ORIGINAL ARTICLE

Diagnostic Accuracy of Mammography, Ultrasound, and Fine-Needle Aspiration in Detecting Breast Cancer in Patients with Painful Breast Masses: A Medical Record-Base Study

Hassan Vafapour [1, 2*], Sajad Borzoueisileh [1], Fatemeh Vafapour [3], Zafar Masoumi Moghaddam [3], Leila Kargar [1], Frough Nikeghbali [1], Yaghoub Barfar [1], Amir Hekmatifar [1]

[1] *Cellular and Molecular Research Center, Yasuj University of Medical Sciences, Yasuj, Iran*

[2] *Ionizing and Non-Ionizing Radiation Protection Research Center, Shiraz University of Medical Sciences, Shiraz, Iran*

[3] *Social Determinants of Health Research Center, Yasuj University of Medical Sciences, Yasuj, Iran*

*Corresponding Author: Hassan Vafapour
Email: vafapour7@gmail.com

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Abstract

Purpose: The objective of our investigation was to conduct a comparative analysis of the precision levels of fine-needle aspiration, ultrasonography, and mammography with regard to detecting the presence of breast cancer. The ultimate goal was to determine the most effective diagnostic methodology based on the patient's age and the particular attributes of the mass in question.

Materials and Methods: This cross-sectional study examined 150 patients who presented breast pain within the last six months. Out of the initial cohort, 66 participants diagnosed with breast cancer were included in the study, presenting an age range of 35 to 98 years and a mean age of 53.72 ± 18.26 years. Among them, six were single and 60 were married. The results of diagnostic tests were compared with pathological findings and the final diagnosis was determined using the chi-square test.

Results: The findings suggested that 10% of masses were hyper-echoic and 90% hypo-echoic on sonography. Sonography showed that 53.3% of the masses were cystic and 46.7% solid. Mammographic results revealed calcifications in 24.2% of masses, with 63.6% showing no calcifications. Mammography, with a sensitivity of 87.8%, was the only modality that could detect calcifications.

Conclusion: Our study suggests that combining diagnostic methods enhances breast lesion detection compared to using a single method. This is crucial in early cancer stages when accurate, timely diagnosis is key. This approach improves early breast cancer detection, leading to better patient outcomes.

Keywords: Breast Cancer; Mammography; Ultrasound; Pathology; Fine Needle Aspiration.

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1. Introduction

Breast cancer, while being the second most deadly cancer among women globally after lung cancer, holds the dubious distinction of being the leading cause of cancer-related mortality among black and Hispanic women [1, 2]. While the incidence of breast cancer is high in advanced countries, there has been an appreciable increase in breast cancer cases in Japan and other Asian countries. This increase has been attributed to lifestyle changes and fertility patterns, leading to a shift toward Western lifestyles. Despite advances in breast cancer diagnosis and treatment, it remains a significant public health challenge globally and underscores the need for continued efforts to improve early detection and access to effective treatment [3]. Breast pain is the most common breast-related complaint among women, raising concerns about breast cancer and prompting them to seek medical attention. Breast cancer is a disease that predominantly affects women aged between 40 and 70 years old, with over 180,000 women receiving breast cancer diagnoses each year in the United States alone [2]. Early detection through regular breast cancer screenings and timely treatment can significantly improve the prognosis for women with breast cancer, emphasizing the importance of regular breast cancer screenings and raising awareness of breast cancer symptoms [4].

Breast cancer has become more common in Iran in recent years, especially in younger women, whose median age is at least ten years lower than that of women in developed nations [5]. The 2019 Global Burden of Disease study reported that the Age-Standardized Incidence Rate (ASIR) of breast cancer among women in Iran was estimated to be 18.8 to 34 cases per 100,000 women [6]. In this country, people between the ages of 40 and 49 are the ones who develop breast cancer at a higher rate, and 23% of cases are diagnosed before the age of 40. Early diagnosis is crucial for treating breast cancer and can be achieved through physical examinations, mammography, ultrasound, Magnetic Resonance Imaging (MRI), and Fine-Needle Aspiration (FNA) [7-10].

While mammography has its limitations, it remains the standard imaging technique for the screening of breast cancer, given its efficacy in evaluating both soft tissue and microcalcification. Despite its potential drawbacks, its role in the early detection and subsequent treatment of breast cancer is undeniably critical [11]. The diagnostic ability of mammography in different studies shows a discrepancy, and according to reports, 5% to 10% have a potential false negative. Therefore, mammography cannot replace a physical examination. Ultrasound is another diagnostic method that is mainly used in dense breasts to help distinguish cysts from suspicious solid masses [7, 9]. This method is also valuable in evaluating suspicious mammography findings. Fine Needle Aspiration (FNA) is another diagnostic method used to assess palpable breast masses [12]. FNA's diagnostic sensitivity has frequently been reported in the range of 95-100%, despite the significant problem of suitable specimen size that has been evaluated in various studies. The invasive nature of FNA and the need for a specialist cytopathologist to report breast cytology are among its most significant challenges [4, 13-15]. Few specialists in this field further restrict the widespread use of FNA, even in advanced countries. Our research aimed to compare the accuracy of FNA, ultrasound, and mammography in detecting breast cancer to choose the best diagnostic approach based on the patient's age and the mass's characteristics.

2. Materials and Methods

In this cross-sectional study, 150 patients with breast pain were evaluated over six months. Sixty-six patients with breast cancer were identified, and their data was obtained from hospital records. The population of this study was made up of women referred to Shahid Rajaie Hospital in Yasuj (IR. yums. rec. 1394.160). The study was approved by the ethics committee of Yasuj University of Medical Sciences, Yasuj, Iran. Patients were included if they had at least three clinical modality results, including ultrasound, mammography, and FNA. Patients under 35 years of age, due to the limitations in achieving accurate diagnoses using mammography, and those without breast pain were excluded from the study. The decision for this specific selection is graphically represented in Figure 1.

Ultrasounds were conducted using the Philips Clearvue 550 system, also mammograms were carried out utilizing the MLO (Mediolateral Oblique), CC (Cranio-Caudal), and LMO (Latero-Medial Oblique) techniques. For FNA two standard views were obtained in this examination: (a) Cephalo-caudal view

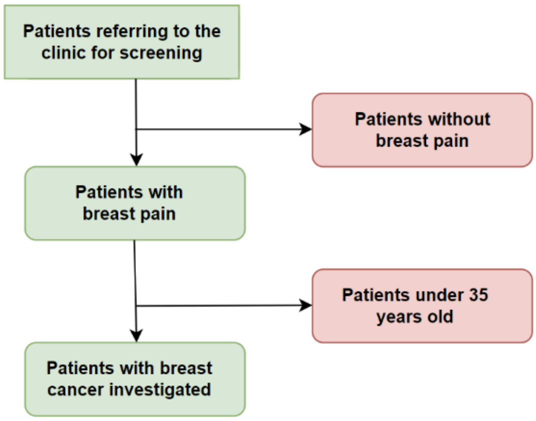

Figure 1. Flowchart to show patients' inclusion and exclusion criteria for the study

(CC view), and (b) Mediolateral oblique view (MLO view). All mammography and ultrasound results were interpreted in accordance with the established BI-RADS (Breast Imaging Reporting and Data System) standards, with classifications ranging from 0 to 5. For all patients, a checklist is filled with demographic and clinical data. After collecting the list, the demographic data and diagnostic sets were compared by descriptive statistics and demographic information. Also, mammography and sonographic data were compared with pathological findings as the standard diagnostic method. In this study, three types of sensitivity metrics were computed: detection, type, and calcification. Each of these measures was calculated using the following formula that calculates the percentage of the true positive rate:

$$\text{Sensitivity} = \frac{\text{True positives}}{\text{True positives} + \text{False negatives}}$$

For instance, 'true positives' represent the cases where the presence of microcalcification was correctly identified, and 'false negatives' denote the instances where microcalcification was present but was not detected. By quantifying these metrics, we can assess the effectiveness and reliability of the detection methods for identifying microcalcification in breast tissue.

3. Results

The participants consisted of 66 patients, with a mean age of 53. 72 ± 18. 26 years and an age range between 35 and 98 years, of whom six were single and 60 were married. Forty people had tumors in the left breast and 26 in the right breast. Fifty-nine people were in grade II, six people were in grade I, and one person was in grade III. Of the participants, 12 (18.2%) had a family history of cancer, while 54 (81.8%) had no family history.

Fourteen individuals (constituting 21.2% of the study population) exhibited secretions from at least one breast. Among the study participants, 56 (accounting for 84.8%) had palpable breast masses, while 10 (15.2%) had non-palpable breast masses. Of the three techniques, FNA emerged as the optimum method for identifying the type of cancer, as it detected 60 cases of ductal carcinoma and 2 instances of lobular carcinoma. However, FNA failed to determine the cancer type in 4 cases (6.1%).

As illustrated in Table 1, the comparison of the diagnostic sensitivity of mammography, ultrasound, and FNA revealed that approximately 10% of the masses exhibited hyper-echogenicity, while approximately 90% exhibited hypo-echogenicity on sonography. The sonographic findings revealed that 53.3% of the masses were cystic in nature and 46.7% were solid. Furthermore, the mammography results showed that 24.2% of the masses demonstrated calcifications, whereas 63.6% did not exhibit calcifications. Generally, mammography, with a sensitivity of 87.8%, was the sole modality capable of detecting calcifications.

4. Discussion

Patient history and physical examination are the initial steps in evaluating breast pain [16]. Choosing

Table 1. Comparison of the diagnostic sensitivity of the three methods of mammography, ultrasound, and FNA in painful breast mass

	Mammography	Sonography	FNA
Sensitivity of cancer detection	58.6	42.1	93.9
The sensitivity of cancer type (lobular or ductal)	6.1	30	93.9
Percentage of tumor-grade detection	10.3	0	90.9
Sensitivity of calcification	87.8		

the appropriate imaging technique for the breast often depends on the patient's age, the character of the breast pain, and the presence or absence of a palpable mass or other abnormal findings on the physical exam. If there is a palpable breast mass, imaging is typically performed using both mammography and ultrasound [17]. Otherwise, mammography is performed to detect occult lesions. Ultrasonography is often utilized for younger patients. Increasing utilization of imaging modalities like mammography, ultrasonography, and FNA is an important step in the early detection of breast cancer and has significantly impacted patient longevity. Still, mammography and sonography have limitations in addition to the aforementioned benefits [18].

The limitations of mammography and sonography cited in various studies pertained to the sensitivity and specificity of the imaging modalities, along with the factors influencing these metrics and how to enhance the sensitivity and specificity of these imaging techniques. However, the outcomes of various studies differ substantially. Due to the impreciseness of some imaging modalities in identifying the nature of lesions, it is vital to perform complementary mammography as well as pathological procedures, including fine-needle aspiration, to improve diagnostic accuracy [19].

This study found sensitivities of 58.6% for mammography and 42.1% for ultrasonography, while sonography at 30% was superior to mammography at 6.1% for diagnosing lobular or ductal carcinoma. Tumor grade was not discernible on ultrasound imaging, but mammography at 10.3% and FNA at 90.9% could accurately determine tumor grade, while a study by Kriege *et al.* found mammography sensitivity was 40%, affected by factors like mammography technique and patient age, and mammography sensitivity decreases at early tumor stages [20].

The sensitivity of ultrasonography in diagnosing breast cancer has been reported variably across various sources [21]. In Sabine Malvor *et al.'s* German study, ultrasonography sensitivity was stated to be 89.1%, while in Devulli *et al.'s* Serbian investigation, ultrasonographic sensitivity was 71.1%. In another study, Haghighatkhah *et al.* [22] reported sensitivities of 73% for mammography and 69% for ultrasonography. The disparate outcomes across different studies related to the use of different devices and the modality-dependent nature, especially for ultrasonography, on the skill of the radiologists. In mammography, digital or analog devices, as well as the type of detectors, can impact the results [23]. In ultrasonography, different probe types with varying sensitivity, along with the types of diagnostic monitors (low or high resolution), can influence the outcomes [24].

In both cases (sonography and mammography), the final results are reported by a radiologist, and their experience and skill can be determinative of the results. In less developed countries like the area of this research, a lack of fellowship training in breast disease and mammography can be one of the primary reasons for the low sensitivity of mammography and ultrasonography, especially ultrasonography. According to the results of the present study, all radiologists involved in the outcomes of the 66 patients in this study did not have supplementary fellowship training.

We also evaluated vascular and breast tissue calcification, wherein mammography exhibited a sensitivity of 87.8%, establishing it as the most reliable modality. Identification of breast vascular calcification via mammography screening has been incorporated into screening programs to detect breast cancer. Figure 2 illustrates the microcalcification found in the patient's breast tissue on the mammogram, magnified to 336x, as compared to the image of the same

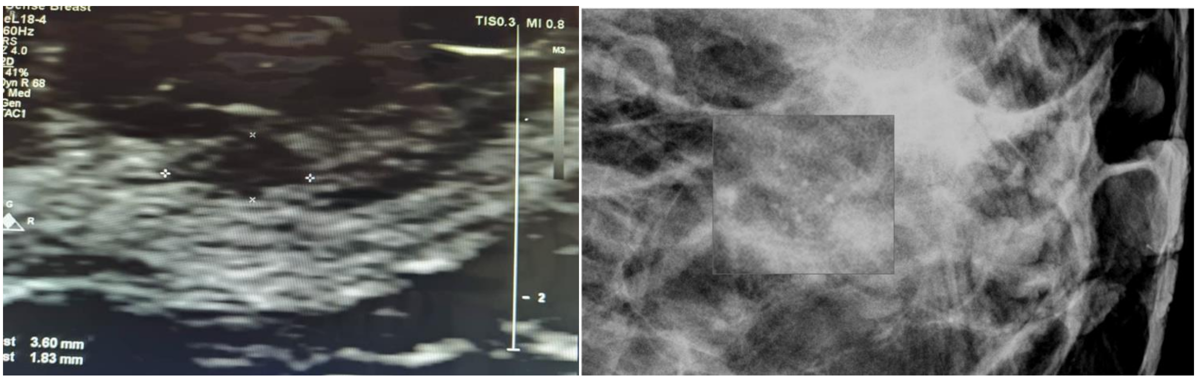

Figure 2. Comparison of the diagnosis of microcalcification in the breast of a patient (on the left side of mammography and the right side of ultrasound) mammography is the most sensitive test for identifying breast calcification

patient's breast at the same location. Microcalcifications are small calcium deposits that manifest as bright white spots or dots in the soft breast tissue when observed on mammography. Detecting these calcifications, also known as their sensitivity, is crucial as they can be associated with specific types of breast cancer. Currently, mammography is often considered the gold standard for detecting microcalcification. The competency of the operator significantly impacts FNA outcomes. An important application of FNA in the diagnostic workup is its effectiveness in the assessment of breast lesions. Breast FNA represents a valuable, low-risk, and cost-effective means of evaluating breast lesions, particularly malignant neoplasms, which constitute one of the most common breast diseases.

Various studies to ascertain the diagnostic worth of breast lumps have revealed FNA sensitivities ranging from 90 to 100 percent [25]. The findings indicate that this method is highly effective in detecting breast cancer cases and their benign masses. In this study, the sensitivity for cancer detection using FNA was 93.9%, much higher than both ultrasound and mammography. It also exhibits a high sensitivity of 90 to 93.9% in determining the tumor type and grade. Fine-needle aspiration could considerably reduce patient discomfort by temporarily evacuating cystic lesions' contents, thereby making the procedure more satisfactory for women, whereas mammography and ultrasound lack this advantage. Nevertheless, in FNA, there exists the possibility that cancer cells can disseminate to other parts of the tissue during aspiration by leaving cancer cells on the aspiration needle tract [26, 27]. This kind of metastasis could be infrequent if the operator has adequate experience. Open surgery on breast tissue will be expensive, time-consuming, invasive, and unwarranted for some patients [28]. Different studies have reported false negatives for histology at around 3.4%, primarily due to difficulties with the tissue sampling technique and problems with the histopathological evaluation process. False-positive diagnoses in FNA specimens are infrequent based on the available evidence. Aspiration cytologic examination using FNA significantly affects the management of palpable breast masses [29]. However, to prevent false-negative results, cytologists and radiologists must be highly skilled. Various reports have reported FNA accuracy of more than 90%. FNA can detect localized cysts with purulent fluid that may be indistinguishable from tumor masses on ultrasound, thereby avoiding the need for open surgery [30]. However, the false negatives in this method indicate the fact that this method cannot be used as a criterion for evaluating breast masses. Moreover, all three methods could be used together for a definitive and reliable diagnosis. Overall, if all three modalities, including ultrasound, mammography, and FNA results prove that the malignant mass in the breast tissue is negative, the patient can safely be prevented from undergoing open surgery. The study [31] revealed a 100% sensitivity when combining ultrasound and FNA findings, while a 93.7% sensitivity was observed when mammography and FNA were used together. Notably, the study achieved a sensitivity equal to biopsy (100%) when performing ultrasound and FNA simultaneously. These findings highlight the significance of using multiple screening methods together.

In conclusion, the advantages and disadvantages of the three methods of mammography, ultrasound, and FNA were highlighted, and these three methods complement each other in diagnosing breast cancer. Calcifications are detectable by mammography and tumor grade by FNA. Ultrasound is an inexpensive and convenient method for patients, and most importantly, it is safe because of the absence of ionizing radiation. Therefore, by performing all three methods, for women who are susceptible to cancer, regularly and periodically, a negative or positive response to the diagnosis can be achieved, and none of these three methods should be substituted.

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