Emerging Modalities in Breast Cancer Imaging

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KEYWORDS

• Breast • Cancer • Imaging • Modalities

KEY POINTS

- Although each of the emerging imaging techniques has advantages compared with standard mammography, they are not perfect, and each has inherent limitations.
- To date, no imaging techniques have been studied by large randomized clinical trials to match the proven benefits of screening mammography; namely the reduction of mortality caused by breast cancer by nearly 30%.
- More research into breast cancer imaging modalities is required.

INTRODUCTION

Breast cancer continues to be the most frequently diagnosed malignancy and the second leading cause of death caused by cancer in women in the United States.[1] Nearly 3 million women were estimated to be living with breast cancer in the United States in 2011. Approximately, 230,000 new cases and 40,000 deaths caused by breast cancer are estimated to occur in 2014. At present, a woman living in the United States has a 1 in 8 (12.3%) risk of developing breast cancer during her lifetime.[2] Today, standard-of-care breast imaging techniques include digital mammography (DM), targeted ultrasonography, and dynamic contrast-enhanced magnetic resonance imaging (MRI).

Mammography has been the mainstay of breast cancer screening programs in the United States and many European countries since the 1990s. Although mammography remains the only imaging modality shown to reduce mortality caused by breast cancer by nearly 30% in multiple large randomized clinical trials, it has several shortcomings. A well-known limitation of mammography is its decreased sensitivity in breasts with predominantly dense parenchyma.[3] Some of the deficiencies of

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Surg Oncol Clin N Am 23 (2014) 735–749
http://dx.doi.org/10.1016/j.soc.2014.07.005 **surgonc.theclinics.com**
1055-3207/14/$ – see front matter

mammography are caused by the depiction of the three-dimensional (3D) breast in a two-dimensional (2D) format. As a result, overlapping tissue may cloak a potential cancer or create a fictitious lesion with features suspicious of a malignancy that is not present. As a result, further unnecessary work-ups and interventions, including needle and excisional biopsies, are performed, incurring both monetary costs and emotional distress to the patient and society. Another important limitation of mammography is the need for breast compression to perform a high-quality study. Breast compression is perhaps the most frequent cause of patient discomfort and anxiety, particularly after recent radiation therapy.

Efforts to overcome these shortcomings of routine mammography have led to the development of newer breast imaging modalities. Apart from targeted ultrasonography, the ubiquitous adjunct to mammography for diagnostic work-up, breast MRI has evolved over the past decade and is now an established modality in breast imaging. Lack of ionizing radiation and high sensitivity when combined with mammography are some of the advantages of MRI. However, lower specificity, requirement of intravenous contrast, high cost, lower patient tolerance, and lack of access have prevented this technique from replacing routine mammograms. With continued improvements in technique, MRI has become established as the modality of choice for specific indications.[4] At present, MRI is most commonly used as a screening supplement to mammography in women at high risk of developing breast cancer.[4] Other common indications for MRI are evaluation of extent of disease and treatment monitoring such as patients receiving neoadjuvant chemotherapy for locally advanced breast cancer. Earlier in the development of this technology, there was prevalent use of MRI for surgical planning, which has now subsided, primarily because of studies with conflicting results regarding desired outcomes such as lowered reexcision and local recurrence rates as well as a paucity of data for survival outcomes. The exact criteria of use beyond screening of high-risk women remains a topic of controversy. Techniques and clinical indications for this modality with an expanding body of evidence for its utility are reviewed elsewhere.[5]

Other breast imaging modalities continue to be developed with hopes of overcoming the challenges of mammography, MRI, and ultrasonography. These modalities include automated whole-breast ultrasonography (AWBUS), digital breast tomosynthesis (DBT), dedicated breast computed tomography (bCT), contrast-enhanced DM (CEDM), and nuclear medicine studies such as positron emission mammography (PEM) and breast-specific gamma imaging (BSGI). These emerging breast imaging technologies show promise in improving the current standards of practice of breast imaging and are the subject of this article.

ULTRASONOGRAPHY REFINEMENTS

Targeted ultrasonography has been a long-standing adjunct to mammography for problem solving and biopsy planning. The advantages of ultrasonography are wide availability, lack of ionizing radiation, and lower cost compared with other techniques such as breast MRI. With increasing awareness of the limitations of mammography, ultrasonography has gained popularity as a supplemental screening tool. Many states such as Texas, New York, Connecticut, and California now have legislation mandating that women be informed of their breast density, encouraging a dialogue between the patient and her referring physician regarding the need for additional screening. Legislation in at least 1 state, Connecticut, has more specific language regarding screening ultrasonography that mandates insurance companies to pay for the examination if recommended by a physician. Whether legislation is the best way to improve clinical