The Future of Breast Cancer Screening: AI-Based Photoacoustic Imaging

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Breast cancer is the most common cancer in women worldwide, yet its death rate is decreasing because of advancements in early detection. Although current imaging systems like mammograms, ultrasounds, and magnetic resonance imaging (MRI) have improved survival, they still suffer from high false positive and negative rates, limited effectiveness for dense breasts, and screening pain. Photoacoustic (PA) imaging, which visualizes vascular rather than morphological features, has the potential to overcome these limitations; however, their images remain too complicated for the naked eye to interpret, limiting clinical viability. Thus, this study developed a novel AI-based PA system using a machine learning model (MLM) to detect breast cancer. To ensure comfort, patients gently pressed their breast against a plastic membrane as the system directed near infrared (NIR) laser light at the breast. Hemoglobin's unique NIR absorption generated ultrasound signals that visualized blood vessels and produced a PA image. An MLM was then trained to diagnose breast cancer from vascular patterns. To address the limited PA dataset, transfer learning, first training with MRI images and retraining with PA and MRI images, was employed. In total, 36 patients with biopsy-proven breast cancer were imaged for transfer learning and evaluation of the developed system. Ultimately, the system achieved a 76.83% diagnostic accuracy, consistent across varying breast densities. These results highlight AI-based PA imaging's potential for clinical integration, addressing the key barrier faced by previous research to improve screening accuracy and comfort.

Awards Won: