# Short Echo Time Spiral Chemical Shift Imaging

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## Introduction

Increasing the information content of Magnetic Resonance Spectroscopy (MRS) in the brain can provide valuable clinical importance. Chemical Shift Imaging (CSI) can increase the spatial information content. Besides the conventional phase encoded CSI method, spiral based readout gradients have efficient k-space coverage allowing extended field of view (FOV). Therefore, the spatial information can be effectively increased using spiral based CSI [1]. As for the spectral component, various different methods can be used to achieve increased information. Of these methods, STEAM (Stimulated echo acquisition mode) excitation is frequently used with minimum echo time (TE) CSI [2], allowing observation of short $T_2$ metabolites. In this abstract, we used spiral readout gradients with STEAM excitation to increase the information content of MRS.

## Methods

Spiral readout trajectories were built into a conventional STEAM sequence for use on a 1.5 Tesla GE whole body imaging scanner. Sagittal and axial scout scans of an in vivo brain were first performed, followed by higher order shimming to increase the field homogeneity. Short echo (TE = 17 ms) three dimensional spectroscopic imaging data were then collected. Spirals covering a 48 cm FOV data were acquired over a 32 x 32 matrix with eight spatial interleaves which achieves a spectral bandwidth of 833 Hz. Phase encodes were implemented on the third dimension to collect volumetric data. Eight phase encodes over a FOV of 8 cm were used. CHESS pulses were used to suppress the water signal. The excitation voxel was placed within the brain while spatial saturation pulses were also used to suppress additional lipid signals from subcutaneous fat. The effective voxel size was 2.25 cc and the total imaging time was 25 minutes. A gridding algorithm was used for data reconstruction.

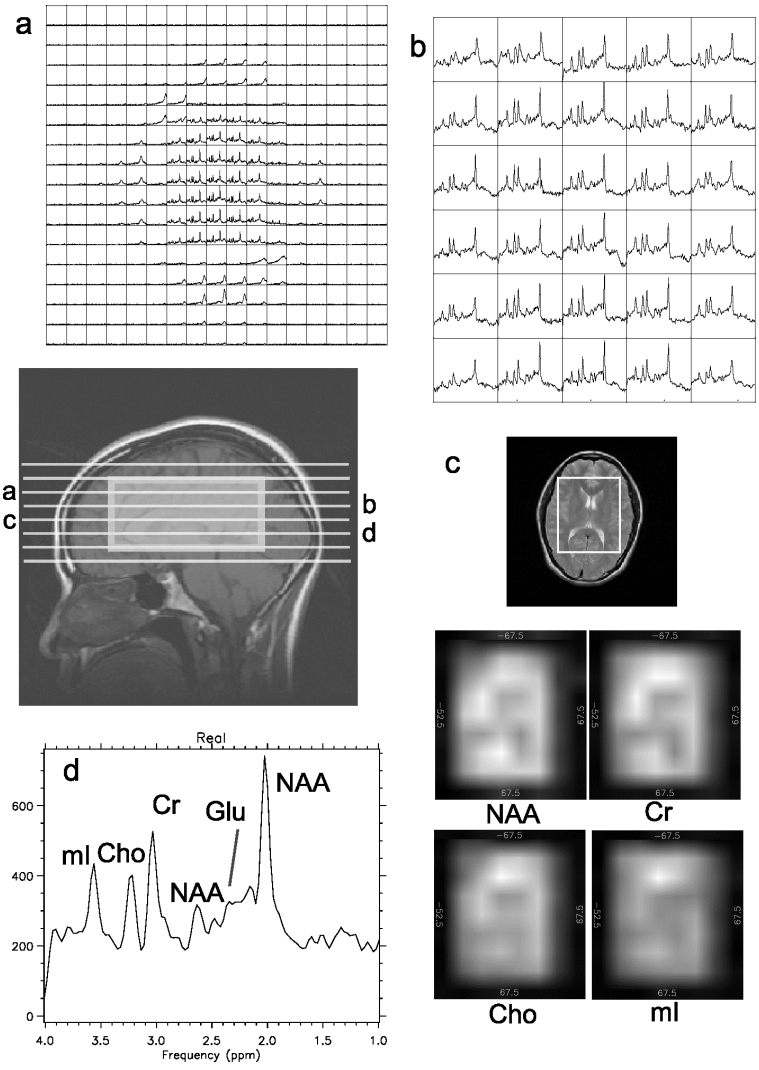
## Results and Discussion

The figure below shows the in vivo results. A sagittal scout image is shown in the middle with the selected excitation box. Each slice from this excited region is represented in the figure in different aspects. For slice (a), a FOV covering 24 cm is shown between the 4-1 ppm region. In this case, pixels with dominant metabolite signal correspond to the selected ROI region. It can be seen that small lipid contaminations are still present even after the spatial saturation pulses are applied. These are well resolved with the spiral acquisition due to the increased spatial coverage. For slice (b), the metabolite spectra within the 4-1 ppm region are given for the selected ROI region only. For slice (c), metabolite images are reconstructed for NAA, Cr, Cho, and mI. Finally, for slice (d), a representative spectrum within the selected ROI is given to illustrate the quality of data that has been acquired using the short echo spiral CSI sequence. As seen, good spectral quality is obtained ($SNR_{NAA} \approx 11$).

Conventional long echo time CSI has been successfully used to detect resonances such as NAA, Cr, and Cho. Increasing the information content can provide broader applications for CSI. Here we have demonstrated the increased spatial information content using spiral readouts and also increased spectral information content by applying a short echo STEAM sequence. For full volumetric coverage, spiral based readouts or echo planar readouts have merit since they require less minimum scan time (1.6 minutes for the above exam). As for the spectral content, other sequences besides the STEAM excitation could also be used. For example, correlation spectroscopy or J-resolved sequences can all be used in combination with the spiral readouts to increase the spectral resolution.

Although PRESS based spectroscopic sequences have been widely used due to increased signal to noise ratio compared with STEAM, at higher field strengths, the increased $B_1$ inhomogeneity may cause problems. STEAM based sequences that are relatively less vulnerable to RF inhomogeneities can potentially be used for application of short echo CSI at higher field strengths.

Finally, the increased information content both in the spectral and spatial dimension creates challenges in methods of display and analysis of the reconstructed data. Different methods need to be explored (as shown here) to accommodate the increased data storage [3].




## Conclusion

We have used short echo excitation combined with spiral based readout gradients. It is seen from in vivo brain exam that the increased spatial coverage offered by the spirals can be effectively used for volumetric coverage and to separate lipid contamination from the subcutaneous fat which can be problematic for short echo sequences while increased spectral content can be achieved with the short echo STEAM acquisition.

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## References

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