USING TWO-DIMENSIONAL MAGNETIC RESONANCE SPECTROSCOPY IN BREAST CANCER DETECTION:COMPARING 3.0T VERSUS 1.5T

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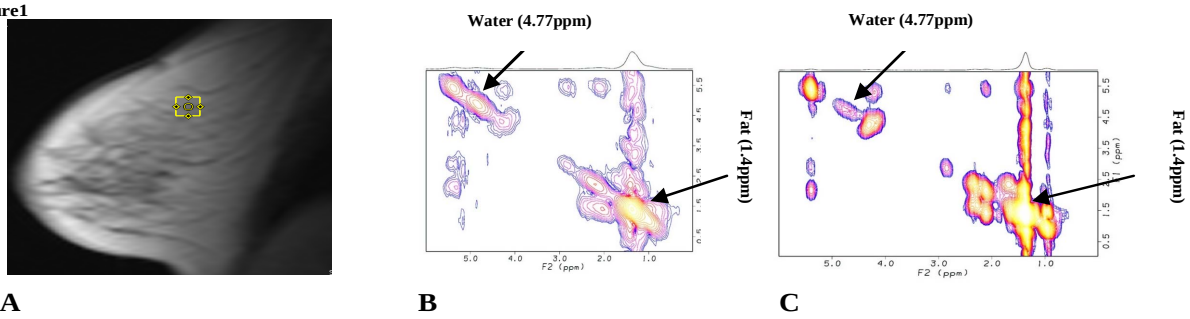
Introduction: Magnetic Resonance Spectroscopy (MRS) allows measurements of the concentrations of metabolites in human organs such as the breast. The noninvasive nature of this technique makes it an ideal diagnostic tool in breast cancer detection because some metabolites like choline appear only in malignant tumors (1).Two-dimensional (2D) MRS has better resolution than one-dimensional (1D) MRS by adding a second dimension to each spectrum and has previously been used in breast cancer detection. Recent studies using MRS for breast cancer detection are limited to 1.5T fields (2). MRS spectral resolution depends on several factors, such as static magnetic field intensity (B_0) and in-homogeneities, scan time, shimming (3). The purpose of this study is to compare the spectral resolution and accuracy for breast cancer detection of volume-localized 2D correlated spectroscopy (L-COSY) MRS technique at 1.5T and 3.0T.

Methods: 3 women with invasive ductal carcinomas (mean age 46 years), 1 woman with benign fibroadenomas, and 7 healthy women (average age 38 years old) were investigated. Each subject was scanned on both the 1.5T Avanto whole body MRI/MRS scanner (Siemens Medical Systems, Erlange, Germany) and the 3.0T Trio whole body MRI/MRS scanner (Siemens Medical Systems, Erlange, Germany). Separate dedicated phased-array breast coils were used to acquire the data on each scanner. 2D L-COSY spectra were recorded using the following parameters: echo time (TE) of 30 ms, repetition time (TR) of 2 seconds, 8 excitations per $\Delta t1$, and 45 increments of $\Delta t1$. The spectra included 1024 complex points, with a 2000 Hz spectral window along the first dimension and 625 Hz at 1.5T and 1250 Hz at 3T in the second dimension. The RF pulse sequence included three slice-selective pulses (90^0-180^0-90^0) to localize a desired voxel. Spectra were acquired from localized volumes of interest (VOIs) in each subject's breast tissue. The size of each VOI was 10 x 10 x 10 mm^3 for all scans. For each patient that had a tumor, at least one spectrum was acquired from a VOI within the lesion and another spectrum was acquired from a VOI in the unaffected contra-lateral breast. In healthy controls, spectra were recorded from both glandular and fatty tissue VOIs. Raw two-dimensional MRS data files were transferred to an SGI O2 workstation (Silicon Graphics, Inc., Sunnyvale, CA), and were processed using Felix software (Felix NMR, San Diego, CA). The raw data were zero-filled to 2048 x 128 points and Fourier-transformed, using a skewed sinebell-squared filter for the first spectral dimension and a sinebell-squared filter for the second spectral dimension (4). 2D L-COSY spectra were processed for each subject's raw data acquired at 1.5T and 3.0T.The diagonal peaks due to water (4.77ppm) and fat (1.4ppm) were used to localize the spectrum along the chemical shift axes.

Results and Discussions: 2D MRS from both 1.5T and 3.0T scanner can show that in healthy breast tissue, the main metabolites are fat and water; in malignant tumor, there is a choline peak at 3.22 ppm; and in benign tumor , there is only a big water peak at 4.77pm. These characteristics can be used to differentiate between health, benign and malignant breast tissue. From processed 2D spectrums, it is clearly to see that 3.0 T shows improved spectral resolution and improved signal to noise ratio (SNR) which is proportional to B_0. As shown in Figure 1: A is an axial MRI of a healthy breast, yellow box shows the volume of interest (VOI) location used for both subsequent MRS spectrums. B shows the healthy spectrum from 1.5T and C shows the healthy spectrum from 3.0T. After analyzing the metabolites for breast cancer diagnosis, Table 1 summarizes our findings.

Figure1



A **B** **C**

Table 1

	1.5T				3T		
	Malignant	Benign	Healthy		Malignant	Benign	Healthy
Diagnosis	3/3	1/1	7/7	Diagnosis	3/3	1/1	7/7
	Sensitivity = 100%				Sensitivity = 100%		
	Specificity = 100%				Specificity = 100%		

Conclusion: Choline is a significant biomarker in malignant breast tumors. This is in agreement with previous studies that have shown choline can be used as a clinical marker for malignancy. In this study, although we found that the sensitivity at both 1.5T and 3.0T are high (100%) and that both specificities are 100%. The SNR gain and spectral dispersion at 3.0T provide higher spectral resolution than at 1.5T, which enables better peak quantification. We detected better metabolite resolution in healthy breast tissue. 3.0T shows promising potential for breast cancer detection. The improved spectral resolution will enable improved metabolite quantification as well as provide data on metabolites that are unseen at 1.5T. These pilot findings need to be evaluated using a large cohort of breast cancer patients.

References:

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