PennState College of Education | CSATS Center for Science and the Schools **Research Experiences for Teachers**

PennState Cancer Institute

Development of human breast phantom for portable ultrasound and photoacoustic imaging of breast cancer.

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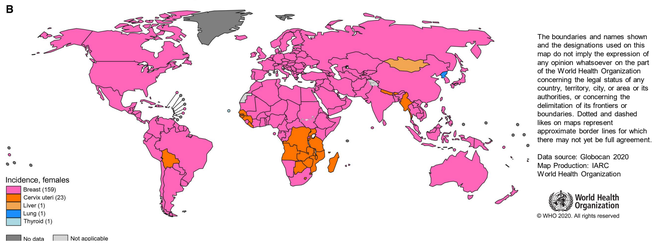
Introduction

In 2020, 2.3 million people were diagnosed with breast cancer making it the most prevalent disease[1].



Early detection is key to survival

- In high income countries survival for 5 years after diagnosis is 90% [1].
- In middle and low income countries survival for 5 years after diagnosis is 60% and lower[2].
- To increase survival rates we need a **portable, affordable imaging system** to detect and monitor the progress of treatment.

Imaging Modalities Rationale

Combining ultrasound with LED Photoacoustic imaging would be an accurate, portable cancer detection device.

Ultrasound is a safe, affordable, and portable imaging modality already accepted as a diagnostic tool in breast cancer imaging. B mode ultrasound gives tumor structural information and shows tumor elasticity. Doppler mode ultrasound shows blood flow and elastography ultrasound shows tissue stiffness.

Photoacoustic imaging with laser is an accepted breast cancer diagnostic tool but it is not portable. Replacing the laser light source with LED for photoacoustic imaging makes the system portable. Photoacoustic imaging sends light into the tissue. Molecules absorb light at different frequencies and emit sound waves detected on the ultrasound transducer, forming an image.

Making the Phantom

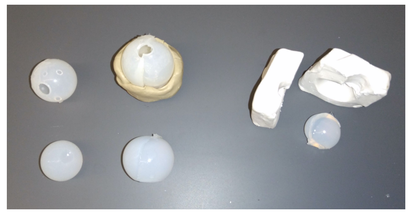
Phantoms are used to test imaging modalities before human studies. All aspects of the imaging modalities and any computer coding program changes are made using the phantom. Only when the imaging modality works consistently and accurately using the phantom can it continue to human trials.

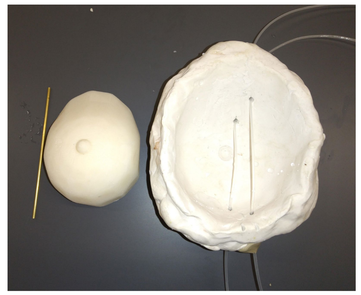
The phantom must have:

- Similar acoustic properties as human tissue
- Vasculature
- Visible tumor

Lesion Molds

- Perfect sphere indicates benign lesion
- Abnormal shape indicates potential malignancy



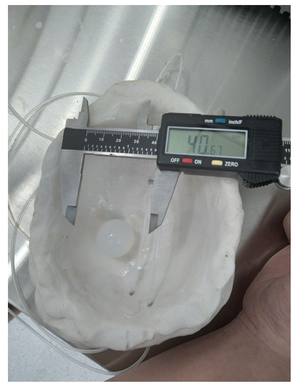


Phantom Mold

- 3-D printed model of breast was used to make a clay mold
- Clay mold has tubes representing blood vessels

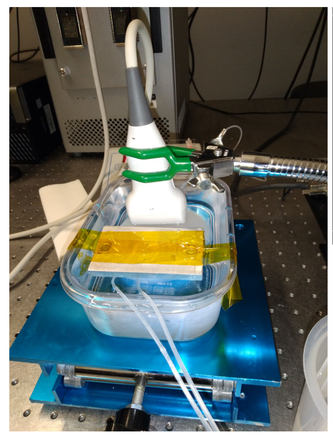
Making the phantom

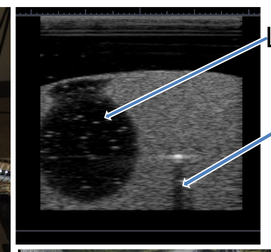
- The lesion and background are made of an agarose base and different concentrations of silica to create contrast.
- The base layer is poured and solidified
- The lesion is placed
- The remaining agarose is poured and solidified.

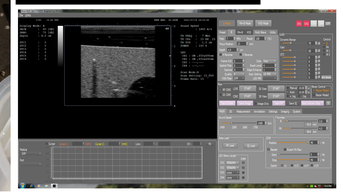


Imaging the Phantom

Plastic tubing representing blood vessels was connected to a pump with water to mimic circulation. The phantom was submerged in a tank of deionized water to prevent air from disrupting the ultrasound signal. B mode ultrasound imaging powered by Acoustic X was run.







Conclusion

Both the lesion and plastic tubing were visible during b mode ultrasound imaging. Both appeared dark as intended. The agarose phantom was an accurate imaging representation and can be used for future imaging tests.

Future Research

Now that the phantom making process has been standardized and tested, a reverse 3-D model will be made. We will add oxygenated and deoxygenated blood to the plastic tubing ("blood vessels") in the phantom and add Photoacoustic imaging with LED to see if the system can correctly detect molecular differences.

Acknowledgements

Special thanks to Dr. Kothapalli, the Kothapalli lab group, and Penn State Cancer Institute. In addition, I want to thank CSATS.

Citations

- Chart: WHO – Retrieved from: https://acsjournals.onlinelibrary.wiley.com/doi/10.3322/caac.21660#
- 1: WHO 2021. Breast Cancer. Retrieved from: https://www.who.int/news-room/fact-sheets/detail/breast-cancer
- 2: Torre, Lindsey A. et al. 2017. Global Cancer in Women: Burdens and Trends. AACR

The RET for Science Teachers is funded by Penn State Cancer Institute.