Abstract #29 | Oral or Poster presentation

Sequence Comparison for Sodium MRI

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Introduction

Sodium MRI enables direct and quantitative examination of tissue viability, cell integrity and function. The acquired biochemical information has great potential in the diagnosis of disease and in monitoring disease progression and response to therapy [1].

Sodium MRI is signal-to-noise ratio (SNR) limited, hence limiting achievable resolution. Thus, main objective is therefore improving SNR as to reducing scan time. The aim of this work was to optimise acquisition parameters, and to implement and compare different k-space sampling schemes.

Methods

SNR-optimal acquisition parameters with respect to T1 and T2* are repetition time = 30ms, flip angle = 60° and readout duration = 15ms (Figure 1).

3D density-adapted Radial trajectories [2] were designed with readout durations of 5, 10, 15 and 20ms to investigate the differences in SNR experimentally. These were compared to 3D constant-amplitude Radial, Cartesian, Floret [3] and rotated Spiral [4] trajectories, each with a 15ms readout duration. For a fair comparison, all trajectories were designed for a nominal matrix size of 80^3 with isotropic resolution and a total scan time of ~10 minutes, requiring averaging for the more sampling efficient trajectories.

MRI examinations were performed on a 3T GE MRI scanner.

Results/Discussion

Main finding is that different sampling schemes exhibit relatively similar results. This is important as different approaches in literature can still be considered comparable (if optimised properly). Sodium images of the brain acquired with different radial readout durations (5, 10, 15 and 20ms) and acquired with different trajectories are shown in Figure 2. Only the Cartesian acquisition has lower SNR and but could potentially be improved by using partial instead of full echo sampling.

Sodium MRI is generally SNR limited and not encoding limited. A long scan time (~10 minutes) is needed for SNR reasons. Hence, using encoding efficient trajectories like Spirals, Floret or Cones requires averaging and thus have little advantages, unless one wants to acquire lower resolution sodium images in a short scan time. The factor between real to nominal resolution for an assumed T2* of 6.4ms and the accompanying matched filter is approximately 1.6 and similar for the different trajectories.

Conclusions

In conclusion, 3D radial encoding is a suitable acquisition scheme relatively easy to implement. Because of SNR limitations in sodium MRI, long total scan times are required for averaging, hence the lower encoding efficiency of radial trajectories is not a significant disadvantage.

Acknowledgement

Disclosure

M.V. and R.F.S. are employees of GE Healthcare. The authors report no conflicts of interest.

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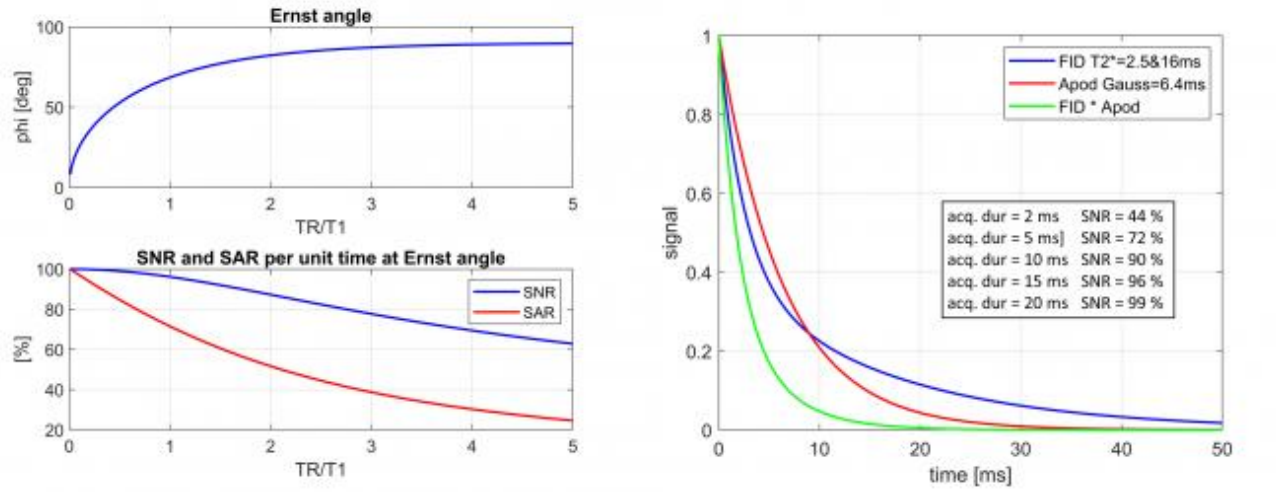

Figure 1 - simulations
Left**)** Simulations to determine SNR-optimal TR and flip angles. Right) Signal decay from bi-exponential FID (blue line) and the applied apodisation function (red line). T2* is dominated by T2, hence assumed to be equal. SNR is determined by the peak height in frequency domain, which corresponds to the integral in time domain of FID*apodisation (green line). When the acquisition duration is too short, SNR is lost.

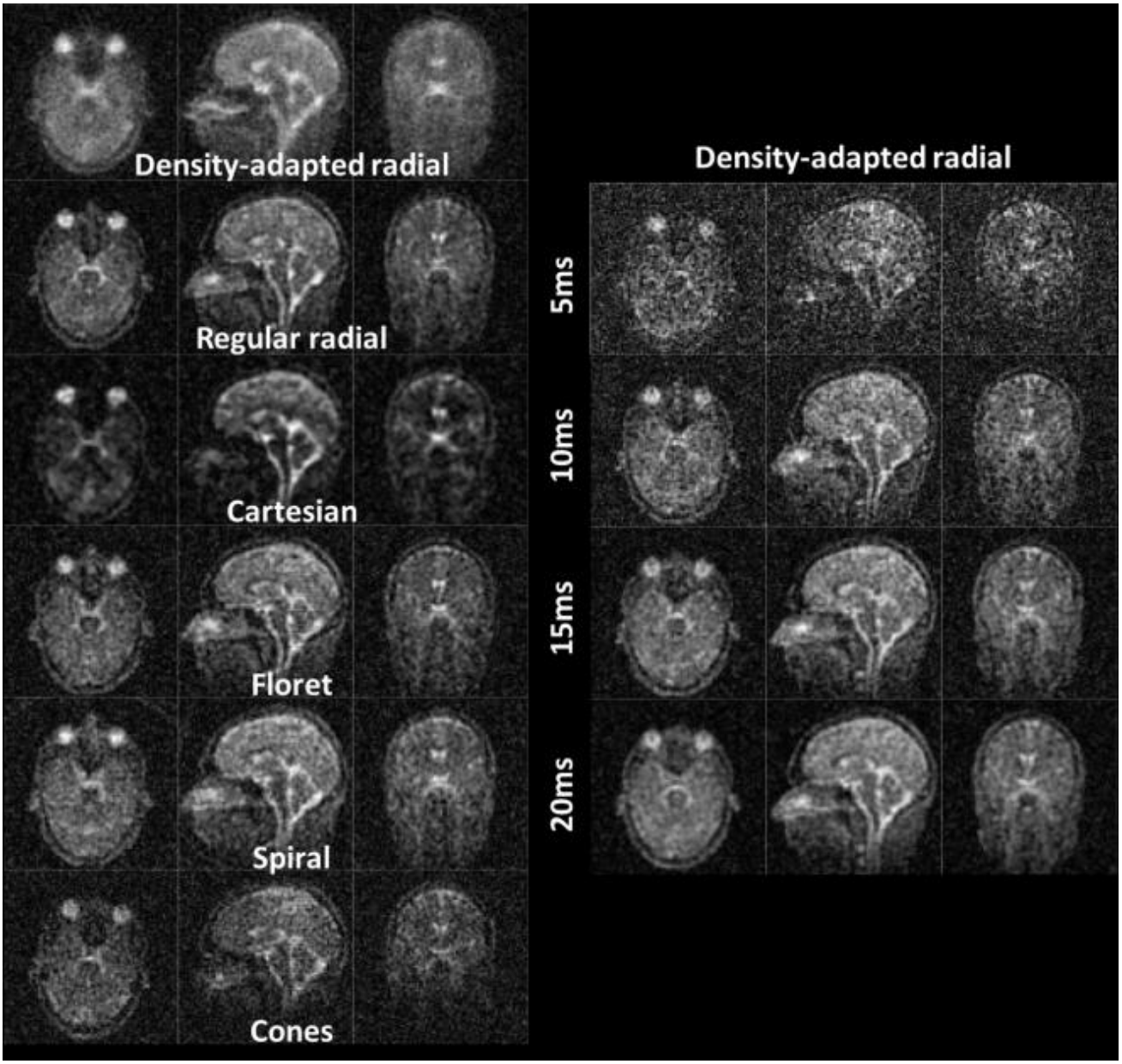

Figure 2 - brain images
Left) Sodium images of the human brain acquired with the different 3D k-space trajectories. Results are qualitatively similar, exhibiting subtle differences in resolution and SNR. Right) Sodium images comparing density-adapted radial trajectories with different readout durations. SNR is visually lower for the 5ms trajectory, and better for the longer ones.