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Commentary

A Brief Overview on Imaging Techniques for the Screening of Breast Cancer

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DESCRIPTION

Breast cancer is the most common malignancy in women and the main cause of cancer death worldwide. Breast cancer was diagnosed in 1.7 million women in 2012, accounting for 23% of all new cancer cases. In that year, 520,000 women died of cancer, accounting for 15% of total female cancer mortality. Incidence and death rates in high Human Development Index (HDI) regions are projected to stabilize in the future, whereas low and medium HDI regions are expected to undergo rapid rise. This is most likely due to the adoption of western lifestyles and diets, as well as higher screening activities and longer life expectancies.

On the one hand, advances in background knowledge of breast cancer biology have led to gradual reduce in the death rates, while on the other side, the distribution of screening programmes has led to gradually falling mortality rates. For detection, diagnosis, neoadjuvant treatment monitoring, guiding biopsies, guiding surgery, and surveillance, imaging plays a critical role throughout the breast cancer management process. X-ray mammography is used in screening programmes to detect breast cancer. Clinical examination, X-ray imaging, ultrasound imaging, and image-guided needle biopsy are used to make a diagnosis if a suspicion is aroused. When X-ray imaging and ultrasound imaging yield conflicting results, Magnetic Resonance Imaging (MRI) is performed.

However, there are certain disadvantages to these modalities. The sensitivity and specificity of X-ray and ultrasound imaging are not ideal. In addition, X-ray mammography exposes women to ionising radiation, causes painful breast compression, and performs poorly in radio-dense breasts. High false positive rates and operator variability in collecting two-dimensional pictures are constraints in ultrasound imaging. By detecting contrast enhancement in tumour vasculature after bolus injection of Gadolinium contrast, MRI demonstrates great sensitivity. The approach is sensitive, doesn't use ionising radiation, and has good spatial resolution. It does, however, have a low specificity and needs contrast agents. The necessity to time imaging during particular parts of the menstrual cycle in pre-menopausal women makes it somewhat logistically challenging. It's also costly, not widely available, and patients are frequently contraindicated because of pacemakers and claustrophobia.

Because of the societal impact of breast cancer and the limitations of existing imaging techniques, researchers are always looking for new ways to non-invasively image the breast and its abnormalities. Several strategies and approaches for enhancing sensitivity and/or specificity, as well as cost-effectiveness, accessibility, patient burden, customized treatment, and safety, are being explored in detail. Mammographic tomosynthesis, dual-energy mammography, robotic whole breast sonography, ultrasound CT, ultrasound elastography, dispersion MR, MR elastography, MR spectroscopy, breast-specific gamma imaging, and single-photon emission mammography are some of the promising methods currently being studied in large-scale clinical trials.

Photoacoustic (PA), also known as optoacoustic imaging, is a technique for visualizing optical absorption in tissue at high resolutions. The probing energy is still light, but unlike in DOT, photons are not quantified and do not generate the observed signal. Instead, stress (acoustic) waves are measured, which give great resolution since they are minimally dispersed and attenuated in soft tissue. Detectors in the United States can have a variety of properties that must be carefully selected since they have a significant impact on detectability, resolution, and image depth. Light is transmitted to the breast in such a way that it produces signals in the breast volume that fall inside the US detecting aperture. The laser is chosen based on particular temporal-spatial-spectral features that affect target detectability and imaging depth. Pre-amplification and digitization electronics for PA signals produced in a big organ like the breast must be low noise and have a high dynamic range. The digitised raw data is a non-ideal measurement that is partial, noisy, and frequently contains artefacts. The goal of image reconstruction is to create an accurate, high-quality visual representation of the breast.

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