2D RF Pulses with Rotating Read Out Direction for Increased FOV with Elevated Central SNR

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Introduction

In MRI exams, focus is often given to a specific pathologic region (eg.: prostate, liver, brain) and in most cases the field of view (FOV) is centred at the region to be analysed. In some approaches, 2D radio frequency (RF) pulses are applied which allow for reducing the FOV to the region of interest without the presence of aliasing [1]. This technique enables either shorter acquisition time or higher signal to noise ratio (SNR) where an increased number of averages is possible in the same acquisition time.

Recently Skare et al. [2] proposed a new technique where 2 orthogonal excitation and refocusing pulses where used to excite a reduced area of the FOV and then the read out (RO) direction was rotated to obtain a full FOV. Here we propose a similar technique where 2D RF pulses are employed and the RO direction is rotated for each individual average, allowing image acquisition with high central SNR (the same SNR as acquired with the actual protocols using 2D RF pulses) and increased FOV.

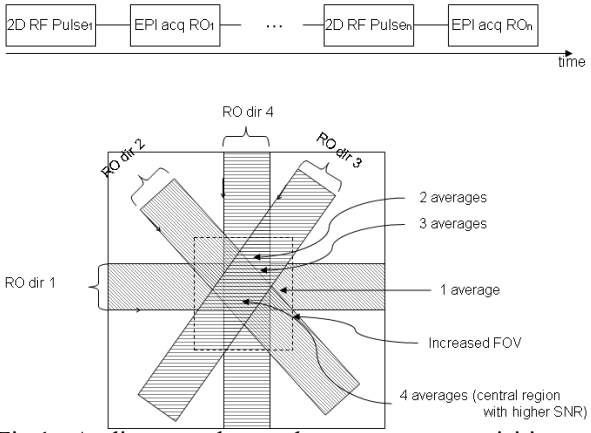

Fig.1: A diagram shows the sequence acquisition scheme where for each average a different RO angle is acquired. For demonstration a scheme with 4 averages was used.

Materials and Methods

To acquire the image data, a sequence was adapted which can perform 2D rectangular FOV excitations where for each average an increase in the angle of the read out direction was performed. After each rectangular excitation, an EPI acquisition with reduced number of PE lines was performed (Fig. 1).The image reconstruction was achieved by gridding the pixels into a full FOV and calculating the average for the overlapping regions. The modified sequence was built on a clinical 1.5T MR system (Siemens, Avanto, Germany) and image reconstruction was implemented on an external computer using Matlab (Mathworks, US). The sequence was tested with a volunteer where the center of the FOV (360x360mm²) was placed at the prostate using the body array for acquiring the MR signal (Matrix: 256x64, TE = 35ms, TR = 2800ms, averages = 4).

Results and Discussion

The reconstructed image is shown in figure 2. As it can be observed, the SNR is reduced in the regions far from the prostate (center of FOV). In prostate diffusion, the image acquisitions need multiple averages (4 or more) so that the obtained SNR for high b-value is enough to produce high quality ADC maps. Using rectangular 2D-RF pulses, the number of phase encoding directions can be reduced, decreasing the total acquisition time. With the proposed sequence, a bigger FOV can be acquired where an ADC map with increased SNR can still be obtained at the region of the prostate also providing a global overview of the lymph nodes surrounding the prostate which could help improving the sensitivity of this technique. Additionally the increased SNR could be used to acquire images with higher definition when comparing to existing protocols. Although this abstract has focused on the application of this sequence for diffusion imaging in the prostate, the idea could be easily expanded for 3D acquisitions and other MR sequences such as HASTE could be combined to this acquisition method to provide different contrasts with high central SNR.

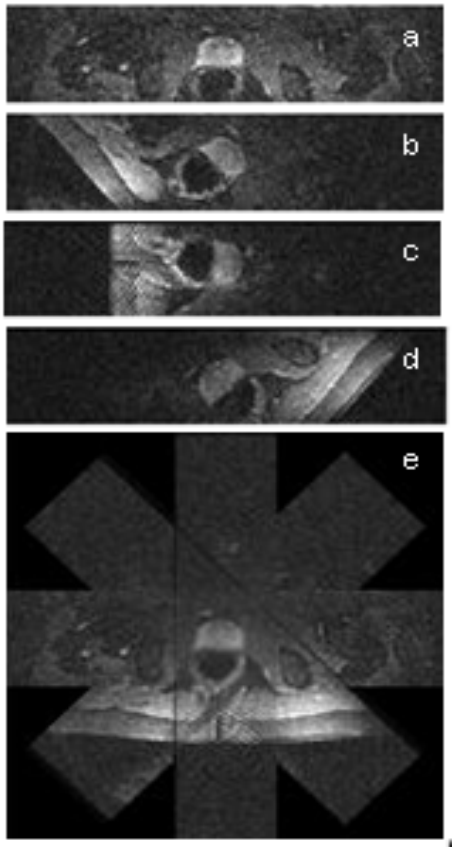

Fig. 2: Individual averages acquired in a volunteer (a-d) and fully reconstructed FOV (e).

References

[1] - Rieseberg S, Frahm J, Finsterbusch J. Magn Reson Med. 2002 Jun;47(6):1186-93.[2] – Skare S., Holdsworth S. J., Bammer R., ISMRM 2010: 188.