Coregistration of Angiogenesis Related Hemoglobin and Tissue Density in breast tumors using opto-acoustic imaging combined with ultrasound

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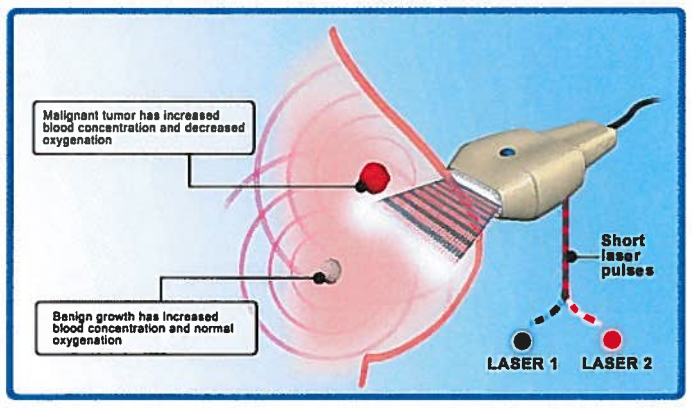
Background

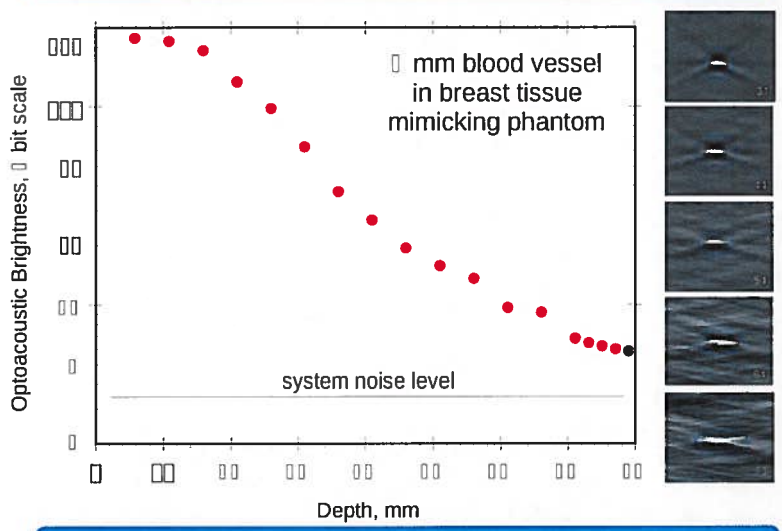
This study was performed to provide preliminary clinical feasibility for the characterization of breast tumors using a real-time dual modality laser opto-acoustic and ultrasound system to provide noninvasive characterization and differentiation of breast tumors based on the concentration of blood and its oxygen saturation in the tumor angiogenesis while also showing structure information based on traditional ultrasonic imaging methods. Opto-acoustic imaging uses pulses of laser light in the near-infrared spectral range to illuminate tissues and detects the resulting pressure with arrays of ultrawide-band ultrasonic transducers. After image reconstruction, tumor location, shape and dimensions are determined with a spatial resolution of better than 1 mm.

Opto-acoustic + Ultrasonic Imaging



US+OA combines and co-registers images based on optical and acoustical contrast to improve the accuracy of cancer detection and diagnosis.

Depth of Imaging / Sensitivity

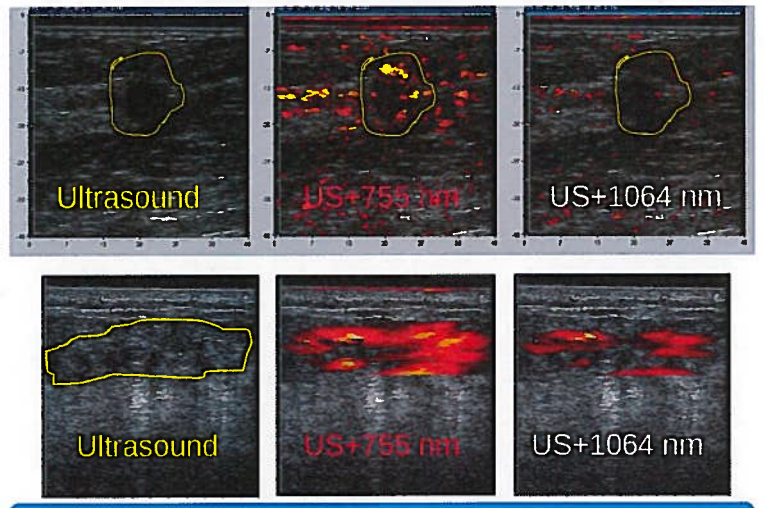


Materials & Methods

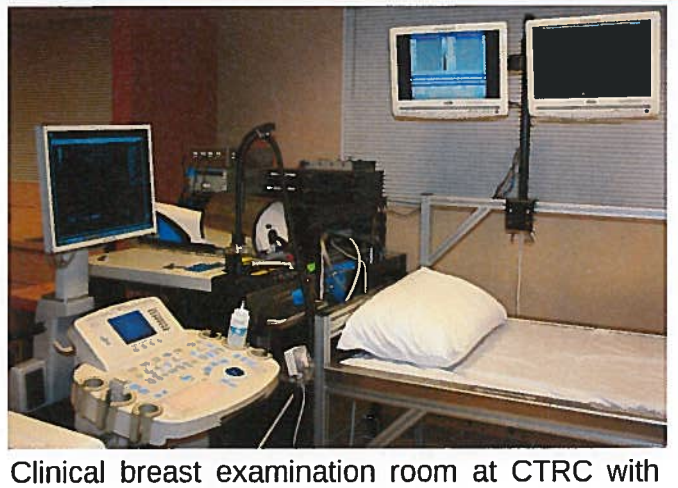
Laser illumination at the wavelength of 757 nm provides contrast based mainly on the hypoxic blood of breast carcinomas, while a wavelength of 1064 nm produces contrast dominated by the enhanced water content and normally oxygenated blood in benign fibroadenomas. Detection of the resulting ultrasonic signals with a commercial handheld ultrasound probe preserves quantitative information about the tumor optical absorption. Two opto-acoustic measurements yield solutions for the concentrations of hemoglobin and oxy-hemoglobin in pixels within the field of view. In the same location, ultrasonic images are generated to provide structure information. The optoacoustic information is displayed with the ultrasonic image to provide coregistered images containing structural and functional information.

Examples of Clinical Results

Invasive lobular carcinomas, cases 93-379 and 81-250



Clinical System at CTRC



Clinical breast examination room at CTRC with opto-acoustic imaging equipment.

Discussion

Initial studies on 15 patients demonstrated that th combined opto-acoustic/ultrasound imaging system ca detect areas of high optical absorption in the region the tumors, confirmed with ultrasound, across varyin tissue densities. Measurement and display of th optoacoustic signal amplitudes showed tumo brightness proportional to the optical absorption. Information obtained at two different wavelengths, on preferentially absorbed by hemoglobin (757 nm) an the other preferentially absorbed by oxyhemoglobi and water (1064 nm) provided noninvasiv differentiation of breast carcinomas from benign tumo based upon differences in absorption in the region the tumor.

Conclusion

The combination of optically-induced functional contra and acoustically generated high resolution imaging in novel breast cancer imaging modality demonstrat clinical feasibility and the potential for noninvasi diagnostics. Furthermore, coregistered ultrasonic a opto-acoustic images provide complimentary structu and functional images. This new imaging system envisioned as an adjunct to X-ray mammography providing ultrasonic imaging enhanced with functio information based on the optoacoustic spectroscopy.

References

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