Comparing Portable and Clinical Ultrasound Systems Using 3D Printed Breast Phantom Inserts

Dustin Valdez, Jami Fukui, Thomas Wolfgruber, Lambert Leong, Gertraud Maskarinec, John A. Shepherd

University of Hawaii Cancer Center, Honolulu, HI, USA

Background

• Late-stage breast cancer rates in the Pacific where mammography services are limited are exceedingly high. Therefore, alternative accessible breast cancer screening technologies such as portable ultrasound is needed.
• Little is known about the performance of portable ultrasound when compared to clinical ultrasound for use in breast cancer screening.
• By utilizing 3D printing technology, we designed breast phantom inserts to replicate various types of lesions [1].
• In this study, we utilized 3D printed breast phantom inserts to compare portable and clinical ultrasound lesion detection performance.

Methods (continued)

• Four different breast inserts were designed using FreeCAD (version 0.19) to replicate different lesion detection properties. The first insert compares lesion shape, the second insert investigates depth and size, the third insert looks at fiber diameter, and the fourth insert looks at clusters.
• The breast inserts were placed in a gelatin-based breast phantom created for ultrasound [2] and a vacuum chamber was used to extract air bubbles. See Figure 1 and 2.
• Using clinical ultrasound (Philips EPIQ 5G), and portable ultrasound (GE Vscan Extend) various images were captured of identical angle and orientation for both devices. See Figure 4-7.
• The number of lesions visualized were counted and presented as a percentage of lesions detected.

Results (continued)

Table 1. Lesion Detection Performance for Portable US and Clinical US

<table>
<thead>
<tr>
<th>Breast Insert</th>
<th>Clinical US</th>
<th>Portable US</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>18/18 (100%)</td>
<td>18/18 (100.0%)</td>
</tr>
<tr>
<td>2</td>
<td>67/72 (93.1%)</td>
<td>65/72 (90.3%)</td>
</tr>
<tr>
<td>3</td>
<td>24/30 (80.0%)</td>
<td>21/30 (70.0%)</td>
</tr>
<tr>
<td>4</td>
<td>103/104 (99.0%)</td>
<td>58/104 (55.8%)</td>
</tr>
</tbody>
</table>

The portable ultrasound had a 100% lesion detection rate for breast insert 1, 93.0% for breast insert 2, 70% for breast insert 3 and 55.8% for breast insert 4 (Table 1). Clinical ultrasound had 100% lesion detection rate for breast insert 1, 93.1% for breast insert 2, 76.6% for breast insert 3, and 99% for breast insert 4.

Conclusion

• Portable ultrasound shows comparable lesion detection capabilities to clinical ultrasound in 3 out of 4 breast phantom insert tests.
• Portable ultrasound may have potential as a capable accessible breast cancer screening device in areas without mammography.

Future Work

• A reader study where different types of readers (radiologist, MDs, and general healthcare workers) are asked to assign a BI-RADS score to breast ultrasound images with and without the aid of an AI system is currently in progress.

References


San Antonio Breast Cancer Symposium - December 7-10, 2021
This presentation is the intellectual property of the author/presenter. Contact them at DustinValdez@hawaii.edu for permission to reprint and/or distribute.