An Innovative Approach to Molecular Imaging of Primary Breast Cancer

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Overview/Abstract

Despite improvements in detection and therapy, breast cancer remains a leading cause of mortality in women. X-ray and magnetic resonance mammography are considered highly sensitive screening/detection methods but have not entirely stemmed the tide, in part because they provide primarily anatomical information, with limited ability to assess cellular/molecular properties, leading to substantial false positive rates. Molecular imaging such as positron emission tomography (PET) holds great promise in that it can be highly specific and provide information on cellular subtypes by targeting specific over-expressed molecular markers of cancer such as estrogen receptors. But commercial PET systems are designed for whole-body imaging and are not well-suited for imaging small lesions in the breast, due to their limited spatial resolution and detection sensitivity. We have proposed a novel PET detector design (SBU patent is pending) based on an alternative paradigm to the pervasive pixelated block design. Our detailed Monte Carlo simulations of this monolithic detector approach, coupled with innovative neural network positioning algorithms have shown that we can achieve unprecedented spatial resolution of <1 mm, which is an improvement of more than a factor of 4 over current clinical systems. If we combine these detectors to construct an imaging system in a unique breast-specific scanner geometry, our analysis demonstrates higher sensitivity while also accessing axillary lymph nodes which are key to detecting the first stage of metastasis. Thus, with this seed funding we propose to procure a physical prototype of this detector and validate its performance in terms of 3D spatial, energy, and time resolution using experimental measurements. At the same time, we will optimize the geometry and related parameters for a breast+lymph node scanner using Monte Carlo simulations. The results will provide the necessary preliminary data for a large, 5-year NIH R01 proposal to build and validate the actual imaging system.