Purpose:
The purpose of this presentation is to report on a clinical study investigating the use of ultrasound tomography for characterization of breast lesions and their environments.

Methods:
A series of clinical studies were carried out using a recently upgraded clinical prototype based on the principles of ultrasound tomography. The in-vivo performance of the prototype was assessed by imaging patients at the Karmanos Cancer Institute's Alexander J. Walt Comprehensive Breast Center. Patients were recruited on the basis of having suspicious masses on mammography and were subsequently imaged with the prototype. Reflection images were constructed using sum and delay type beamforming in post-processing while sound speed and attenuation images were reconstructed using bent-ray tomographic techniques. Masses were identified by biopsy and their locations inferred from conventional mammography and ultrasound exams to provide the ground truth against which the performance of the prototype was measured.

Results:
Our techniques successfully demonstrated tomographic imaging of breast architecture as well as masses as small as 4 mm in size. Detected masses included cancers, cysts, fibroadenomas and hamartomas while anatomical structures corresponding to fat, parenchyma and fibrous stroma were also revealed. Masses were characterized using a combination of qualitative reflection parameters and the quantitative acoustic parameters of sound speed and attenuation. Furthermore, visualization and characterization of the tumor environment was achieved by combining the three imaging parameters, leading to clear evidence of the interaction of cancer with its surroundings.

Conclusions:
These results indicate that operator-independent whole-breast imaging and the detection and characterization of cancerous breast masses and their environment are feasible using ultrasound tomography techniques. This approach has the potential to provide a low cost, non-invasive, and non-ionizing means of evaluating breast masses, leading to a better understanding of tumor development and possible improvements in lesion detection and identification compared to current breast imaging techniques.