Opto-acoustic Breast Imaging with Co-registered Ultrasound

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Findings

- Feasibility Study showed preliminary evidence that fused opto-acoustic and ultrasonic images
  - improves specificity over that of conventional diagnostic ultrasound
  - can potentially reduce the number of negative biopsies performed without missing cancers
Imagio & Breast Cancer Diagnosis

• Opto-acoustics can display real-time functional information about the metabolism of tumors

• The Imagio system could be used as an additional diagnostic test following mammographic screening
Breast Cancer

• Over 38 million mammograms in USA per year\textsuperscript{1}
• 1.6 million breast biopsies in USA per year\textsuperscript{2}
  – Around 80\% of biopsies performed are negative\textsuperscript{3}
• 261,000 cases of breast cancer in USA per year\textsuperscript{2}

\textsuperscript{1} - FDA MQSA National Statistics, http://www.fda.gov
Diagnostic Imaging

- Initial screening with additional ultrasound and MRI can increase sensitivity but generate more false positives than mammography\(^1\)
- Ultrasound useful for characterizing breast tumors, but has low specificity and causes high percentage of negative biopsies\(^2\)

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\(^1\) Berg, W. et. al, JAMA 2012, Volume 307, No. 13
\(^2\) Stavros, A. T., et al., Breast Ultrasound, Lippincott Williams & Wilkins, 2003
Functional Opto-acoustic Imaging
Tumor Metabolism

As compared to normal tissue and benign tumors

– cancers are metabolically more active
– cancers have more blood vessels and more blood
– cancers have irregular branching vessels
– cancers pull more oxygen out of blood and thus de-oxygenate tissues more
– cancers can have hypoxic or necrotic regions of tissue

• Functional opto-acoustics provides information about tumor metabolism
• OA demonstrates this relatively greater de-oxygenation within malignant tissues
• OA demonstrates this increased internal blood within lesions
Imagio™ Breast Imaging System

Functional Contrast
Imagio™ Breast Imaging System

Functional Contrast

deoxygenated
tumor

oxygenated
tumor

Short laser pulses

LASER 1  LASER 2
Oxygenation Level of Tumors

- **Deoxygenated Tumor**
  - Signifies Malignant (Bad) – Red

- **Oxygenated Tumor**
  - Signifies Benign (Good) - Green
Invasive Ductal Carcinoma (Malignant)
Invasive Ductal Carcinoma (Malignant)
Fibroadenoma
(benign)
Clinical Phase II Trial Feasibility Study

- 155 subjects with solid breast masses imaged with conventional diagnostic ultrasound underwent Imagio scans at two IRB approved sites
- 79 biopsies performed
  - 40 benign
  - 34 malignant
  - 6 excluded
- Images retrospectively interpreted by 5 independent readers blinded to biopsy results
Clinical Phase II Trial Feasibility Study

- Probability of malignancy (POM) assigned by readers to each lesion based on Imagio opto-acoustics (OA) vs. conventional diagnostic ultrasound (CDU)
- Area under receiver operating characteristic (ROC) curve derived from POM compared to biopsy results and sensitivity and specificity were calculated
- OA had same sensitivity as CDU but 40% better specificity

<table>
<thead>
<tr>
<th></th>
<th>OA</th>
<th>CDU</th>
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<tbody>
<tr>
<td>POM for all malignant lesions</td>
<td>73.6</td>
<td>62.1</td>
</tr>
<tr>
<td>Sensitivity</td>
<td>0.99</td>
<td>1.0</td>
</tr>
<tr>
<td>Specificity</td>
<td>0.237</td>
<td>0.161</td>
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</table>
Clinical Phase II Trial Feasibility Study

• Readers also classified lesions according to **BI-RADS** (Breast Imaging-Reporting and Data System) categories

• For 40 biopsied benign lesions, downgrades were achieved as follows
  - **BI-RADS 3 (≤ 2% POM)**
    - 5/5 (100%) remained BI-RADS 3
  - **BI-RADS 4a (>2% to ≤10% POM)**
    - 12/22 (54%) downgraded to BI-RADS 3
  - **BI-RADS 4b (>10% to ≤50% POM)**
    - 3/13 (23%) downgraded to BI-RADS 3

• All 34 biopsied cancerous lesions remained at original BI-RADS per site PI
OA safer than competitive functional imaging tests

• OA uses no ionizing radiation and no contrast agents, making Imagio completely safe for use on patients
  – PET/CT, PEM and Technetium Gamma Imaging (BSGI) use ionizing radiation
  – MRI uses a gadolinium contrast agent which can have side effects
Conclusion

• Imagio can display real-time functional information about the metabolism of tumors

• Clinical results from Feasibility Study illustrate that
  – the technology may have the capability to improve overall accuracy of breast tumor diagnosis, monitoring and treatment
  – the potential to reduce the number of biopsies
  – to characterize cancers that were not seen well with conventional ultrasound

• Further study in a large population is being underway at multiple sites