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Perspective on the Developing Modalities for Breast Cancer Imaging

Digital mammography has already become the new standard, replacing screen-film for breast cancer screening, and for diagnostic work-up of suspicious findings. New digital imaging technologies may use x-ray beam characteristics such as tungsten target, silver filtration, and higher kVp; in ways that represent a departure from the long established screen-film techniques. Representing a logical evolution from twodimensional to tomographic and 3D imaging of the breast, breast tomosynthesis and dedicated breast CT are currently investigated as potential replacements or adjuncts to mammography. Mammography (screen-film or digital) is the single most effective tool for the detection of occult breast cancer with an overall sensitivity as high as about 85% for older women and about 60% or lower for women under the age of 50 years (Rosenberg RD et al. Radiology. 1998;209:511-8, Pisano E et al. N. Engl. J. Med. 2005;353: 1773-83). Attempts to increase sensitivity have included the use of intravenously injected (IV) contrast with digital mammography, tomosynthesis or breast CT but these efforts are in the research stage. With improved hardware and image acquisition techniques, the role of IV contrast injected MRI is gradually expanding as a diagnostic tool, and it is also recommended for screening of high risk patients, due to its high sensitivity. Ultrasound, a well established modality for diagnostic work-up is evolving from the conventional pulse echo-based approach to elasticity imaging and ultrasound CT of the breast. Breast scintigraphy with a dedicated camera is now in clinical use and it receives much attention as an adjunct to mammography. Other technologies that include diffuse optical tomography as a stand-alone modality or in conjunction with MRI or with x-ray imaging are currently under investigation. We are likely to see an increasing use of alternative imaging approaches in conjunction with mammography, ultrasound and MRI, the three essential modalities for breast cancer detection and for diagnostic work-up of positive findings.

Educational Objectives:

1. Appreciate recent advances in the physics and engineering in x-ray detector technology that contributed to the development of digital mammography, tomosynthesis and dedicated breast CT.

2. Recognize the potential quantitative applications and important limitations of the xray based breast imaging modalities.

3. Appreciate recent technological developments in current clinical non-x-ray modalities such as MRI and ultrasound and their increasingly important role in breast cancer imaging.

4. Gain perspective on some emerging modalities such as optical diffuse tomography and their potential role in the detection and diagnosis of breast cancer.