Tomosynthesis in Breast Cancer Imaging

How Does It Fit into Preoperative Evaluation and Surveillance?

Mohammad Eghtedari, MD, PhD[a], Catherine Tsai, MD[b], Julie Robles, MD[b], Sarah L. Blair, MD[c], Haydee Ojeda-Fournier, MD[a,*]

KEYWORDS

• Breast cancer • Digital mammography • Digital breast tomosynthesis
• Breast imaging • Diagnostic breast imaging • Mammography
• Image-guided interventions

KEY POINTS

- Digital breast tomosynthesis is a quasi-three-dimensional radiograph mammogram with radiation dose well below the maximum allowed by the Mammography Quality Standards Act.
- Digital breast tomosynthesis has been shown to increase the number of breast cancers detected while lowering the callback rates when compared with full-field digital mammography.
- Availability of digital breast tomosynthesis–guided breast interventions allows for the minimally invasive sampling of lesions detected with this new modality.
- Digital breast tomosynthesis shows increase in the detection of sclerosing papillary lesions and scars; however, fewer cysts and fibroadenomas are called back for evaluation.

INTRODUCTION

Screening mammography has been shown in multiple, long-term, randomized clinical trials to decrease breast cancer mortality rates by 30% and possibly more.[1–6] These randomized clinical trials were started 40 years ago and used screen-film mammography. In 2005, the Food and Drug Administration (FDA) approved the use of

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[a] Department of Radiology, Breast Imaging Section, UC San Diego Health, Moores Cancer Center, 3855 Health Sciences Drive, #0846, La Jolla, CA 92093-0846, USA; [b] Department of Surgery, University of California San Diego, 9500 Gilman drive, La Jolla, CA 92093-0846, USA; [c] Department of Surgery, Division of Surgical Oncology, UC San Diego Health, Moores Cancer Center, 3855 Health Sciences Drive, La Jolla, CA 92093-0846, USA
* Corresponding author.
E-mail address: hojeda@ucsd.edu

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full-field digital mammography (FFDM) and since then, most mammographic units in the United States are FFDM. The DIMIST trial[7] showed that there was no difference in breast cancer detection between screen-film mammography and FFDM except in three groups of women: (1) those younger than 50 years old, (2) those with dense breast tissue, and (3) premenopausal or perimenopausal women. In that subgroup of women, FFDM found more cancers. Both screen-film mammography and FFDM use x-ray to create a two-dimensional (2D) image of the breast. The main limitation of 2D mammography is that the entire volume of tissue is displayed as a planar image with tissue overlap. In dense breasts, the overlap may obscures masses, the so-called masking effect.[8] In 2011, the FDA approved the first digital breast tomosynthesis (DBT) unit. Since then, additional vendors have obtained FDA approval for commercial DBT units. DBT overcomes the overlapping of tissue limitation of 2D mammography by generating images of the breast in planes.

In addition to screening for breast cancer, x-ray mammography is used to evaluate patients presenting with breast clinical findings as the first-line imaging modality in patients 30 years old or older. Mammography is also used in the preoperative- and postoperative evaluation of patients with breast cancer and for image guidance in patients requiring wire localization or biopsy of nonpalpable breast lesions that are not seen on ultrasound. DBT has rapidly been adopted in clinical practices across the United States because it detects more invasive breast cancers and reduces the callback rate. DBT is also used in the diagnostic setting and is referred to as a better mammogram, which is specifically true in the evaluation of patients with dense breast tissue.

This article reviews the technology used to create a DBT study, summarizes recent clinical studies, and focuses on the utility of DBT in the preoperative evaluation and surveillance of patients.

TECHNIQUE

DBT, first described by Niklason and colleagues[9] in 1997, reconstructs a tomographic quasi-three-dimensional (3D) radiographic image of the breast by applying a mathematical algorithm to a few low-dose 2D projection images. Reconstructed 3D images are superior to 2D mammograms mainly because they provide blurring of the tissue above and below the selected plane lowering the effect of overlapping breast tissue. A composite 2D image, which looks like a conventional FFDM image, can also be generated from the projection images, the so-called synthetic view.

In DBT, the breast is compressed against a detector while the x-ray tube rotates around the breast in an arc and captures a series of 2D images that are known as projections.[10,11] Because of the limited angular rotation of the x-ray tube, the z-resolution of the 3D (ie, perpendicular to the detector surface) is worse than that of in-plane resolution. However, even this limited z-resolution seems to be sufficient to lower the superimposition of breast tissue resulting in better cancer detection and lower callback rates as reported in the literature.

The FDA has approved the following DBT systems with the year approved shown in parenthesis: Hologic Selenia Dimensions (2011), GE SenoClaire (2014), Siemens Mammomat Inspiration (2015), Fujifilm ASPIRE Cristalle (2017), and GE Senographe Pristina (2017). Most DBT machines use similar components, such as a full-field digital detector, breast compression mechanism, and an x-ray tube mounted on an arm that rotates around the compressed static breast. The x-ray tube may rotate continuously (Hologic, Bedford, MA, USA and Siemens, Malvern, MA, USA) or may rotate in steps (GE, Waukesha, WI, USA). The detector is usually static; however, Hologic Selenia