Human Breast Lipid Composition Determination by in Vivo Proton MRS at 7T

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INTRODUCTION

An issue of great interest to the public is the role of diet in the pathogenesis of breast cancer. Fat consumption is correlated with breast cancer mortality rates (1). Saturated fat in the diet weakly correlated with breast cancer (2) in one analysis, but in the Nurses’ Health Study, intake of animal fat and high-fat dairy foods was associated with a significant increase in risk for breast cancer (3). These observations support the hypothesis that nutrition, specifically a diet high in saturated and monounsaturated fats, is an environmental determinant of breast cancer. Interventional studies tend not to support this hypothesis but the extent to which these diets actually change breast fat composition is not known. It has proven difficult to study the relation of breast fat composition to the risk of cancer with invasive biopsies, and the role of ¹H NMR spectroscopy to detect tumor biomarkers is a promising area of research. Here we report on the non-invasive determination of lipid composition in human breast by proton MRS at 7T.

METHODS

All spectra were acquired on a whole-body 7T scanner (Achieva, Philips Medical Systems, Cleveland, OH, USA) using a 10-cm diameter linear transmit/receive surface coil. The coil consists of a 1 mm-diameter silver wire segmented every 6 cm (x/10 by 3.9 pF non-magnetic capacitors (ATC, Series B, Huntington Station, NY) and placed on a flexible Teflon former. Two variable capacitors (1–40 pF; Johansson, Camarillo, CA) were used for tuning and matching in a balanced configuration. To reduce power deposition in the patient, 1 cm² copper patches were placed on the former between the capacitors and the patient. The coil was padded with ~ 1 cm thick foam to reduce patient-induced losses by the lift-off effect. The coil was SAR modeled with FDTD for the breast configuration; heating tests on a human torso phantom were also performed to insure the coil’s safety. All human volunteers were scanned with local IRB approval. Healthy volunteers (n = 5, age 28 ± 5 y) were positioned on their right side and the coil was placed under the right breast. Small (~150 ml) bags filled with 0.9% saline were used to keep the coil centered. To avoid distorting the coil’s shape and its performance, water suppression was not used. Small (1.5 cm) square copper patches were placed on the chest to allow triggering. Respiratory triggering was performed using a 0.5 cm diameter inductive loop (4). This was done in order to eliminate frequency modulation sidebands caused by the large lipid peak at 1.3 ppm. Each STEAM acquisition was a TE-averaged scan with four TE’s - 23 to 26 ms, with 16 averages per TE. Other parameters were TM 20 ms, TR 2.5 s, no water suppression, BW 4 kHz, 4096 samples. The total scan time for the two STEAM series was about 10 min. T₁ and T₂ were measured (n = 2) using standard inversion recovery and echo-series sequences. All volunteers tolerated the exam well. After adding the two STEAM series, the data were phased, baseline corrected and fitted with Voigt lineshapes using ACD software (Toronto, Canada). Peaks were assigned and ratios quantified according to a previous study (4).

RESULTS AND DISCUSSION

Figure 1 shows a spectrum from subcutaneous fat of the breast. Ten lipid peaks were typically resolved with all selection and dephasing gradients inverted. This was done in order to eliminate frequency modulation sidebands caused by the large lipid peak at 1.3 ppm. Each STEAM acquisition was a TE-averaged scan with four TE’s - 23 to 26 ms, with 16 averages per TE. Other parameters were TM 20 ms, TR 2.5 s, no water suppression, BW 4 kHz, 4096 samples. The total scan time for the two STEAM series was about 10 min. T₁ and T₂ were measured (n = 2) using standard inversion recovery and echo-series sequences. All volunteers tolerated the exam well. After adding the two STEAM series, the data were phased, baseline corrected and fitted with Voigt lineshapes using ACD software (Toronto, Canada). Peaks were assigned and ratios quantified according to a previous study (4).

REFERENCES