Target Audience: Oncologists, radiologists, biochemists developing oncology therapeutics, and ultra-high-field RF engineers and MR spectroscopists.

Purpose: There is a need for a technology capable of evaluating the presence of macroscopic tumors in the lymph nodes of patients prior to, during, and after chemotherapy. Patients with a complete pathological response in breast and lymph nodes have a 5-year survival rate of 87%, as compared to 51% for patients in which lymph nodes have residual macro-metastases. Existing noninvasive methods for staging axillary lymph nodes have poor sensitivity (CT/PET 63%; DCE-MRI 72%), and therefore sentinel node biopsy remains the standard method for evaluation. However, the false detection rate falls to 50% after chemotherapy and a previously obtained sentinel node biopsy.

Methods: The lymph node coil system combines near-field and far-field approaches. A quadrature coil is dual tuned for transmit and receive and provides resonance on 31P and 1H signal (Fig. 1a, 1b). Excitation of 1H nuclei is achieved with a fractionated-dipole antenna, placed on the back of the patient (Fig. 1b). Using a novel circuit in the loop elements, the resonance frequency is shifted away from 1H (298 MHz to 290 MHz) without altering the resonance at 31P (120 MHz) by forward biasing 1 pin diode during transmit (Fig. 1c). Local quadrature transceivers were used for 31P and 1H MRI and MRS for the human breast (MRcoils BV, Drunen, The Netherlands), and the dedicated lymph node coil was used for the axillary nodes (Fig. 1). Safety was assessed by simulation and experimental validation. Second order B0 shimming was applied on the region of interest using B0 maps. 31P MRS sequence: fully adiabatic multi echo spectroscopic imaging (AMESING) with 1 FID and 5 echoes, 8x8x voxels of 1.25 cm isotropic resolution, TR = 6 s, delta TE = 45 ms, spherical k-space sampling. Subjects: Written informed consent was obtained from the healthy volunteers and the local ethical committee approved the study.

Results: Healthy lymph nodes (<1 cm) can be imaged deep within the axilla (Fig. 2a). The axillary lymph node coil system is compatible with the bilateral breast coil array (Fig. 2b). The set up can resolve spectra from a spherical 2 mM phantom with 2 mM of PME metabolites (Fig. 2c). In vivo spectra from 1.25 cm isotropic voxels of muscle (M) and lymph node (LN), scaled to phosphocreatine (PCr) demonstrate that the peak between 6.2 and 8 ppm observed in the lymph node cannot be attributed to voxel bleeding from neighboring muscle tissue, hence suggesting detection of very low levels of PME originating from the lymph node (Fig. 2d). The coil is safe for use, as verified by simulation (Fig. 3), and corroborated with phantom measurements.

Conclusion: We demonstrate the first in vivo 31P spectra of an axillary lymph node. Compatible with the bilateral breast coil, the axillary lymph node system allows simultaneous investigation of the axilla and the breasts. Discussion: Healthy lymph nodes are both smaller and contain lower levels of PME, therefore resolving peaks just above the noise floor in healthy lymph nodes indicates, it may be possible to provide MR spectra from enlarged axillary lymph nodes with macro-metastases of breast cancer patients.