement times and may be a diagnostic alternative to PET and proton MRI.

References

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