Asian Journal of Medical Principles and Clinical Practice

Volume 7, Issue 1, Page 127-132, 2024; Article no.AJMPCP.113921

Digital Breast Tomosynthesis and Advanced Radiology Techniques: A Review of Their Role in Elderly Females with Breast Cancer

Gilan Abdel Aziz Ahmed Abdel Aziz Ramadan [a++*]

[a] *Mediclinic Hospital, UAE.*

Author's contribution

The sole author designed, analysed, interpreted and prepared the manuscript.

Article Information

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/113921

Mini-Review Article

Received: 26/12/2023
Accepted: 01/03/2024
Published: 06/03/2024

ABSTRACT

Breast cancer is considered one of the leading causes of women's mortality and morbidity worldwide. Despite several treatment and therapeutic procedures available, this sector still needs to be improved. The reason for this mainly lies in the fact that women mainly get diagnosed very late in the disease process and when this happens, usually not much could be done to save their lives. However, thanks to the advancements taking place in the field of medical science, there is strong hope that people will see better days in the future. Digital breast tomosynthesis (DBT) has emerged as a promising tool in breast cancer screening and diagnosis, offering enhanced imaging capabilities over traditional mammography. The aging population presents unique challenges in breast cancer detection and management, necessitating tailored approaches to imaging. This review shall focus on the recent research findings, technological advancements, and clinical outcomes related to DBT in elderly females with breast cancer. This review provides an update on the utilization of advanced radiology techniques in DBT specifically tailored for elderly females with breast cancer. Additionally, the article discusses the role of DBT in guiding treatment decisions and

[++] *Specialist Radiology;*
**Corresponding author: E-mail: drgilanabdelazizramadan@gmail.com;*

assessing treatment responses in elderly breast cancer patients. Insights into the benefits, limitations, and future directions of DBT in this demographic are provided, with implications for clinical practice and research highlighted. Overall, this review highlights the evolving landscape of DBT in addressing the unique needs of elderly females with breast cancer and sets the stage for further advancements in this critical area of breast imaging.

Keywords: Breast cancer; diagnostic techniques; digital breast tomosynthesis; elderly females; early intervention.

1. INTRODUCTION

Breast cancer stands as the most prevalent form of cancer among women, marking over a tenth of new cancer diagnoses annually and ranking second in cancer-related female mortality worldwide [1]. Anatomically, the breast comprises milk-producing glands situated against the chest wall, supported by ligaments and encased in fatty tissue that dictates its size and contour. These glands, organized into 15 to 20 lobes, form the structural framework of the breast, with each lobe containing lobules responsible for milk production under hormonal cues [2].

The insidious nature of breast cancer often sees it progress rapidly, with many individuals only detecting it through routine screenings, though others may notice symptoms like breast lumps, changes in shape or size, nipple discharge, or occasional breast pain [3]. Prompt diagnosis, facilitated through physical examinations, imaging modalities such as mammography, and tissue biopsies, proves to be extremely helpful in improving survival rates. The disease's tendency to spread via lymphatic and hematologic routes underscores the importance of early detection, as delayed diagnosis can lead to distant metastasis and poorer outcomes [4].

This emphasizes the critical role of breast cancer screening initiatives in identifying the disease at its earliest, most treatable stages, thereby underlining the necessity of widespread screening programs [1].

Breast cancer (BC) remains an important health concern, constituting the most prevalent form of cancer among women worldwide, with over 2 million new cases recorded in 2020 alone [5]. The incidence and mortality rates of BC have seen an upward trajectory over the past three decades, attributed to shifts in risk factor profiles, improved cancer registration practices, and enhanced detection methods [6].

The multitude of risk factors associated with BC encompasses both modifiable and non-modifiable factors, contributing to its complex etiology. Currently, the majority of BC cases occur in individuals aged over 50, highlighting the significance of age as a risk factor. Survival outcomes hinge on various factors, including disease stage and molecular subtype [7].

Invasive BC encompasses a diverse array of tumors exhibiting variability in clinical presentation, behavior, and morphology [8]. Molecular profiling based on mRNA gene expression has enabled the categorization of BC into distinct subtypes, including Luminal A, Luminal B, HER2-enriched, and basal-like, offering valuable insights into tailored treatment approaches and patient stratification [9].

The eighth edition of the TNM classification system has introduced a revised staging system for BC, which not only considers anatomical features but also incorporates biological factors, reflecting advancements in our understanding of the disease's underlying biology [10].

The management of BC follows a broad, multi-centred approach, often combining surgery, radiotherapy, chemotherapy, hormonal therapy, and biological therapies in varying sequences tailored to individual patient needs. The evolving landscape of BC treatment underscores the importance of personalized, multidisciplinary care strategies aimed at optimizing patient outcomes in this complex disease paradigm [11].

2. ADVANCED RADIOLOGICAL TECHNIQUES FOR THE DIAGNOSIS OF BREAST CANCER

Mammography remains the only breast imaging modality to have proved to be effective in reducing breast cancer mortality with a sensitivity of 75%-80% on population-based screening [12]. Nevertheless, its sensitivity drastically drops in high-risk women with dense breasts, remaining roughly at 50%. As complementary diagnostic methods, breast ultrasound and contrast-enhanced breast MRI have been adopted [13].

In high-risk populations, ultrasound is capable of detecting approximately four additional cancers per 1,000 women; on the other hand, MRI demonstrates extraordinary sensitivity even detecting four to five cancers per hundred screened women. The sensitivity of both ultrasound and MRI is good but at the expense of more benign biopsies. Hence a short follow-up is needed [14].

The transitioning landscape of breast imaging is characterized by the emergence of various new techniques geared toward improving the early diagnosis of early-stage breast cancer. These advancements fall into two categories: improvements to existing methods and the development of completely new imaging systems [15].

In addition to the existing techniques, new enhancements include digital breast tomosynthesis, contrast- enhanced mammography and ultrasound with elastography or microbubbles which are showing promising steps in achieving higher diagnostic sensitivity. Concomitantly, new imaging modalities such as breast computed tomography (CT) and radionuclide breast imaging present an additional potential for breast cancer diagnosis [16].

Although these progressions come with a great deal of promise, the considerations of cost-effectiveness and radiation exposure reaffirm the need for objective evaluation of each modality to determine how much clinical utility and whether it brings additional meaningful information. In this time of intense emphasis on cost containment and radiation safety, an assessment of emerging breast imaging technologies becomes crucial in optimizing patient care and outcomes [17].

Many researchers have assessed the sensitivity and specificity of digital and computed mammography compared to the older film/screen technology. Notably, one federally funded trial spearheaded by researchers backed by the United States Department of Defense involved 4,945 women over 40 undergoing screening mammography [18-20].

For that, Alvin Hendrick made a study that covered 625 women with sponsorship of General Electric. This study was done with the five independent interpretations of radiologists for each image. Research findings from this work establish that the rate of recall was also significantly lower with digital radiography. Additionally, specificity and sensitivity almost were as good as those of film/screen radiography [13].

A brief overview of the different modalities that are currently being used for the early detection and diagnosis of breast cancer has been given as under.

2.1 Digital Breast Tomography (DBT)

In 1971, DBT technology emerged as a pioneering solution to tackle the challenge of overlapping structures in breast imaging. The early days of Digital Breast Tomography focused on capturing images from varied angles and amalgamating them to generate slices of breast tissue. Notably, digital detectors were absent during this era, and computational processing speeds lagged considerably behind contemporary standards [21].

The evolution of DBT faced limitations until the 1990s, when the advent of digital detectors marked a pivotal turning point. The breakthrough came with the development of the first functional unit at Massachusetts General Hospital in 2000. Subsequently, numerous other systems emerged, each experimenting with different imaging angles and refining image-processing algorithms to enhance the technology's efficacy [22].

In 2011, following a series of comprehensive studies affirming the efficacy of digital breast tomosynthesis (DBT) in distinguishing between cancerous and noncancerous lesions, the United States FDA granted approval for its use in breast imaging. These studies underscored heightened detection rates and improved sensitivity, solidifying DBT's role as a significant advancement in breast cancer diagnostics [23].

Tomosynthesis takes 3D images and is usually combined with 2D digital mammography images. DBT requires the use of a moving X-ray tube and a digital detector [24] The digital detector is an electronic device made of tiny detector elements. In practice, we have two principal detector types. One kind utilizes a process of indirect image capture. This is some residual radiation emitted from the patient, which hits the scintillator at the detector surface [25].

In the scintillator-based detection process, typically composed primarily of cesium iodide, the scintillator emits light when exposed to radiation. This emitted light is subsequently captured by the detector elements, where it is converted into an electrical charge. This charge is then digitized and rendered on a computer screen, displaying spatial and intensity values. Alternatively, direct detection utilizes a different approach, employing a direct conversion process. Here, remnant radiation is directly converted into an electrical signal at each individual detector element, bypassing the intermediate step of light emission and capture. This direct conversion method offers its own advantages in terms of efficiency and signal fidelity [11]. During tomosynthesis, at least 10 scans are typically acquired, covering an angle range from 10° to 50°. The process of image acquisition can be executed through two primary methods. Firstly, the step-and-shoot method involves the X-ray tube halting at distinct points along its arc around the breast to acquire images. At each stopping point, a scan is performed before moving to the next position. This method allows for precise control over the acquisition process and is well-suited for capturing high-quality images. Alternatively, the continuous technique involves the X-ray tube moving in a continuous arc around the breast throughout the acquisition process. This continuous movement facilitates a seamless acquisition workflow, potentially reducing imaging time and patient discomfort. However, maintaining image quality and alignment during continuous movement requires careful synchronization and motion control. Both methods offer distinct advantages and may be selected based on factors such as imaging objectives, equipment capabilities, and patient comfort [21].

The radiation dose to the patient is slightly higher with Digital Breast Tomosynthesis compared to digital mammography. Nevertheless, for dose estimation diverse methods are applied but mainly related to imaging protocols and breast thickness, its density and age are taken into consideration.

In addition, the dose is also dependent on reader preference connected with image noise [26]. The dose elevation causes a sharpening image by reducing noise. The amount of acceptable noise is often dictated by the interpreting radiologist and hence it differs based on the institution.

Lately, on the national news and media, the benefits of DBT have been emphasized to push women to request healthcare providers for this technology in addition to mammography [27]. Unfortunately, DBT is not available in many radiology departments and breast imaging centers in rural areas. Human-machine interface (HMI) purchase by the hospital/clinic is necessary for the utilization of beneficial DBT technology. Similar to any new technology, start-up costs are huge [28]. The acquisition of DBT equipment is economically infeasible in the case of small hospitals and breast centers at the moment. In rural areas, there could be a lack of patient volume to be able to pay for the new technology. Moreover, reimbursement from third-party payers lags behind the costs of new technology [29].

3. CONCLUSION

Modern technological developments involve digital radiography, MRI, ultrasound and tomosynthesis in breast cancer diagnosis. Knowledge about these different diagnostic modalities is essential for nurses because of the known fact that new radiologic imaging technologies can potentially bring better results for breast cancer patients.

Briefly, digital breast tomosynthesis is becoming the standard of care in both screening and diagnostic breast imaging due to improving patient outcomes and radiology department efficiency. The short-term data, at least the initial data, are promising, but still prolonged research is required in order to identify how this digital breast tomosynthesis imaging might affect long-term outcomes, particularly when it comes to equivalents in screening, because the biology of cancers detected and undetected, is highly important.

CONSENT

It is not applicable.

ETHICAL APPROVAL

It is not applicable.

COMPETING INTERESTS

Author has declared that no competing interests exist.

REFERENCES

1. Alkabban FM, Ferguson T. Breast Cancer. In: StatPearls. Treasure Island (FL): StatPearls Publishing; 2024. [cited 2024 Feb 10]. Availablefrom:http://www.ncbi.nlm.nih.gov/books/NBK482286/
2. Rivard AB, Galarza-Paez L, Peterson DC. Anatomy, Thorax, Breast. In: StatPearls. Treasure Island (FL): Stat Pearls Publishing; 2024. [cited 2024 Feb 10]. Availablefrom:http://www.ncbi.nlm.nih.gov/books/NBK519575/
3. Henderson JA, Duffee D, Ferguson T. Breast Examination Techniques. In: StatPearls. Treasure Island (FL): StatPearls Publishing; 2024. [cited 2024 Feb 10]. Availablefrom:http://www.ncbi.nlm.nih.gov/books/NBK459179/
4. Smolarz B, Nowak AZ, Romanowicz H. Breast cancer—Epidemiology, classification, pathogenesis and treatment (Review of Literature). Cancers. 2022, May 23;14(10):2569.
5. Arzanova E, Mayrovitz HN. The Epidemiology of Breast Cancer. In: Mayrovitz HN, editor. Breast Cancer. Brisbane (AU): Exon Publications; 2022. [cited 2024 Feb 10]. Availablefrom:http://www.ncbi.nlm.nih.gov/books/NBK583819/
6. Giaquinto AN, Sung H, Miller KD, Kramer JL, Newman LA, Minihan A et al. Breast cancer statistics, 2022. CA Cancer J Clin. 2022, Nov;72(6):524–41.
7. Admoun C, Mayrovitz HN. The Etiology of Breast Cancer. In: Mayrovitz HN, editor. Breast Cancer. Brisbane (AU): Exon Publications; 2022. [cited 2024 Feb 10]. Availablefrom:http://www.ncbi.nlm.nih.gov/books/NBK583809/
8. Sun YS, Zhao Z, Yang ZN, Xu F, Lu HJ, Zhu ZY et al. Risk factors and preventions of breast cancer. Int J Biol Sci. 2017, Nov 1;13(11):1387–97.
9. De Silva S, Tennekoon KH, Karunanayake EH. Overview of the genetic basis toward early detection of breast cancer. Breast Cancer Targets Ther. 2019, Jan 21;11:71–80.
10. Shiovitz S, Korde LA. Genetics of breast cancer: a topic in evolution. Ann Oncol. 2015, Jul;26(7):1291–9.
11. Criscitiello C, Corti C. Breast cancer genetics: Diagnostics and treatment. Genes. 2022, Sep 6; 13(9):1593.
12. Reeves RA, Kaufman T Mammography. In: StatPearls. Treasure Island (FL): StatPearls Publishing; 2024. [cited 2024 Feb 10]. Availablefrom:http://www.ncbi.nlm.nih.gov/books/NBK559310/
13. Budh DP, Sapra A. Breast Cancer Screening. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2024. [cited 2024 Feb 10]. Availablefrom:http://www.ncbi.nlm.nih.gov/books/NBK556050/
14. Gunduru M, Grigorian C. Breast Magnetic Resonance Imaging. In: StatPearls [Internet]. Treasure Island (FL): Stat Pearls Publishing; 2024. [cited 2024 Feb 10]. Availablefrom:http://www.ncbi.nlm.nih.gov/books/NBK539727/
15. Gao Y, Reig B, Heacock L, Bennett DL, Heller SL, Moy L. Magnetic resonance imaging in screening of breast cancer. Radiol Clin North Am. 2021, Jan;59(1):85–98.
16. Houser M, Barreto D, Mehta A, Brem RF. Current and future directions of breast MRI. J Clin Med. 2021, Nov 30; 10(23):5668.
17. Mann RM, Cho N, Moy L. Breast MRI: State of the art. Radiology. 2019, Sep; 292(3):520–36.
18. Destounis SV, Arieno AL, Morgan RC. Preliminary clinical experience with digital breast tomosynthesis in the visualization of breast microcalcifications. J Clin Imaging Sci. 2013;3:65.
19. Schoub PK. Understanding indications and defining guidelines for breast magnetic resonance imaging. SA J Radiol. 2018, Oct 30;22(2):1353.
20. Wekking D, Porcu M, De Silva P, Saba L, Scartozzi M, Solinas C. Breast MRI: Clinical indications, recommendations, and future applications in breast cancer diagnosis. Curr Oncol Rep. 2023, Apr; 25(4):257–67.
21. Chong A, Weinstein SP, McDonald ES, Conant EF. Digital breast tomosynthesis: Concepts and clinical practice. Radiology. 2019, Jul; 292 (1):1–14.
22. Linder JMB, Schiska AD. Progress in diagnosis of breast cancer: Advances in

radiology technology. Asia-Pac J Oncol Nurs. 2015;2(3):186–91.
23. Lewin JM, D'Orsi CJ, Hendrick RE, Moss LJ, Isaacs PK, Karellas A et al. Clinical comparison of full-field digital mammography and screen-film mammography for detection of breast cancer. AJR Am J Roentgenol. 2002, Sep; 179(3):671–7.
24. Bowles D, Quinton A. The use of ultrasound in breast cancer screening of asymptomatic women with dense breast tissue: A narrative review. J Med Imaging Radiat Sci. 2016;47(3):S21.
25. Gennaro G, Bernardi D, Houssami N. Radiation dose with digital breast tomosynthesis compared to digital mammography: Per-view analysis. Eur Radiol. 2018, Feb;28(2):573–81.
26. Svahn TM, Chakraborty DP, Ikeda D, Zackrisson S, Do Y, Mattsson S et al. Breast tomosynthesis and digital mammography: A comparison of diagnostic accuracy. Br J Radiol. 2012, Nov;85(1019):e1074–82.
27. Dhamija E, Gulati M, Deo SVS, Gogia A, Hari S. Digital breast tomosynthesis: an overview. Indian J Surg Oncol. 2021, Jun;12(2):315–29.
28. Helvie MA. Digital mammography imaging: Breast tomosynthesis and advanced applications. Radiol Clin North Am. 2010, Sep;48(5):917–29.
29. Gao Y, Moy L, Heller SL. Digital breast tomosynthesis: Update on technology, evidence, and clinical practice. Radiogr Rev Publ Radiol Soc N Am Inc. 2021; 41(2):321–37.

Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle5.com/review-history/113921