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# A Comparison of Diagnostic Accuracy and Radiation Dose Between CT and Mammography in Detection of Asymptomatic Breast Cancer

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## Abstract

*The aim of this study is to compare the radiation dose and diagnostic accuracy of Breast Computed Tomography and Mammography in asymptomatic breast cancer patients. The study included forty seven patients, aged between forty and seventy years, with a mean age of 55 years. 30 patients underwent CT scan for breast cancer detection, 17 patients underwent mammography and from which two patients underwent both Breast Computed Tomography (BCT) and Mammography (MG) for metastasis detection, data were obtained from BVH and BINO cancer Hospital Bahawalpur in 2024. Breast CT demonstrated a higher sensitivity (96.2%) and specificity (75%) compared to mammography, which showed a sensitivity of (92.3%) and specificity of (50%). Mammography has a lower average dose per patient (2.0 mGy) compared to the effective dose per patient for breast CT scans (1.4 mSv). The total radiation dose for mammography (34 mGy for 17 patients) is lower than the total effective dose for breast CT scans (42 mSv for 30 patients). BCT offers superior diagnostic accuracy for detecting metastasis in asymptomatic breast cancer patients compared to MG. However, the higher radiation dose associated with breast CT necessitates careful consideration of its use, particularly in routine screening. The results indicate that Breast CT become a important tool in breast cancer screening, especially for larger populations.*

## 1. INTRODUCTION

**Breast cancer** is an illness where abnormal breast cells grow uncontrollably, forming a tumor. If untreated, the tumor can spread throughout the body and become life-threatening. It can enlarge within the breast and spread through the bloodstream to other organs or nearby lymph nodes. Annually, over 1.5 million women worldwide (25% of all female cancer cases) are diagnosed with breast cancer [1 ]. The DNA and RNA of cancer cells are similar but not identical to those of the original organism, which can make it difficult for the immune system, especially if compromised, to recognize them. Mutations in DNA and/or RNA cause normal cells to become cancerous. [2]. Early detection of breast cancer is essential to

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reduce patient suffering and death rates. A five-year survival rate of 99% is possible if breast cancer is detected in its early stages, when treatment is available. Among the factors contributing to early breast cancer identification include increased awareness of the disease, adequate screening practices, and advancements in technology [3]. Imaging methods such as mammography, ultrasound, breast CT scan, and MRI that are used for diagnosing breast cancer , have significantly improved in terms of detection and description [4]. The Karachi Cancer Registry reported, the highest incidence in Asia, with ninety thousand new cases detected annually and fort thousand deaths a year. Obstacles in breast cancer care in minimum-resources countries include a lack of recognition, a lack of trained health care workers, and social or cultural barriers. Improving early detection and treatment requires robust data collection, raising awareness, and improved early-stage diagnosis with trained health care providers [5]. The annual Age-Standardized Incidence Rate (ASIR) for breast cancer in 2012 was 43.3/100,000 females globally and 50.3/100,000 in Pakistan. The Shaukat Khanum Memorial Cancer Hospital and Research Center in Lahore, Pakistan, recorded 11,853 breast cancers between 2008 and 2012. A total of 127,929 neoplasms, of which 8,443 were benign and 119,486 were malignant, were reported at the SKMT centers during the past 28 years. Male and female distributions were found to be 46.9% and 53.1%, respectively. A total of 8,284 neoplasms, of which 903 were benign and 7,381 were malignant, were added to the registry database in 2022 [6].

Mammography is commonly used for breast cancer screening and also diagnosis. X-rays of low dose is utilized to produced pictures of the breast tissue for the detection of masses, calcifications. Early cancer detection, lower mortality, efficient screening, and high-risk individual monitoring are some of its benefits. It also aids in treatment decisions, teaches, and encourages research [7]. Axillary adenopathy, calcification, architectural distortion, skin retraction, thickness, and nipple retraction are a few associated symptoms. A study of 477 Pakistani women revealed, high mammographic breast density in 62.4% women of minor age and larger benign breast disease history. Body mass index was lower for dense breasts, but no association with vitamin D levels or diet. Although mammography is presently regarded as the gold standard for screening of cancer, its sensitivity and specificity are minor [8].

Computed tomography(CT) scan utilize x-rays to create elaborated images or scans of certain body parts for diagnosis and treatment. Each image taken over during this process is called a slice, showing organs, tissues, or bones along a plane. While digital image consists of pixels, a CT image is made up of volume elements from the collection of CT slices, forming a entire volumetric image of a particular organ. CT was the first non-invasive technique to provide internal images of the body [9]. In computed tomography (CT) imaging, X-rays are directed from beam source. When an attenuation decreases, detectors record the amount of x-rays that enter the patient's body and measure it. A computer processes the data gathered from different locations and perspectives, and then use algorithms to put the photos together [10]. The field of Stratigraphy emerged in the 1930s, laying the foundation for tomography. The first clinical single CT was introduced in 1989, followed by double CT in 1994, Multi-slices CT (MSCT) in 2001, and 320-row spiral CT in 2007. These developments marked the next stage in the development of CT technology [11].

## 2. Protocol and Parameter:

### 2.1 Age Range:

30 to 70 years. This research will involve a sample of asymptomatic women diagnosed with breast cancer, from BVH and BINO hospital Bahawalpur. Inclusion criteria will be women aged 40-70 years with a confirmed diagnosis of breast cancer but no symptoms of metastasis. Gather relevant patient information, Age, Tumor characteristics (size, location,) Histological type, Any relevant medical history Document this data for each patient.

### 2.2 CT Scan Protocol:

A Chest Computed Tomography (CT) scan was conducted using a Toshiba Aquilion Prime machine, which has 160 slices. The scan was performed with a voltage setting of 120 kVp and a current of 350 mA. The images were taken with a slice thickness of 1 mm in the body axial plane, and the interval between images was 2 seconds. An iodinated contrast agent, Omnipaque, was used to enhance the imaging. The

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effective radiation dose for this procedure ranged from 5 to 7 mSv.

**2.3 Mammography Protocol:**

A mammography examination was conducted using a Metaltronica machine from Toshiba. The tube voltage was set at 25 kVp, and the tube current was 250 mAs. The exposure time varied depending on the breast's thickness and density. Four cassettes, each measuring 24x30 cm, were used—two for mediolateral oblique (MLO) views and two for craniocaudal (CC) views. The compression force applied ranged typically between 10 to 20 kg. The machine featured an Automatic Exposure Control (AEC) system, which adjusted the exposure parameters automatically based on the breast's density and thickness to optimize image quality and minimize radiation dose. The average radiation exposure from background radiation over a period of approximately seven weeks is equivalent to the procedure's effective dosage of 27.2 mSv.

**Figure 1: Conventional mammography machine model 2005/ Toshiba with CR system (BINO hospital Bahawalpur)**

**Figure 2: Toshiba Aquilion Computed tomography machine with 160 slices (Bahawalpur Victoria hospital)**

**3 Result and discussion:**

The study included 47 patients, aged between 40 and 70 years, with a mean age of 55 years. 30 patients undergoes CT scan for breast cancer detection, 17 patients undergoes mammography and from which two patients undergoes both Breast Computed Tomography (BCT) and Mammography (MG).

**3.1 Breast CT Scan:**

From 30 patients that undergoes CT scan, 25 patients report show cancer. Now, we discus some cancer patient reports below:

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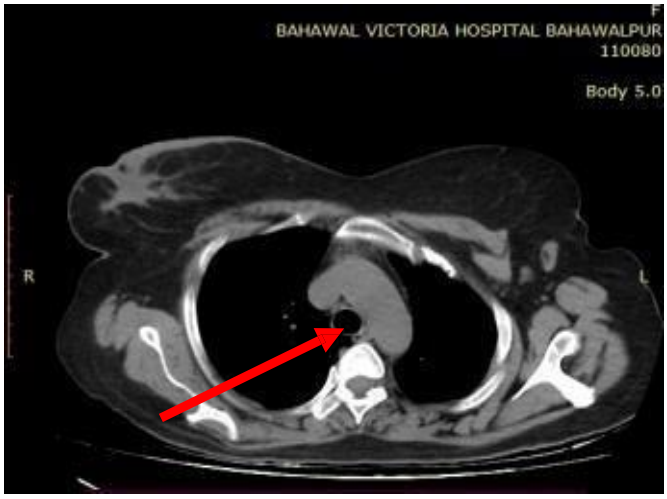


**Figure 3.1.1: Biopsy proven case of invasive carcinoma grade 2 right breast with status post chemotherapy current imaging shows interval regression of disease process.**

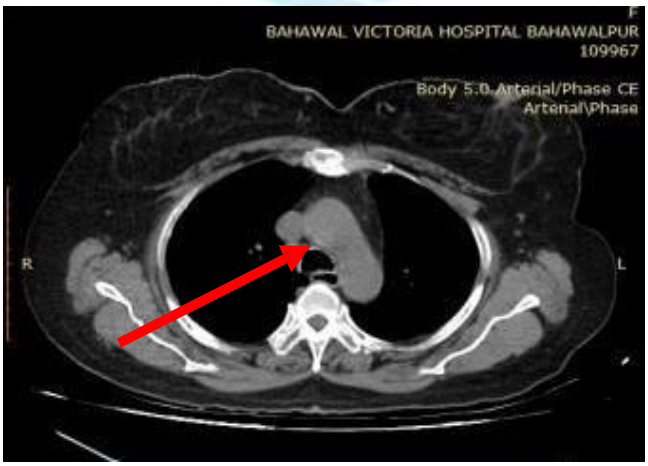


**Figure 3.1.2: Malignant mass left breast with sub-centimeter size axillary lymph nodes.**

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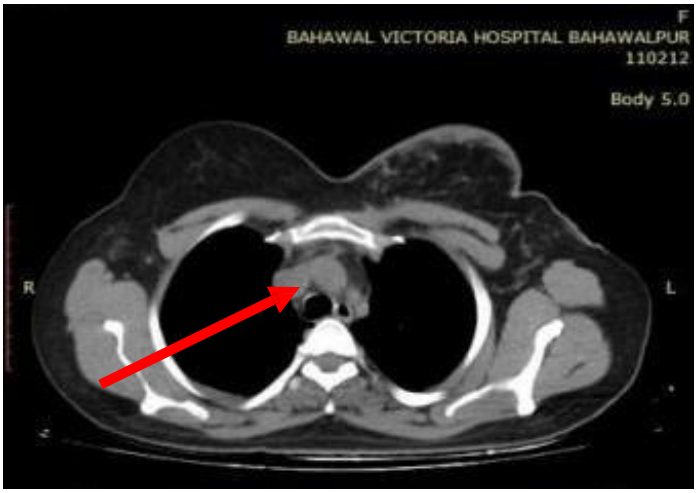


**Figure 3.1.3: Biopsy proven case of invasive carcinoma grade 3. Left breast malignant mass with pulmonary metastasis.**


**Figure 3.1.4: Imaging finding are likely suggestive of advanced right breast malignancy with extensive regional and distant metastasis**

### 3.2 Mammograpy

From 17 patients that undergoes mammography, 12 patients report show cancer. Now, we discus some cancer patient reports below:

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**Figure 3.2.1:** CC &MLO view shows Dense opacity in right breast(BI-BADS-4B)

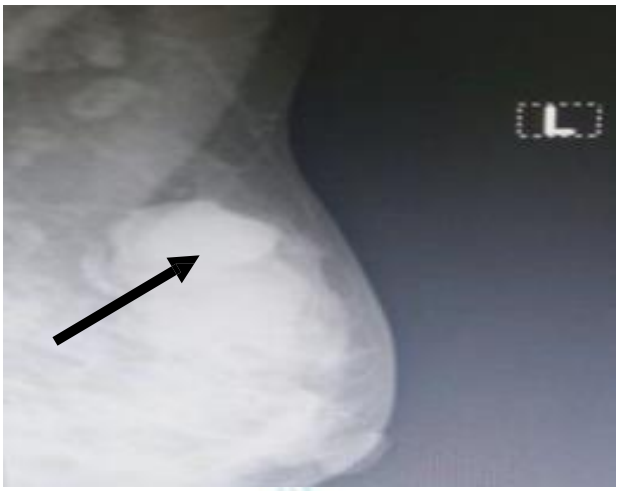

**Figure 3.2.2:** CC & MLO view shows Dense opacity in left breast(BI-RADS-4B)

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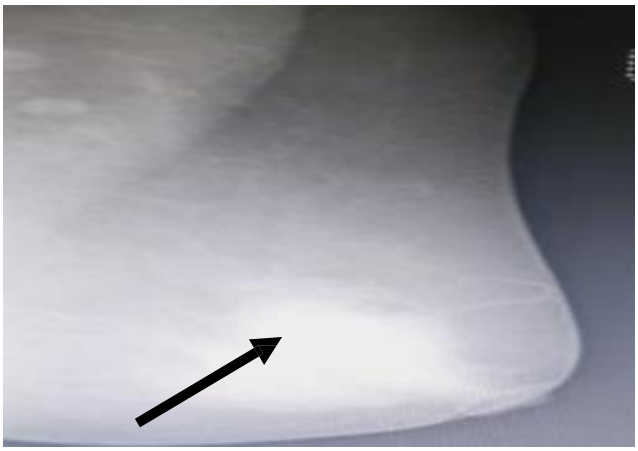

**Figure 3.2.3:** CC & MLO view shows Dense opacity in left breast(BI-RADS-4B)

## **3.3** Comparison Case 1

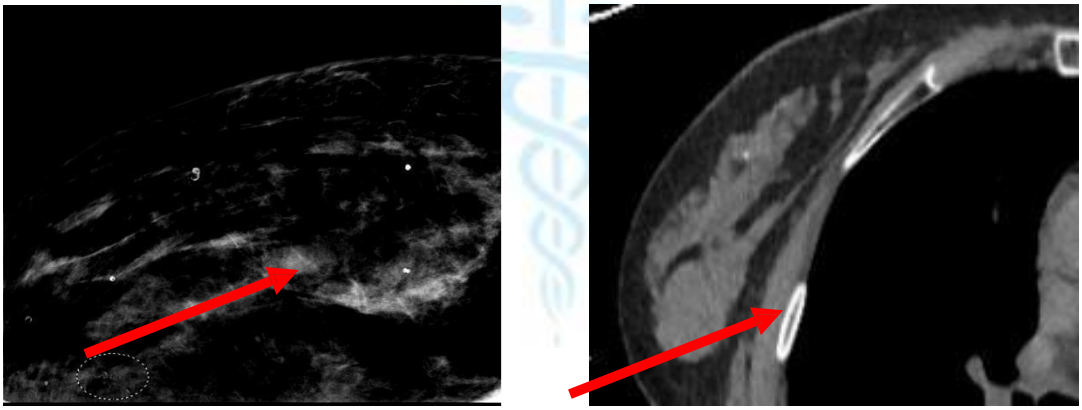

*Figure 3.3.1a)Mammography: Right breast is replaced by a dense opacity with irregular margins. . Right axillary lymph nodes are seen.b) A well define soft tissue density heterogeneously enhancing mass with spiculated margins and architectural distortion, main bulk in outer quadrant of It is measuring about 87×40 mm in size. Multiple enlarged lymph nodes are seen in bilateral axilla, largest one measuring about 15×10 mm on right side.*

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3.4 Comparison Case 2

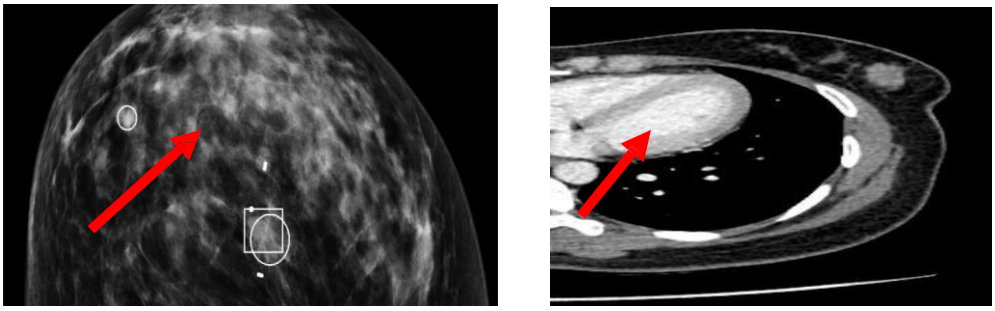

*Figure 3.2.1a)Mammography: Dense opacity is seen in left breast at lower inner quadrant with irregular margins.b) CT Scan:An irregular soft tissue intensity enhancing lesion is seen in lower quadrant of left breast measuring 17×19mm.*

**3.5 Diagnostic Accuracy:**

For mammography, there were 12 true positives, 2 true negatives, 1 false negative, and 2 false positives. In comparison, the CT scan results showed 25 true positives, 3 true negatives, 1 false negative, and 1 false positive. So, CT scans show higher sensitivity (96.2%) and specificity (75%) compared to mammography, which has a sensitivity of 92.3% and specificity of 50%.

**Table 1: Diagnostic Accuracy of mammography compared to breast CT.**

| | Mammogram | Breast CT |
|---|---|---|
| Total patients | 17 | 30 |
| Sensitivity | 92.3% | 96.2% |
| Specificity | 50% | 75% |
| Accuracy | 82.4% | 93.3% |

**3.6 Radiation Dose:**

The previously discussed calculation indicates that the average dose for mammography is 2.0 mGy, which is less than the effective dose for breast CT scans, which is 1.4 mSv. Compared to breast CT scans, which had a total effective dose of 42 mSv for 30 patients, mammography has a lower total radiation dose of 34 mGy for 17 patients.

**4. Discussion:**

The results indicate that BCT has a higher sensitivity and specificity compared to MG in detecting metastasis in asymptomatic breast cancer patients. Because BCT has a better sensitivity, it may be more successful in detecting genuine positive cases and less likely to overlook metastases. The higher specificity of BCT indicates a lower rate of false positives, which is crucial for minimizing unnecessary follow-up procedures and patient anxiety. The findings suggest that BCT could be a valuable addition to breast cancer screening protocols, particularly for high-risk populations where the benefits of improved diagnostic accuracy may outweigh the risks associated with higher radiation exposure. However, the increased radiation dose necessitates careful consideration and patient counseling to ensure informed decision-making.

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## 5. Conclusion

In conclusion, BCT demonstrates superior diagnostic accuracy compared to MG for detecting metastasis in asymptomatic breast cancer patients, albeit with a higher radiation dose. These results highlight the potential of BCT as a valuable diagnostic tool, warranting further research and technological advancements to optimize its clinical application.

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