Clinical Feasibility Study of Combined Opto-Acoustic and Ultrasonic Imaging Modality Providing Coregistered Functional and Anatomical Maps of Breast Tumors

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Principles of Opto-Acoustic Imaging

- Optical imaging provides high contrast BUT low resolution, and does not permit deep imaging.

- Ultrasound provides high resolution and tissue morphology, BUT low contrast for blood and provides neither quantitative molecular or functional images.

- **Solution**: Opto-acoustic (OA) imaging provides high contrast with molecular specificity, quantitative information and high resolution in the depth of tissue.
Real-time Optoacoustic vs Ultrasound Imaging of Blood Vessels

Ulnar Artery and a vein in Human Arm

Opto-acoustic image provides high contrast of blood

Ultrasonic Image provides high contrast of tissue morphology
Optical Absorption of Tissue as a Function of Laser Wavelength

Absorption Coefficient, $\mu_a$ (cm$^{-1}$)

Wavelength, nm

- 757 nm
- 1064 nm

- H-Hb
- O2-Hb
- Fat/Lipids
- H$_2$O
The Imagio™ System
— The Combination of OA and US —

Malignant tumor has increased blood concentration and decreased oxygenation

Benign growth has increased blood concentration and normal oxygenation
Image Contrast and Resolution versus Depth

Optoacoustic Brightness versus Depth, mm

Blood vessel in a breast phantom

20 mm
40 mm
60 mm

noise floor

0 10 20 30 40 50 60 70 80

0 10 20 30 40 50 60 70 80 90 100

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Coregistered Ultrasonic and Optoacoustic Images

Ultrasound

Opto-Acoustic

Invasive Ductal Carcinoma
Coreregistered Ultrasonic and Optoacoustic Images

Ultrasound

Opto-Acoustic

Benign Fibroadenoma
RESULTS and CONCLUSION

OA Imaging as an Emerging Technology

RESULTS

- 6 tumors identified by mammography and ultrasound as suspicious for malignancy; 3 were confirmed malignant by biopsy.
- 2 out of 3 histologically benign tumors were differentiated as benign with opto-acoustics.
- 3 of 3 carcinomas were correctly identified by opto-acoustics.

**Opto-acoustics correctly diagnosed 5 of the 6 lesions.**

CONCLUSION

- Opto-acoustic imaging provides additional diagnostic information based on angiogenesis and blood oxygen saturation.
- These data are being used to formulate a multi-center trial.
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