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Digital Breast Tomosynthesis for Dense Breasts

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Introduction

"Breast cancer is the most common cancer among women in the United States, and after lung cancer, it accounts for the most cancer-related deaths in women" (Paterson & Havrda, 2020, p. 369M). Digital Breast Tomosynthesis (DBT) also referred to as three-dimensional digital mammography is a form of mammography that has been developed to aid in the diagnosis of breast cancer. It provides a new approach and technique that allows for the reconstruction of the whole breast into multiple images that way each layer of the breast will be able to be viewed. This technique provides a way to remove superimposition from overlapping structures within the breast, allowing for a more accurate diagnosis. (Haouimi & Vadera, 2020)

Mammography

The process of creating images of the breast for screening and diagnostic purposes by using low dose radiation.

- Screening mammograms
  - Performed at age forty and then annually
  - Provides earlier detection of breast cancer for a better chance of survival
- Diagnostic mammograms
  - Performed when a patient has a strong family history of breast cancer or clinical evidence (Long, Rollins, & Smith, 2016)
- The patient's anatomic breast density, the screening and diagnostic testing received, and subsequent reporting and notification are important in the successful diagnosis and treatment of breast cancer. (Paterson & Havrda, 2020)

Projections Acquired

Craniocaudal (CC) & Mediolateral Oblique (MLO) views are obtained on each breast

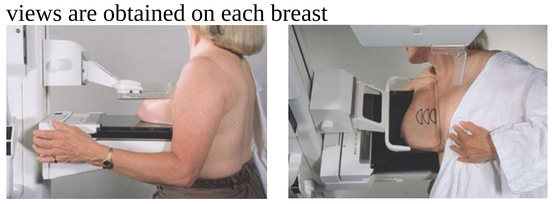


Figure 1. The first image (left) shows accurate positioning to obtain a CC view. The second image (right) shows accurate positioning for a MLO view. (Pate-Schloder, 2019)

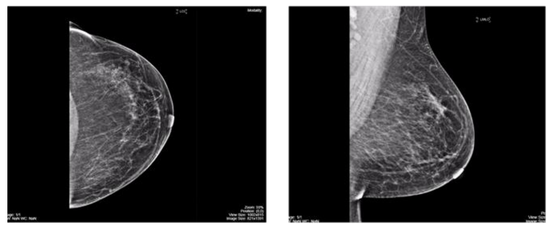


Figure 2. The first image (left) displays a normal 2D CC projection. The second image (right) displays a normal 2D MLO projection. (Mah & Burbridge, 2017)

Characteristics of Breast Tissue

- Breasts vary in shape and size:
  - Amount of fat and glandular tissue
  - Condition of the suspensory ligaments
- Breast density is influenced by:
  - Genetics
  - Age
  - Pregnancy or Menopausal Status
  - Body Weight
  - Alcohol and Drug Use (Johnson, 2017)
- Breast tissue changes from puberty to menopause:
  - Breast density decreases with age
  - Replaces fibroglandular tissue with more fatty tissue. (Long et al., 2016)

Imaging Dense Breast Tissue

- Breast tissue density
  - Ratio of fatty to glandular tissue within the breast
  - More glandular tissue and connective tissue compared to fatty tissue means the denser the breast
  - Denser breasts make it more difficult for x-rays to penetrate the tissue
- Breasts are classified into four density ranges:
  - Fatty, scattered, heterogeneously dense, and extremely dense (Long et al., 2016)
- Cancerous tumors found in the breast have:
  - Irregular boarders that appear spiculated and as architectural distortions (Østerås, Martinsen, Gullien, & Skaane, 2019)
- Dense breast tissue can
  - Mask spiculations
  - Be considered an independent risk factor for breast cancer (Phi, 2018)

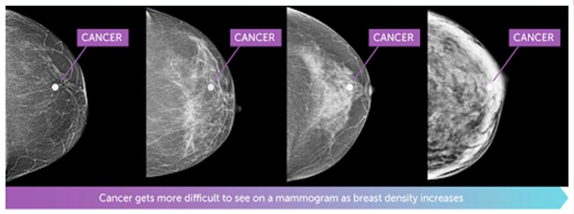


Figure 3. Demonstrates CC views with a white circle in the central breast that represents cancer across the four types of breast density ranges; fatty, scattered, heterogeneously dense, and extremely dense (left to right). (BC Cancer Screening, n.d.)

Digital Breast Tomosynthesis

- The x-ray tube is mounted above the patient and may move in an arc around a point within the breast or sweep across a linear path (Johnson, 2017)
- During image acquisition, the arc varies between fifteen to sixty degrees in a plane aligned with the chest wall
- Numerous projections acquired across the arc
- These projections are then reconstructed into a series of stacked images or slices
- These stacked images may be panned through displaying one slice in focus

(Chong, Weinstein, McDonald, & Conant, 2019)

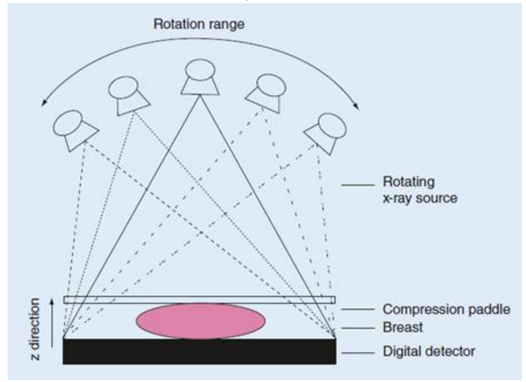
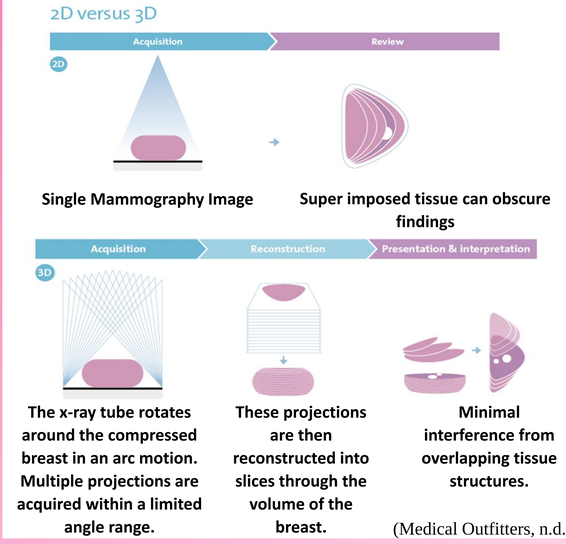


Figure 4. Displays the arc movement and rotation range of the tube over the compressed breast. (Kiarashi & Samei, 2013)

2D Mammography vs DBT

- Tomosynthesis was developed to overcome the limitations of 2-D imaging: (Johnson, 2017)
  - Masking effect from structures overlapping each other on one single image
- DBT was found to have:
  - Reduced masking and resolved superimposition of structures
  - Detected more cancers in all density and age groups
  - Higher true-positive & lower false-positives rates (Østerås et al., 2019)



(Medical Outfitters, n.d.)

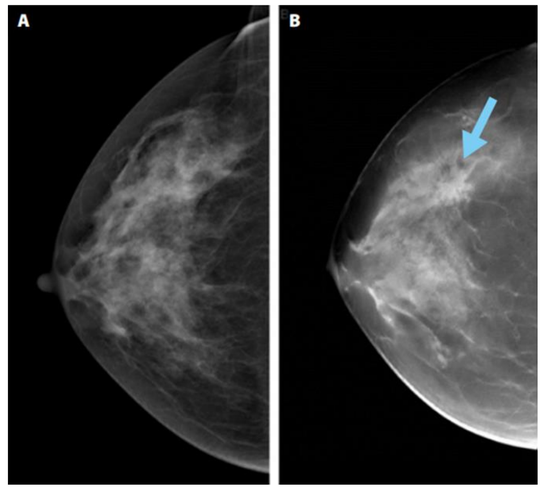


Figure 5. Image A is a CC view of a screening digital mammogram. Image B displays a DBT slice of the same patient, in the same position, and depicts a spiculated mass in the central breast. (Johnson, 2017)

Advantages & Disadvantages

Advantages:

- Reduces masking and resolves superimposition
- Provides better discrimination of tissues
- Improves visualization of lesions (Østerås et al., 2019)
- Reduces the frequency of false-positive results and recalls
- Improves breast cancer detection
- Improves dense breast imaging (Chong et al., 2019)

Disadvantages:

- Increased image acquisition time
- Increased exposure time
- Higher dose to the patient (Nichols, 2019)

Conclusion

Digital Breast Tomosynthesis is becoming the standard of care for breast imaging based on improvements in both screening and diagnostic imaging outcomes. DBT reduces masking and resolves superimposition of breast tissue allowing better discrimination of tissue structures and improves visualization. DBT offers many advantages including improved breast cancer detection, better visualization in dense breast imaging, as well as reducing the frequency of false-positive results and recalls. Future advancements in technology will continue to improve and aid in the detection of breast cancer.

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