# Multi-modality compressed breast imaging

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## ABSTRACT

Measurement of breast tissue response to external stimulation has the potential to unveil additional dynamic biomarkers of disease states. Recently tumor contrast generated by breathing-gas induced vascular changes has been demonstrated using both BOLD imaging [1] and MRI-guided near infrared diffuse optical tomography [2]. At the same time, in the biomedical optics community, temporally resolved hemodynamic changes in the breast resulting from the application of external compression are being investigated as breast cancer biomarkers [3]. Building on our previous optical compressed breast imaging studies [4], we have developed a combined MRI-optical breast compression platform to enable simultaneous dynamic optical and MRI acquisition of the post-compression dynamics. MRI and diffuse optical imaging integrate synergistically, as MRI structural images are used to guide optical reconstructions, and deoxy-hemoglobin (HbR) dependent BOLD scans can be correlated with optical HbR measurements. We describe instrumentation development and report initial dynamic MRI results from healthy volunteers.

## MATERIALS AND METHODS

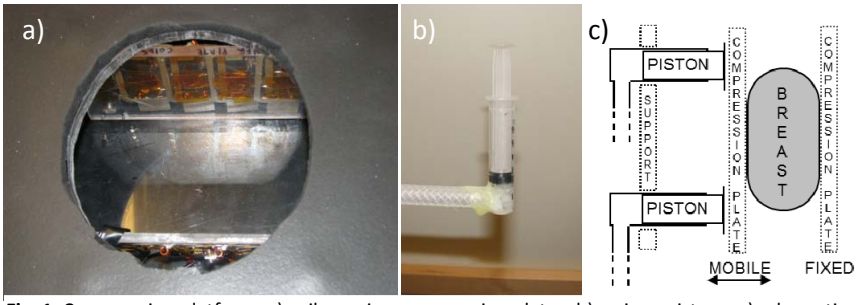
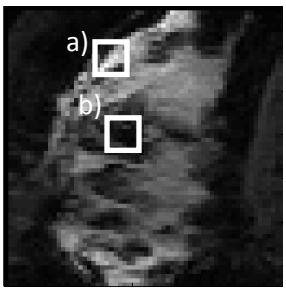



**Fig. 1**. Compression platform: a) coil carrying compression plates; b) syringe pistons; c) schematic

Figure 1 shows details of the compression platform. An 8-element receive phased array is mounted sagitally on hydraulically actuated compression plates. Arrays of 32 source and 32 detection optical fibers are mounted on each plate, respectively, using the space inside the coil elements. MRI markers (Beekley MR Spot) are placed at the corners of the compression plates. The protocol consists of 3-5 2 minute compressions during which the subject's left breast is imaged simultaneously with a multi-slice EPI sequence, as well as 12 Hz continuous-wave optical imaging. After 2 minutes of compression, a T1-FLASH 3D structural image is acquired to locate the optical fibers using the corner MRI markers in conjunction with the known relative fiber locations on the two plates. Optical imaging co-registration algorithms are currently under development, thus we report on the temporal characteristics of the breast BOLD signal below.

## RESULTS AND DISCUSSION



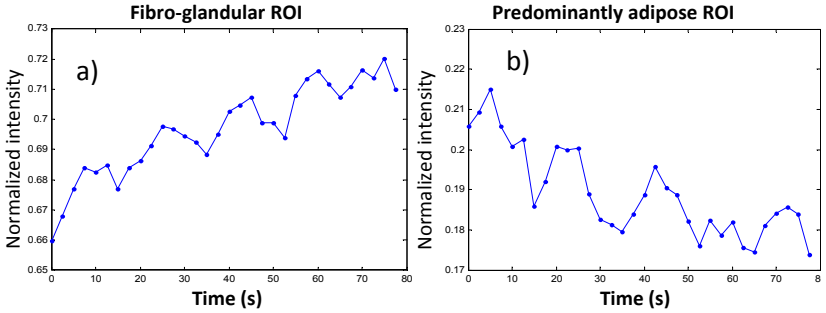




**Fig. 2**. Compressed breast sagittal GE-EPI slice; **Fig. 3** a) BOLD timecourse in fibro-glandular area; b) BOLD in adipose area

Figures 2 shows an example compressed sagittal slice from a healthy volunteer (GE-EPI, TR/TE/α=2500/31/90, 64x64, 120 mm square FOV). Figure 3 shows post-compression normalized image intensity from areas of a) fibro-glandular and b) adipose tissue, respectively.

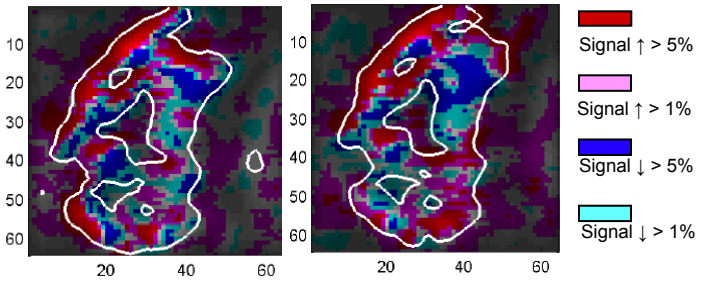



**Fig. 4** Slope maps of BOLD image intensity change

The fibroglandular ROI shows a 7.5% signal increase, while the adipose ROI signal decreases 15%, likely indicating opposing trends of the deoxy-hemoglobin concentration in the two tissues. Figure 4 shows slope maps of the image intensity for two consecutive compression cycles from another volunteer. Pixels undergoing a greater than +/-5% variation are highlighted in red and blue, respectively, while pixels whose intensity changed between +/-1% and +/- 5% are highlighted in magenta and cyan, respectively. The white outline gives the contour of the breast fibro-glandular tissue as determined from thresholding the image intensity (as water-rich glandular tissue appears bright on this fat-suppressed sequence). While the signal slopes do not obviously correlate with breast anatomy, the spatial distribution of slope signs is repeatable across multiple compression cycles in a given subject. A possible explanation is that signal slopes correlate with vascular structure and to this end we are planning to add angiographic sequences to our protocol to obtain the location of the breast major vessels.

## REFERENCES

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