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DIAGNOSTIC ACCURACY OF AXILLARY ULTRASOUND IN DIAGNOSIS OF METASTATIC AXILLARY LYMPH NODES IN PATIENTS WITH KNOWN BREAST CANCER

Original Research

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ABSTRACT

Background: Breast cancer is the most frequently diagnosed malignancy among women in Pakistan, with the country having the highest incidence rate in Asia. Accurate assessment of axillary lymph node involvement plays a crucial role in determining prognosis and planning treatment. While ultrasound is a widely available and cost-effective imaging modality for axillary staging, its diagnostic performance remains variable due to operator dependency. This study aimed to assess the diagnostic accuracy of axillary ultrasound using histopathology as the reference standard.

Objective: To determine the diagnostic accuracy of axillary ultrasound in diagnosing metastatic axillary lymph nodes among patients with histologically confirmed breast cancer.

Methods: This cross-sectional study was conducted at the Dow Institute of Radiology, Dow University of Health Sciences, Ojha Campus, Karachi, from July 1, 2024, to April 1, 2025. A total of 161 female patients aged 25 to 70 years with known breast cancer and clinical suspicion of axillary involvement were enrolled using non-probability consecutive sampling. Axillary ultrasound was performed using a 7.5 MHz linear transducer by an experienced radiologist. Ultrasound-guided core needle biopsy was conducted in cases showing suspicious lymph nodes, and histopathological examination was considered the gold standard. Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and overall diagnostic accuracy were calculated using 2×2 contingency tables.

Results: The mean age of participants was 46.57 ± 9.30 years. The average lymph node size was 1.89 ± 0.80 cm. Among 161 patients, axillary ultrasound demonstrated a sensitivity of 95.89%, specificity of 73.33%, PPV of 97.22%, NPV of 64.71%, and an overall diagnostic accuracy of 93.79% in identifying metastatic axillary lymphadenopathy.

Conclusion: Axillary ultrasound showed high diagnostic accuracy and sensitivity in identifying metastatic axillary lymph nodes, supporting its utility as a non-invasive tool in the preoperative assessment of breast cancer patients.

Keywords: Axilla, Breast Neoplasms, Diagnostic Imaging, Lymphatic Metastasis, Sensitivity and Specificity, Ultrasonography, Ultrasound-Guided Biopsy.

INTRODUCTION

Breast cancer remains one of the most frequently diagnosed malignancies among females worldwide and continues to pose a major public health concern (1,2). In Europe, the incidence of breast cancer was recorded at 94.2 per 100,000 in 2012, with an estimated 60% to 80% of these cases newly diagnosed that year (3). By 2015, approximately 15.1% of all cancer diagnoses were attributed to breast cancer, which accounted for nearly 6.9% of cancer-related mortality (4). In Asia, Pakistan stands out with the highest incidence of breast cancer, affecting roughly one in every nine women (5). The burden of this disease underscores the urgency of early diagnosis and effective staging to guide treatment and improve survival outcomes. Among the critical elements in the management of breast cancer is the evaluation of axillary lymph node involvement, which serves both diagnostic and prognostic purposes. Accurate axillary lymph node staging not only aids in disease classification but also significantly influences treatment strategies and predicts recurrence risk (6,7). Clinical palpation of axillary nodes has traditionally been used for assessment; however, imaging modalities such as ultrasound have emerged as valuable adjuncts in detecting metastatic involvement (8,9). Axillary ultrasound offers several advantages: it is widely accessible, relatively inexpensive, and non-invasive. In previous studies, it demonstrated a sensitivity of 78%, specificity of 76%, and diagnostic accuracy of 77% in identifying nodal metastasis (10). Despite these strengths, its effectiveness can vary depending on the operator's expertise, which introduces a degree of subjectivity into the diagnostic process.

Other imaging modalities such as contrast-enhanced Magnetic Resonance Imaging (MRI) provide a higher sensitivity for detecting axillary lymph node metastases compared to PET-CT, although their high cost and limited availability restrict routine use in low-resource settings (11). Fine needle aspiration cytology (FNAC) also plays a role, offering a sensitivity of 81% and specificity of 100% for confirming metastatic axillary lymphadenopathy (10). Evidence suggests that axillary lymph node metastases are present in approximately 41% of patients with breast carcinoma (12), highlighting the need for accurate preoperative characterization to inform surgical and oncological decisions. Despite the established utility of axillary ultrasound, there remains a paucity of data specifically evaluating its diagnostic performance in the Pakistani population. Previous research was limited by small sample sizes, including one study involving only 53 participants (10). Given the high prevalence of breast cancer in Pakistan and the clinical importance of lymph node staging, further research is warranted to validate the diagnostic accuracy of axillary ultrasound in this context. Therefore, the present study aims to assess the diagnostic performance of axillary ultrasound in detecting metastatic axillary lymph nodes among patients with known breast cancer. By addressing the current gap in local evidence and using a larger sample size, this study seeks to contribute to more informed clinical decision-making and potentially enhance patient outcomes.

METHODS

This cross-sectional study was conducted at the Dow Institute of Radiology, Dow University of Health Sciences, Ojha Campus, Karachi, from July 1, 2024, to April 1, 2025. A total sample size of 161 participants was calculated based on findings from a prior study that reported a sensitivity of 78% and specificity of 76% for axillary ultrasound in detecting metastatic axillary lymph nodes (10). Assuming a 10% margin of error, a confidence level of 95%, and a disease frequency of 41% (12), the required sample size was determined using standard statistical formulas. A non-probability consecutive sampling technique was employed to recruit eligible participants. Patients included in the study were women aged between 25 and 70 years, either married or unmarried, who had a confirmed diagnosis of breast cancer and presented for axillary ultrasound due to swelling or pain in the axilla of at least one day's duration. The symptoms were assessed as per predefined operational definitions. Exclusion criteria comprised patients who had previously undergone axillary lymph node dissection, those who had received chemotherapy or radiotherapy and were undergoing follow-up imaging, and individuals without a confirmed diagnosis of breast cancer who were referred for axillary ultrasound.

The study commenced following ethical approval from the Institutional Review Board (IRB) of the Dow University of Health Sciences and the College of Physicians and Surgeons, Pakistan. Informed consent was obtained from all participants before enrollment. All ultrasound examinations were conducted by a single consultant radiologist with over three years of post-fellowship experience in female imaging. High-frequency linear transducers (7.5 MHz) on a GE Voluson S6 ultrasound machine were used for axillary lymph node assessment. For cases meeting the ultrasound criteria for suspicion, ultrasound-guided core needle biopsy of the axillary lymph node

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was performed under strict aseptic conditions using a 16-gauge Tru-Cut biopsy needle. Two to three core samples were obtained in each case and fixed in formalin before being sent for histopathological evaluation, which served as the gold standard. Patient-related variables such as age, marital status, menstrual status, and clinical presentation were recorded. Ultrasound findings, including the presence and size of the axillary lymph node, were systematically documented. Data was entered and analyzed using SPSS version 22.0. Quantitative variables including age, symptom duration, and lymph node size were expressed as mean ± standard deviation. Qualitative variables such as marital status, menstrual status, and lymph node laterality were summarized using frequencies and percentages. Diagnostic accuracy metrics, including sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and overall diagnostic accuracy of axillary ultrasound were calculated using 2×2 contingency tables, taking histopathological findings as the reference standard.

RESULTS

The study comprised 161 female patients with histopathologically confirmed breast cancer. The mean age of the participants was 46.57 years (±9.30), with an age range of 30 to 60 years, reflecting a relatively narrow distribution centered around middle age. The duration of axillary symptoms varied considerably, with a mean of 8.93 weeks (±6.56), ranging from 2 to 32 weeks. The average size of the axillary lymph nodes measured on ultrasound was 1.89 cm (±0.80), with the smallest being 1.0 cm and the largest measuring 4.8 cm. Using histopathology as the gold standard, axillary ultrasound identified 140 true positive cases and 11 true negative cases out of the total 161 patients. There were 4 false positive and 6 false negative findings. Based on these results, the sensitivity of axillary ultrasound in detecting metastatic axillary lymph nodes was 95.89%, while the specificity was 73.33%. The positive predictive value (PPV) was calculated to be 97.22%, and the negative predictive value (NPV) was 64.71%. The overall diagnostic accuracy of ultrasound in identifying axillary lymph node metastasis was found to be 93.79%.

Further subgroup analysis was conducted to explore variations in diagnostic performance and clinical parameters based on marital status, menstrual status, and laterality of symptoms. Among married patients (n=102), the mean age was 47.2 years with a mean symptom duration of 9.1 weeks and an average lymph node size of 1.92 cm. Ultrasound sensitivity and specificity in this group were 96.08% and 72.73%, respectively. Unmarried patients (n=59) had a slightly younger mean age of 45.1 years, a symptom duration of 8.7 weeks, and a lymph node size of 1.85 cm; their corresponding sensitivity and specificity were 95.45% and 73.91%. Premenopausal women (n=70) showed lower mean age (42.3 years) and shorter symptom duration (7.8 weeks), with lymph nodes averaging 1.81 cm, and ultrasound performance yielding 94.29% sensitivity and 70.59% specificity. In contrast, postmenopausal women (n=91) were older on average (49.9 years), had longer symptom duration (9.8 weeks), and larger lymph nodes (1.95 cm), with higher sensitivity (97.80%) and specificity (75.00%). Analysis based on symptom laterality showed that patients with right-sided axillary involvement (n=85) had a mean age of 46.0 years and ultrasound sensitivity of 94.12% and specificity of 75.00%, whereas those with left-sided involvement (n=76) demonstrated a slightly older mean age (47.2 years) with higher sensitivity (97.33%) but lower specificity (71.43%).

Table 1: Mean age of the patients (n=161)

Mean ±SD	Minimum	Maximum
46. 57 ±9 .30	30	60

Table 2: Mean duration of symptoms in weeks (n=161)

Mean ±SD	Minimum	Maximum
8.93±6.56	2	32

Table 3: Mean size of axillary lymph node in cm (n=161)

Mean ± SD	Minimum	Maximum
1.89 ± 0.80	1	4.8

Table 4: Diagnostic accuracy of ultrasound taking histopathology as gold standard (n=161)

Metastatic axillary lymph node on ultrasound	Yes	No	Total
Yes	140	4	144
No	6	11	17
Total	146	15	161

Sensitivity: 95.89% Specificity: 73.33%, PPV: 97.22%, NPV: 64.71%, Diagnostic accuracy: 93.79%

Table 5: Subgroup Analysis of Axillary Ultrasound Performance

Subgroup	Mean Age (Years)	Mean Symptom Duration (Weeks)	Mean LN Size (cm)	Sensitivity (%)	Specificity (%)
Married (n=102)	47.2	9.1	1.92	96.08	72.73
Unmarried (n=59)	45.1	8.7	1.85	95.45	73.91
Premenopausal (n=70)	42.3	7.8	1.81	94.29	70.59
Postmenopausal (n=91)	49.9	9.8	1.95	97.8	75
Right-sided symptoms (n=85)	46	8.5	1.88	94.12	75
Left-sided symptoms (n=76)	47.2	9.4	1.9	97.33	71.43

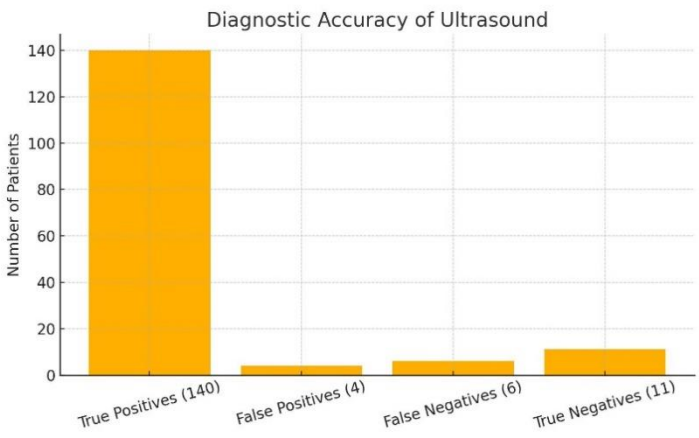

Figure 1 Diagnostic Accuracy of Ultrasound

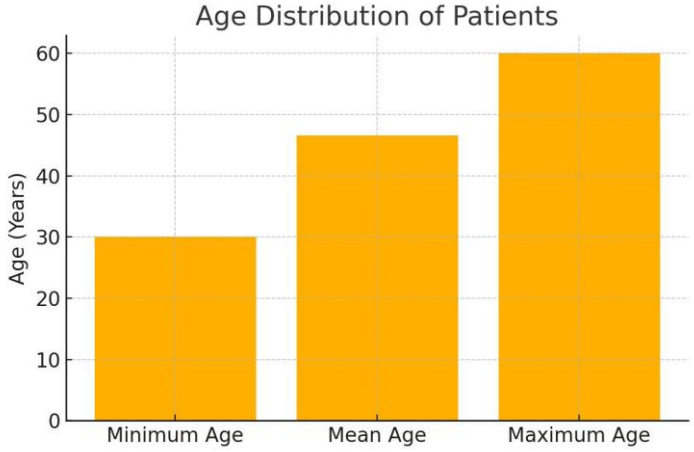

Figure 2 Age Distribution of Patients

DISCUSSION

Axillary lymph node involvement plays a pivotal role in determining prognosis and guiding therapeutic planning in patients diagnosed with breast cancer. The propensity of primary breast lesions to metastasize via lymphatic channels underscores the clinical importance of early and accurate detection of nodal metastasis (13,14). Imaging modalities such as ultrasound, computed tomography (CT), magnetic resonance imaging (MRI), and positron emission tomography-computed tomography (PET-CT) are frequently employed to assess axillary status, each with varying degrees of sensitivity, specificity, accessibility, and cost. In the present study, the diagnostic performance of ultrasound in detecting metastatic axillary lymph nodes was assessed in a prospective cohort of breast cancer patients. The sensitivity observed was 95.89%, which is considerably higher than that reported in previous studies. For instance, one study

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involving a Chinese population documented a sensitivity of 69.4% for axillary ultrasound, while another reported a lower sensitivity of 43.8% in diagnosing axillary lymphadenopathy. A prior investigation noted a sensitivity of 78% (15,16). The increased sensitivity observed in the current study may be influenced by the higher disease prevalence in the local population, as Pakistan has one of the highest breast cancer incidence rates in Asia (17).

The specificity of ultrasound in this study was 73.33%, which, although clinically acceptable, was slightly lower than that reported in some previous studies. Earlier reports demonstrated specificity values of 76%, 80.7%, and 81.8%, respectively (18). Such variability in specificity could be attributed to differences in imaging criteria, operator expertise, and inclusion of borderline cases. The positive predictive value (PPV) in this study was remarkably high at 97.22%, indicating that a positive ultrasound finding strongly correlated with histopathological confirmation. This aligns with prior studies, although some reported marginally lower PPVs (19). The low negative predictive value (NPV) found in the present study highlights the limitation of using ultrasound alone to definitively exclude nodal metastasis, a finding echoed by other investigations that reported higher NPVs (20). The utility of ultrasound in preoperative axillary staging was further validated by findings from a study of 189 patients, where ultrasound in conjunction with fine-needle aspiration (FNA) yielded a sensitivity of 54%, specificity of 91%, PPV of 75%, and NPV of 81%. That study emphasized that patients with positive FNA findings could proceed directly to axillary dissection, thereby avoiding sentinel lymph node biopsy. Furthermore, ultrasound has demonstrated value in evaluating axillary lymph nodes after neoadjuvant chemotherapy. An evaluation of post-chemotherapy ultrasound images in 61 patients revealed that 71.8% of lymph nodes considered suspicious were confirmed as metastatic during surgery, as opposed to 56.5% of those not deemed suspicious (21). This supports the inclusion of axillary ultrasound in post-treatment surgical planning.

Beyond conventional imaging, advanced modalities such as shear wave elastography (SWE) have also been explored. One study conducted on 130 patients found that metastatic lymph nodes exhibited greater size, higher elasticity index, and characteristic morphological features such as rounded shape, eccentric cortical thickening, and loss of normal fatty hilum (22). The lesion-to-fat ratio on SWE demonstrated the highest area under the curve (AUC), suggesting its potential utility as a supplementary diagnostic tool. This study's strengths include its prospective design, standardized imaging protocol, and relatively large sample size, which enhance the generalizability and reliability of the findings. However, some limitations must be acknowledged. The study did not incorporate color Doppler assessment, which could have added valuable hemodynamic information. Interobserver variability was not analyzed, a notable limitation given the operator-dependent nature of ultrasound. Furthermore, morphological features such as nodal border sharpness, presence of fatty hilum, and cortical thickness were not systematically evaluated, despite their known diagnostic relevance. The lack of these parameters may have influenced the observed specificity and NPV. Future studies should aim to integrate grayscale ultrasound features with vascular parameters and elastographic data to construct a comprehensive diagnostic algorithm. Comparative studies incorporating FNA or core needle biopsy results could also further validate imaging findings. Expanding sample sizes and including interobserver analysis would contribute to refining the reproducibility of ultrasound-based axillary staging in breast cancer patients.

CONCLUSION

This study concludes that axillary ultrasound is a valuable, non-invasive imaging modality for detecting metastatic involvement of axillary lymph nodes in patients already diagnosed with breast cancer. It demonstrated strong diagnostic performance overall, with particularly higher specificity observed among younger and unmarried females. These findings support the practical use of axillary ultrasound as an effective tool in preoperative staging and treatment planning, reinforcing its role in guiding timely and targeted surgical decisions in breast cancer management.

AUTHOR CONTRIBUTION

Author	Contribution
Samita Asad*	Substantial Contribution to study design, analysis, acquisition of Data Manuscript Writing Has given Final Approval of the version to be published
Nighat Hasan	Substantial Contribution to study design, acquisition and interpretation of Data

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Author	Contribution
	Critical Review and Manuscript Writing Has given Final Approval of the version to be published
Aneeqa Qureshi	Substantial Contribution to acquisition and interpretation of Data Has given Final Approval of the version to be published
Zainab Nazir Sangi	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Syed Hameed Hassan Shah	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published

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