Three-dimensional Proton MR Spectroscopic Imaging of Human Breast Lesions

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Purpose: Single voxel proton MR spectroscopy (MRS) and spectroscopic imaging (MRSI) are promising techniques for the non-invasive diagnosis of breast lesions that are suspicious for neoplasm [1-3]. We implemented and investigated the diagnostic value of 3D-MRSI in patients with breast lesions who were scheduled for biopsy. Lesions were classified as either benign or malignant based on the absence or presence of a choline signal, and results compared to histopathological analysis.

Materials and Methods: Thirteen patients underwent breast MRI and 3D-MRSI imaging using a Philips 1.5T Intera MRI scanner, with a dedicated phased-array breast coil with 2 channels per side. Axial 3D-MRSI was performed with PRESS excitation and spectral saturation of the water and lipid using dual hyperbolic-secant pulses [4]. Scan parameters were FOV 16x16x8, matrix size 16x16x8, 32x32x8 after processing (nominal voxel size 0.25 cm^3), 70% FOV reduction, spherical phase-encoding pattern (50% scan time reduction compared to square encoding), TR/TE 1010/280 ms, acquisition window 682 ms (echo position 20%), one signal average, scan time = 12 min 6 secs. In some patients the FOV had to be increased to 18 cm to avoid foldover. After MRSI, rapid gradient echo imaging was performed to measure B_0 and B_1 field distributions. After 3D MRSI, conventional high-resolution T1-weighted images were recorded before and after administration of GdDTPA, in order to identify lesion location. Water, lipid, and choline (Cho) images were reconstructed from MRSI data. Cho signal-to-noise ratios (SNR) were measured from voxels within the lesions as identified by contrast enhancement. Lesions were classified as malignant or benign depending on the SNR ratio≥5, and results were compared with histology.

Results: Thirteen patients were studied (age=44±6; mean±SD) by histopathology, 3 cases were classified as malignant carcinoma; one was ductal carcinoma in situ (DCIS), and 7 were benign. In 2 cases, no pathology results were available. Cho was detected in 3 of 3 cases of breast cancer and no Cho was detected in the case with DCIS. Of 7 cases with benign diagnoses, 5 failed to show a detectable Cho signal, with one case of fibroadenoma demonstrating detectable choline, and 1 case was a technical failure due to motion. The malignant lesion volume was 3.1±1.0 cm^3 with an average Cho SNR of 10.1±4.5, whereas for benign lesions, the lesion volume was 1.0±0.5 cm^3 with an SNR of 2.9±1.0.However, the one fibroadenoma case with a prominent Cho signal exhibited an SNR of 4.4.

Discussion: Unilateral, 3D-MRSI with nearly whole breast coverage is feasible in a single session combined with conventional, bilateral breast MRI. The potential advantage of 3D-MRSI over single slice [2-3] or single voxel spectroscopy [1] include the ability to assess multiple lesions, as well as tissue with normal MRI appearance, and to gauge lesion borders and infiltration into surrounding tissue throughout the entire breast volume. Future clinical trials in a larger number of subjects would appear to be warranted to investigate the sensitivity and specificity of breast cancer diagnosis using 3D-MRSI.

References: [1]Roebuck JR, *Radiology.* 1998;209:269-275 [2]Jacobs MA, *JMRI* 2004;19:68-75 [3]Jacobs MA, *JMRI* 2005;21:23-28 [4] Smith, MA, 2005 Magn Reson Med 54, 691-696

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Figure 1. a) T1WI MRSI localizers and 3D MRSI maps of b) water, c) lipids and d)choline

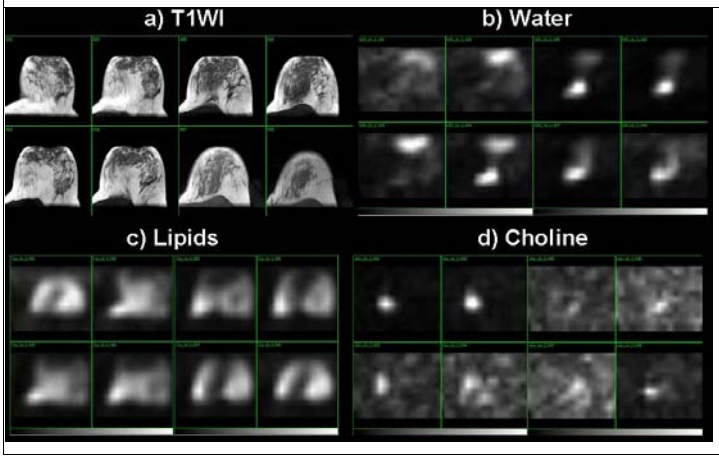

Figure 2. a) 3D fused post contrast T1WI with MRSI localizers. b) corresponding spectra from two slices within the lesion