Three dimensional spectroscopic imaging in breast cancer at 3Tesla: A pilot study.

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Introduction: Breast cancer is one of the most common cancers of the female population in the western world. High resolution magnetic resonance imaging (MRI), in particular contrast-enhanced MRI, provides high sensitivity for the detection of breast lesions. In contrast to the high sensitivity, the specificity of MRI is low. The standard procedure, therefore, is to take (multiple) biopsies of the MRI-detected lesions to distinguish between benign an malign lesions. Therefore, it is important to have non-invasive diagnostic techniques to classify breast lesions. In several studies it was shown that MR-spectroscopy (MRS) may be an important tool to detect malignant lesions due to increased choline (Cho) in tumor tissue [1-4]. Most studies were performed using single voxel spectroscopy (SV-MRS). Other groups could successfully demonstrate the potential of 2 dimensional MR-spectroscopic imaging (2D-MRSI) in differentiation between benign and malignant lesions [3,4]. However, SV-MRS and 2D-MRSI can only cover a small fraction of the breast within one measurement.
In this study, a high resolution 3D-MRSI protocol at 3 Tesla was used in female patients, who had known lesions from routine imaging techniques to test the value of 3D-MRSI as a diagnostic tool for breast lesions. The sequence was designed to cover a large fraction of the breast in a clinically acceptable measurement time of approximately 10-12 minutes. Results from MRS were compared with biopsies taken from the corresponding lesions.

Methods and Materials: 8 patients were successfully measured on a 3T system (Siemens Tim Trio, Erlangen, Germany) using a 4 channel breast coil running the software packet VB13. Written informed consent, according to the guidelines and approval of the local review board was obtained from all subjects prior to the study. After performing a standard imaging protocol including high-spatial-resolution T1-VIBE and T2-STIR, 3D-MRSI was applied. For 3D-MRSI a sequence with PRESS preselection was used for all measurements (TR/TE = 750/145ms). The sequence included spectral water and fat suppression and spatial outer volume suppression. Voxel size was 1 cm x 1cm x 1cm in all measurements. The Field of View (FOV) was chosen to cover the whole breast. Phase encoding steps were chosen to match the voxel size with the smallest possible FOV, resulting between 10 and 16 phase encoding steps in each of the three spatial directions. Weighted k-space sampling was used. Acquisition weighting was performed using a hamming-filter (100%) and 4-10 averages per measurement.
Before processing, the data were zero filled to 16 × 16 × 16 voxels. Metabolic maps of Cho (if detectable) were created using the Siemens spectroscopy software (syngoMR VB13). Additionally cho-containing voxels were processed using LCModel to obtain signal-to-noise ratios (SNR) for all spectra in which Cho was detectable.

Results: In 3/8 patients (patients S1, S2, S3) cancer was confirmed via biopsy. Increased Cho was detected in more than one slice in all 3 patients with cancer. (see Table 1.). From all slices located in the lesion, the one with the largest number of Cho-containing voxels of each patient was processed with LCModel to estimate SNR. In patient S1 SNR was ≥ 10 in approx. 50% of Cho-containing voxels. In patients S2 and S3 SNR was ≥ 5 in 50% of Cho-containing voxels. In patient S4, who underwent no biopsy, we found 44 (of 648 voxels) containing Cho signal. SNR was lower than in patients S1, S2, and S3, however, SNR was ≥ 5 in 20% of Cho-containing voxels. In Fig. 1 three representative voxels are plotted from patients S1, S2, and S4. Note the difference in line width (i.e. shim quality). Fig 2. shows a metabolic map of Cho overlaid with the anatomical MRI. In the other 4 patients (without biopsy confirmed cancer or malign tissue) we could detect Cho in a small number of voxels with low SNR (≤ 5) in 2 of them.

Discussion and Conclusion:
In this pilot study we could perform 3D-MRSI in patients with breast lesions with sufficient data quality. Compared to previous studies using SV-MRS or 2D-MRSI, we could cover a larger fraction of the breast. In all patients with confirmed cancer, Cho was detectable in more than one slice, pointing out the importance of 3D-MRSI for diagnosis of breast cancer. We could confirm previous results, reporting Cho in malign breast tissue. In one patient without biopsy confirmed cancer we found Cho in 6 of 8 slices. The percentage of Cho-containing voxels with sufficient SNR was lower in this patient, however, SNR values were comparable to voxels containing cancer tissue from other patients. These patient underwent no biopsy, because other imaging techniques did not indicate tumour tissue. In conclusion, 3D-MRSI may become an important tool for diagnosis of breast cancer. Specificity has to be tested in further studies.

Subject	Slices / with Cho	Voxels / with Cho	SNR / %	Conf.
S#1	8 / 4	720 / 67	10-29 / 50%	yes
S#2	10 / 8	1000 / 157	5-12 / 50%	yes
S#3	8 / 2	576 / 15	5-10 / 50%	yes
S#4	648 / 44	8 / 6	5-8 / 20%	no

Table 1. From left to right: Patient number; number of slices measured and those with cho-containing voxels; number of voxels measured and those containing cho; SNR range and number of voxels in this range; Confirmation via biopsy or not.

Fig. 1.

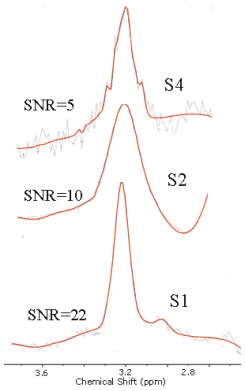

Fig. 2.

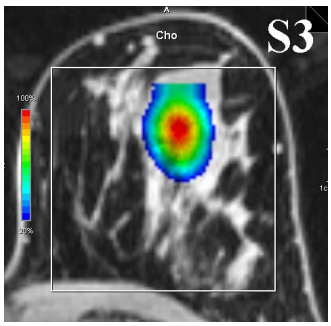

Figure captions:

Fig 1. Shows three chosen spectra from the measured patients. The two spectra at the bottom were acquired in cancer tissue. The top one was acquired in breast tissue in which, cancer was not confirmed via biopsy.
Fig 2. Shows a metabolic map of the Cho signal. The PRESS box is indicated with the white square (thin line).

References:

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