INTERNATIONAL JOURNAL OF HEALTH & MEDICAL RESEARCH

ISSN(print): 2833-213X, ISSN(online): 2833-2148

Volume 03 Issue 06 June 2024

DOI : 10.58806/ijhmr.2024.v3i06n10

Page No. 311-314

Imaging Diagnosis of Breast Cancer

Majid. A.Z. Albadry [1], Hussban Abood Saber [2], Ahmed M. Amshawee [3], Ali A. Al-fahham[4]

[1] Education directorate of Thi-Qar, Ministry of Education, Iraq,

[2] Department of Electrical and Electronic Engineering, University of Kerbala, 56001 Karbala, Iraq,

[3] Hilla University College, Iraq,

[4] Corresponding Author, Faculty of Nursing, University of Kufa, Iraq,

ABSTRACT: With millions of people all over the world being affected by it, breast cancer remains a big and ubiquitous health problem that continues to be a concern. With regard to the early identification and treatment of breast cancer, this review paper places a strong emphasis on the central role that diagnostic equipment play. Molecular testing and magnetic resonance imaging are two examples of new technologies that have been used to improve mammography, a crucial screening method for breast cancer. These technologies offer increased sensitivity and specificity in the diagnosis of breast cancers, making mammography an important screening approach. Nevertheless, the provision of screening programs to a diverse variety of persons continues to be a challenge, particularly in locations that have limited materials and resources.

1. INTRODUCTION

The utilization of imaging techniques is able to efficiently disclose the histology and area of tumor tissues, hence providing physicians with essential clinical information. The screening, pre-operative care, and monitoring of breast cancer patients are all accomplished through the utilization of these procedures. However, patients may be exposed to potential dangers as a result of the utilization of contrast compounds and high-energy radiation in these procedures. Because of this, it is of the utmost importance to analyze and choose the diagnostic methods that are the most appropriate for breast cancer patients (Bicchierai et al., 2021). In this study, the key techniques that will be taken into consideration are going to be mammography (MG), ultrasonography (US), magnetic resonance imaging (MRI), positron emission computed tomography (PET), computed tomography (CT), and single-photon emission computed tomography (SPECT).

The use of PET, CT, and SPECT for the diagnosis of breast cancer patients is not recommended due to their high cost, limited practicality, and potential radiation hazards. However, these methods can be employed as supplementary diagnostic instruments in specific situations, such as the identification of bone and lymph node metastases and metastatic breast cancer. Thus, we will prioritize MRI, US, and MG, which are the preferred modalities for breast cancer screening. In order to improve clinical diagnostics and better assist patients, it is essential for physicians to summarize and evaluate these frequently employed imaging techniques (Pathak et al., 2021).

1. MAMMOGRAPHY

Mammography, often known as MG, is a method that makes use of x-rays to create a photograph of the breasts while exposing the patient to only a small amount of radiation. The peculiar findings from a clinical breast examination are monitored with the help of this tool. Within the context of a biopsy operation, mammography can also be utilized to identify an aberrant location (Chang et al., 2022).

Mammography is the preferred method for screening and diagnosing breast cancer, providing doctors with essential clinical information about patients. Literature indicate that early mammography screening can reduce the death rate of breast cancer patients by 30%-40%. However, mammography results are only positively diagnostic for 4%-10% of breast cancer patients, such as those who show only slight calcification (Weigel et al., 2010).

Mammography technique is enhanced constantly with progression of time. Digital breast tomosynthesis (DBT) and contrast-enhanced mammography (CEM) are at current the most commonly used techniques that detect BC subjects in hospitals. Research indicates that contrast-enhanced mammography (CEM) outperforms full-field digital mammography (FFDM) and its diagnostic accuracy and ability to evaluate the extent of the disease are comparable to those of breast MRI (Covington et al., 2018).

Imaging Diagnosis of Breast Cancer

Overall, mammography (MG) and its variants are crucial for screening and diagnosing breast cancer patients. Their advantages include quick screening, high precision, affordability, and suitability for widespread implementation. Therefore, MG is an excellent imaging method for low-income patients and helps reduce the risk of breast cancer. However, MG may not be appropriate for everyone. For example, it involves the use of potentially harmful contrast agents and X-rays, restricting frequent use, and is not recommended for patients under 40. In the future, MG is likely to become safer and offer higher resolution. Moreover, advancements in artificial intelligence (AI) and sensor technology could enable automated breast cancer detection and analysis (Helal et al., 2018).

2. ULTRASOUND

The ultrasound technique makes photos of different organs and tissues using sound waves with high frequencies. An ultrasound is employed to specify if a mass in the breast is a cyst or solid tumor. Furthermore, health care providers may employ ultrasound to direct them to the biopsy site. In order to evaluate whether liver metastasis has occurred, an ultrasound may be administered to women with advanced breast cancer (Wang et al., 2019).

Ultrasonography is employed to observe the structure and changes in tumor tissues, accurately pinpointing lesion locations. It poses no harm to humans and is suitable for all individuals. Initially, grayscale US only revealed the presence of tumors at detection sites but struggled to differentiate between benign and malignant tumors due to its low resolution. Similarly, two-dimensional US only captured flat tumor images, potentially influencing physician assessments. To address this, three-dimensional US technology emerged, enabling the three-dimensional imaging of tumor morphology and blood vessel distribution during diagnosis. Among these, color Doppler US stands out as it vividly illustrates tumor status and blood flow information, providing doctors with invaluable clinical insights to distinguish between benign and malignant tumors (Wang & Yang, 2021).

Ultrasonography has a number of advantages, such as the fact that it requires just a small amount of contrast agents, that it does not need the use of high-energy rays, and that it is appropriate for people of all ages. Furthermore, ultrasound can be utilized as an alternative method of breast cancer diagnosis in situations where mammography is not within the realm of possibility. The use of ultrasound, on the other hand, has several drawbacks, such as the requirement for a professional operator and a lesser definition and resolution in comparison to CT scans. Importantly, obese individuals and those with metastasis in parasternal lymph nodes are not ideal candidates for ultrasound diagnosis. Looking ahead, the advent of intelligent ultrasound detection represents a new trend, promising to significantly reduce errors stemming from inexperienced judgments and thereby aiding physicians in achieving more precise diagnostic outcomes (He et al., 2020).

3. MAGNETIC RESONANCE IMAGING

Magnetic resonance imaging (MRI) makes it possible to diagnose familial breast cancer at an earlier stage, regardless of the patient's age, breast density, or risk level. This diagnostic technique is also applicable to breast cancer. MRDW imaging, also known as magnetic resonance diffusion-weighted imaging, is a specialized technology that provides an accurate depiction of the movement of water molecules throughout the physiological system. Because of this, MRDW has been demonstrated to be an effective diagnostic tool for patients suffering from breast cancer disease. According to the findings of experts, malignant tumors exhibit significant restrictions in water transport as compared to benign tumors. Therefore, researchers are able to differentiate between benign and malignant breast cancers by utilizing MRDW to measure the apparent diffusion coefficient (ADC) values of tumors, which are indicative of diffusion limits (Bougias et al., 2016).

It has been reviewed that the optimum threshold level for ADC in discriminating between malignant and benign BC are as follows: 1.05×10^{-3} mm^2/s ~ 1.11×10^{-3} mm^2/s. Dynamic contrast-enhanced MRI (DCE-MRI) may have more resolution level of soft tissues than magnetic resonance diffusion-weighted, and it can accurately exhibit histological properties and hematological properties of the tumor in vivo. Scientists discovered that the positive predictive value PPV for DCE/MRI is about (97.9%) which is more than that of MRI solely (76.9%), while the specificity reaches 96.9% (Guindalini et al., 2019).

Magnetic resonance imaging (MRI) serves as an adjunctive method with numerous advantages in breast cancer diagnosis. However, its widespread use is impeded by various factors, including extended imaging durations, elevated costs, and incompatibility with patients harboring metal implants, among others. Consequently, MRI is applicable in scenarios where the primary breast cancer is minuscule, comprehensive tumor information is imperative, or for screening high-risk groups. Looking ahead, MRI technology is poised to enhance with improved signal-to-noise ratios, reduced imaging durations, and diminished costs. Furthermore, advancements in MRI should prioritize reducing dependency on contrast agents to ensure accessibility for all individuals (He et al., 2020).

4. POSITRON EMISSION COMPUTED TOMOGRAPHY (PET)

In the process of staging, diagnosing, and re-staging a wide variety of malignancies, including breast cancer, Positron Emission Tomography/Computerized Tomography (PET/CT) has found tremendous use. Breast cancer is characterized by increased glucose consumption, which enables it to be identified by the utilization of the glucose analogue 18F-fluorodeoxyglucose (18F-FDG) in the process of PET measurement. The amount of fluorodeoxyglucose (FDG) that is taken up by the primary tumor can vary quite a bit, and the characteristics of the tumor itself play a key part in indicating the degree to which glucose is metabolized. There are a number of major parameters that influence FDG absorption in breast cancer. Some of these factors include the volume of viable tumor cells, the histological subtype of the tumor, the grade of the tumor, the density of the microvessels, and the proliferative activity of the tumor! (Anand et al., 2009).

Positron Emission Tomography plays a crucial role in identifying distant metastases, assessing tumor recurrence, and evaluating treatment effectiveness. However, its diagnostic utility is somewhat limited when compared to other imaging techniques for diagnosing primary breast lesions and determining locoregional staging (Vercher-Conejero et al., 2015).

The resolution of FDG-PET systems typically falls within the range of 4.9 to 7.9 mm. Tumors smaller than 9.9 mm may not be completely discernible, leading to an underestimation of tracer concentrations due to partial volume effects. In cases where tumors are smaller than 9.9 mm, the sensitivity of 18F-FDG PET/CT is only 24.9%. However, for tumors ranging between 9.9 mm and 19.9 mm, the sensitivity significantly improves to 83.9% (Avril et al., 2001).

5. SINGLE-PHOTON EMISSION COMPUTED TOMOGRAPHY (SPECT).

The classic approach of single photon emission computed tomography (SPECT) remains relevant, particularly when paired with computed tomography (CT), in this century, where positron emission tomography (PET) appears to represent the bleeding edge of nuclear medicine imaging. It is clear that this combination continues to be significant. In addition to the provision of precise attenuation correction and fusion imaging capabilities, the advent of new hybrid SPECT/CT devices that are outfitted with modern technology has resulted in a reduction in the amount of time required for acquisition. This review analyzes and evaluates the potential of SPECT/CT to increase the sensitivity and specificity of imaging in both oncological and non-oncological situations. SPECT/CT is particularly useful in the treatment of cancer. A clear definition of disease location and the potential involvement of surrounding tissues are the key advantages of SPECT/CT. Additionally, the increased specificity and greater attenuation correction are also significant advantages of this imaging technique (Mariani et al., 2010).

SPECT-CT in identifying the sentinel lymph node (SLN) in breast cancer presents established benefits compared to traditional planar lymphoscintigraphy. Occasionally, it reveals unusual findings such as mediastinal lymphatic drainage. SPECT-CT has been observed to detect a greater number of nodes than planar images, effectively distinguishing mediastinal and IMC nodes. This capability aids in accurately depicting the SLN and its relationships with surrounding anatomical structures. (Serrano-Vicente et al., 2016).

CONCLUSIONS

The imaging equipment that are currently the standard method for breast cancer screening will continue to be used since they are suited for widespread usage in the years to come. The developments that have been made in these diagnostic technologies have also resulted in considerable improvements to the outcomes of early identification and treatment. Mammography, along with other new technologies such as magnetic resonance imaging and molecular testing, can promote timely intervention and perhaps improve patient outcomes. Breast cancer identification in its early stages is vital, and breast cancer detection can be accomplished by mammography.

REFERENCES

1) Anand, S. S., Singh, H., & Dash, A. K. (2009). Clinical Applications of PET and PET-CT. Medical journal, Armed Forces India, 65(4), 353–358. https://doi.org/10.1016/S0377-1237(09)80099-3
2) Avril, N., Menzel, M., Dose, J., Schelling, M., Weber, W., Jänicke, F., Nathrath, W., & Schwaiger, M. (2001). Glucose metabolism of breast cancer assessed by 18F-FDG PET: histologic and immunohistochemical tissue analysis. Journal of nuclear medicine : official publication, Society of Nuclear Medicine, 42(1), 9–16.
3) Bicchierai, G., Di Naro, F., De Benedetto, D., Cozzi, D., Pradella, S., Miele, V., & Nori, J. (2021). A Review of Breast Imaging for Timely Diagnosis of Disease. International journal of environmental research and public health, 18(11), 5509. https://doi.org/10.3390/ijerph18115509
4) Bougias, H., Ghiatas, A., Priovolos, D., Veliou, K., & Christou, A. (2016). Whole-lesion apparent diffusion coefficient (ADC) metrics as a marker of breast tumour characterization-comparison between ADC value and ADC entropy. The British journal of radiology, 89(1068), 20160304. https://doi.org/10.1259/bjr.20160304
5) Chang, C. C., Ho, T. C., Lien, C. Y., Shen, D. H., Chuang, K. P., Chan, H. P., Yang, M. H., & Tyan, Y. C. (2022). The Effects of Prior Mammography Screening on the Performance of Breast Cancer Detection in Taiwan. Healthcare (Basel, Switzerland), 10(6), 1037. https://doi.org/10.3390/healthcare10061037
6) Covington, M. F., Pizzitola, V. J., Lorans, R., Pockaj, B. A., Northfelt, D. W., Appleton, C. M., & Patel, B. K. (2018). The Future of Contrast-Enhanced Mammography. AJR. American journal of roentgenology, 210(2), 292–300. https://doi.org/10.2214/AJR.17.18749

7) Guindalini, R. S. C., Zheng, Y., Abe, H., Whitaker, K., Yoshimatsu, T. F., Walsh, T., Schacht, D., Kulkarni, K., Sheth, D., Verp, M. S., Bradbury, A. R., Churpek, J., Obeid, E., Mueller, J., Khramtsova, G., Liu, F., Raoul, A., Cao, H., Romero, I. L., Hong, S., … Olopade, O. I. (2019). Intensive Surveillance with Biannual Dynamic Contrast-Enhanced Magnetic Resonance Imaging Downstages Breast Cancer in BRCA1 Mutation Carriers. Clinical cancer research : an official journal of the American Association for Cancer Research, 25(6), 1786–1794. https://doi.org/10.1158/1078-0432.CCR-18-0200
8) He, Z., Chen, Z., Tan, M., Elingarami, S., Liu, Y., Li, T., Deng, Y., He, N., Li, S., Fu, J., & Li, W. (2020). A review on methods for diagnosis of breast cancer cells and tissues. Cell proliferation, 53(7), e12822. https://doi.org/10.1111/cpr.12822
9) Helal, M. H., Mansour, S. M., Salaleldin, L. A., Alkalaawy, B. M., Salem, D. S., & Mokhtar, N. M. (2018). The impact of contrast-enhanced spectral mammogram (CESM) and three-dimensional breast ultrasound (3DUS) on the characterization of the disease extend in cancer patients. The British journal of radiology, 91(1087), 20170977. https://doi.org/10.1259/bjr.20170977
10) Mariani, G., Bruselli, L., Kuwert, T., Kim, E. E., Flotats, A., Israel, O., Dondi, M., & Watanabe, N. (2010). A review on the clinical uses of SPECT/CT. European journal of nuclear medicine and molecular imaging, 37(10), 1959–1985. https://doi.org/10.1007/s00259-010-1390-8
11) Obeagu, E. I., & Obeagu, G. U. (2024). Breast cancer: A review of risk factors and diagnosis. Medicine, 103(3), e36905. https://doi.org/10.1097/MD.0000000000036905
12) Pathak, P., Jalal, A. S., & Rai, R. (2021). Breast Cancer Image Classification: A Review. Current medical imaging, 17(6), 720–740. https://doi.org/10.2174/0929867328666201228125208
13) Serrano-Vicente, J., Rayo-Madrid, J. I., Domínguez-Grande, M. L., Infante-Torre, J. R., García-Bernardo, L., Moreno-Caballero, M., Medina-Romero, F., & Durán-Barquero, C. (2016). Role of SPECT-CT in breast cancer sentinel node biopsy when internal mammary chain drainage is observed. Clinical & translational oncology : official publication of the Federation of Spanish Oncology Societies and of the National Cancer Institute of Mexico, 18(4), 418–425. https://doi.org/10.1007/s12094-015-1384-x
14) Vercher-Conejero, J. L., Pelegrí-Martinez, L., Lopez-Aznar, D., & Cózar-Santiago, M.delP. (2015). Positron Emission Tomography in Breast Cancer. Diagnostics (Basel, Switzerland), 5(1), 61–83. https://doi.org/10.3390/diagnostics5010061
15) Wang, X., & Yang, M. (2021). The Application of Ultrasound Image in Cancer Diagnosis. Journal of healthcare engineering, 2021, 8619251. https://doi.org/10.1155/2021/8619251 (Retraction published J Healthc Eng. 2023 Dec 6;2023:9789783)
16) Wang, Y., Chen, H., Li, N., Ren, J., Zhang, K., Dai, M., & He, J. (2019). Ultrasound for Breast Cancer Screening in High-Risk Women: Results From a Population-Based Cancer Screening Program in China. Frontiers in oncology, 9, 286. https://doi.org/10.3389/fonc.2019.00286
17) Weigel, S., Decker, T., Korsching, E., Hungermann, D., Böcker, W., & Heindel, W. (2010). Calcifications in digital mammographic screening: improvement of early detection of invasive breast cancers?. Radiology, 255(3), 738–745. https://doi.org/10.1148/radiol.10091173