Turbo-Spin-Echo Based Correlated Spectroscopic Imaging of Breast Tissues In Vivo: A Preliminary Study

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Introductions:

Magnetic resonance spectroscopy (MRS) can provide key biochemical information non-invasively. MRS studies have shown differences in metabolite concentrations in healthy breast tissue and abnormal lesions (1). Two-dimensional (2D) MRS has an advantage over one-dimensional (1D) MRS due to increased spectral dispersion of J coupled peaks along the second dimension (2). However, single voxel (SV) MRS has significant limitations in terms of breast coverage, it cannot provide information on the regional distribution of metabolites within the breast (3). Multi-dimensional magnetic resonance spectroscopic imaging (MRSI) provides higher spatial resolution and generates metabolic images of fat, water and other metabolites (4). The purpose of this study is to demonstrate the feasibility of evaluating a 4-echo based Turbo-Spin-Echo based Correlated Spectroscopic Imaging (TSE-COSI) sequence to acquire multi-voxel based 2D COSY of breast tissues *in vivo*.

Methods:

6 healthy volunteers (mean age 36 year old) and 1 subject (age 38 year old) with a benign tumor were scanned using a Siemens 3T Trio-Tim MRI scanner with a dedicated "Receive" 4-channel phased-array breast coil. A 4-echo-based spatial encoding scheme has been integrated into 2D L-COSY sequence compiled using the Siemens Idea VB15 compiler. The following parameters were used: TR = 2 sec, TE = 30 ms, average of 1, echo train length (ETL) of 4, 8x8 spatial encoding, 2000 Hz bandwidth, 45 $\Delta t1$ of 1 ms increments before the second 90º pulse. Total scan time was 24 minutes. The extracted voxel size was between 0.5~1 cm^3 with a thickness of 1 cm. The raw data were processed using a custom MATLAB based post-processing algorithm: First, the raw data were extracted, next a spatial Hamming filter was applied, followed by a phase correction algorithm and then spatial 2D FFT along X and Y directions. Each SV 2D MRS within the 8x8 matrix was processed separately by zero filling along F2 and F1 directions, followed by application of skewed sine-bell filters, then a 2D FFT along F1 and F2 directions was completed. In 8x8 plots, drawing the contour for six metabolite peaks: WATER at (4.8,4.8)ppm, FAT at (1.4,1.4)ppm, UFD at (5.4,5.4)ppm, UFL (2.9, 5.4)ppm, UFR at (2.1,5.4)ppm and TGFR at (4.3,5.3)ppm, the 2D contour shows the six metabolite concentrations distributed throughout the breast. By selecting a certain frequency domain to encompass the peak of the desired metabolite, the volumetric value can be calculated by integrating the intensity inside the contour, the results of which are the voxel values of the TSE-COSI for each metabolite (5).

Results:

Figure 1 A shows the localization used to acquire TSE-COSI data from a healthy volunteer, the axial MRI shows there are 8x8 2D COSY spectra inside the yellow box, Figure 1 B,C,D is the TSE-COSI imaging for three metabolites: FAT, WATER, UFD. Figure 2 A shows the localization used to acquire TSE-COSI data from a patient with benign tumor, the axial MRI shows there are 8x8 COSY spectra inside the yellow box. Figure 2 B,C,D is the TSE-COSI imaging for the three metabolites. It is clear to see FAT, WATER, UFD have different distribution patterns in healthy and benign breast tissues. The higher water and lower fat intensities suggest benign tumor positions. In addition, three cross peaks UFR, UFL and TGFR have continuous distribution in healthy breast tissue, but can not be detected in benign breast tissue. These results indicate that TSE-COSI can distinguish between healthy breast and breast with benign tumors.

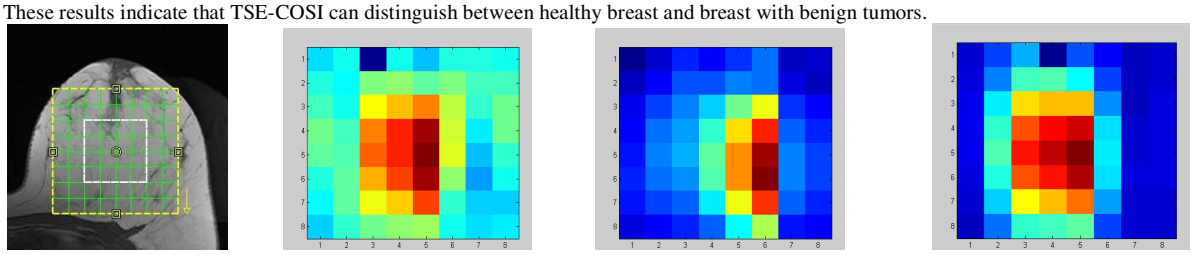

Figure1 A) Healthy breast B) FAT C) WATER D) UFD

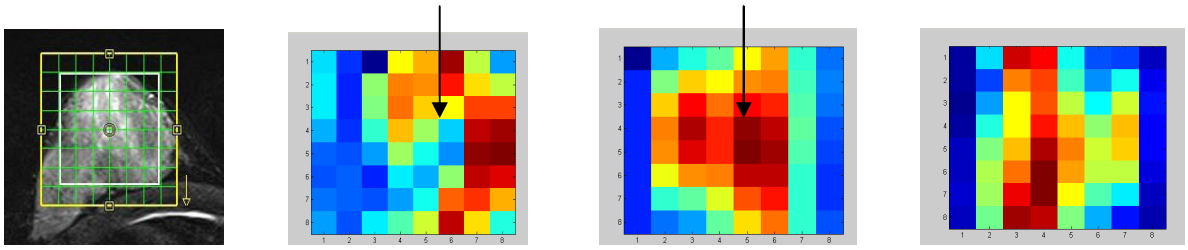

Figure 2 A) Benign breast B) FAT C) WATER D) UFD

Conclusions:

The present study is the first report using the 4- echo based spatially resolved TSE-COSI sequence to acquire 2D spectral + 2D spatial in healthy and benign breast tissues. Preliminary results show that this method can distinguish between healthy and benign breast tissues based on the spatial distributions of metabolites and lipids. The metabolite distribution patterns may serve as the biomarker for early diagnosis of breast diseases. These pilot findings need to be evaluated using a large cohort of breast cancer patients.

References:

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