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

Jason Zalev¹, Don Herzog¹, Bryan Clingman¹, Tom Miller¹, Sergey Ermilov², Vyacheslav Nadvoretsky², Andre Conjusteau², Richard Su², Dmitri Tsyboulski², Alexander Oraevsky², Pamela Otto³, Kenneth Kist³, N. Carol Dornbluth³, B. Michelle McCorvey³

¹Seno Medical Instruments, San Antonio, Texas, USA
²TomoWave Laboratories, Houston, Texas, USA
³University of Texas Health Science Center, San Antonio, Texas, USA
Ultrasound Breast Lesions
Clinical Breast Imaging

• MRI, X-ray, PET, Ultrasound
• Not specific or sensitive enough
• Need imaging modality that can help reduce unnecessary biopsy and improve early detection
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

Short laser pulses

LASER 1  LASER 2
Image Contrast and Resolution versus Depth

Blood vessel in a breast phantom

Optoacoustic Brightness versus Depth, mm

Noise floor
Fluence of Blood Vessel in Tissue

Blood Vessel Diameter: 5mm
Real-time Optoacoustic vs Ultrasound Imaging of Blood Vessels

Ulnar Artery and a vein in Human

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

600 700 800 900 1000 1100

$\mu_a$ values for different wavelengths:
- 757 nm
- 1064 nm

Absorption curves for:
- H-Hb
- O2-Hb
- H$_2$O
Imaging Calibration Phantom

757 nm  1064 nm  Functional Overlay

oxygenated  deoxygenated

oxygenated

deoxygenated
Invasive Ductal Carcinoma

Fibroadenoma
Summary

• Other types of optical imaging provides high contrast BUT low resolution in deep tissue

• Ultrasound provides high resolution and tissue morphology, BUT low contrast for blood

• Optoacoustic imaging provides high contrast with molecular specificity, quantitative information and high resolution in the depth of tissue
Questions ?