

DIAGNOSTIC ACCURACY OF AXILLARY ULTRASONOGRAPHY DETECTION OF AXILLARY LYMPH NODES METASTASIS IN MALIGNANT BREAST CARCINOMA PATIENTS TAKING HISTOPATHOLOGY AS GOLD STANDARD

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Abstract

Objective: To determine the diagnostic accuracy of axillary ultrasonography in detecting axillary lymph node metastasis in patients with malignant breast carcinoma, using histopathology as the gold standard.

Study Design: Cross-Sectional Validation Study.

Study Setting: Department of Radiology, Shifa International Hospital, Islamabad, Pakistan.

Study Duration: Six months - October 2023 to April 2024

Methodology: This cross-sectional validation study included 270 female patients aged 18–60 years with histopathologically confirmed malignant breast carcinoma and clinically negative axillae. AUS findings were classified based on cortical thickness ≥ 3 mm and loss of fatty hilum. Histopathological analysis of lymph nodes following mastectomy served as the reference standard. Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and diagnostic accuracy were calculated.

Results: Out of 270 patients, AUS correctly identified 70 true positive and 170 true negative cases. It misclassified 12 false positives and 18 false negatives. The sensitivity of AUS was 79.5%, specificity 93.4%, PPV 85.4%, NPV 90.4%, and overall diagnostic accuracy was 88.9%.

Conclusion: Axillary ultrasonography demonstrated high sensitivity and specificity, indicating it is a reliable and effective modality for preoperative detection of axillary lymph node metastasis. Its non-invasive nature and high negative predictive value support its use in triaging patients and minimizing unnecessary surgical procedures. Integration of AUS with cytological confirmation is recommended for equivocal cases.

INTRODUCTION

Axillary lymph node involvement remains a key prognostic indicator in breast cancer management.^{1,2} Tumor size combined with nodal status offers a dependable basis for survival prediction. Sentinel lymph node biopsy (SLNB) has become the standard method for axillary staging in patients with early-stage breast cancer.³ It guides

surgical decisions regarding the axilla and influences recommendations for adjuvant radiotherapy and systemic therapies based on the number of affected nodes. Historically, axillary lymph node dissection served as the reference procedure for assessing nodal involvement; however, it is associated with higher morbidity

without a corresponding improvement in distant metastasis outcomes.⁴

Compared to complete axillary lymph node dissection (ALND), sentinel lymph node biopsy (SLNB) is linked to significantly fewer complications. Nevertheless, incorporating additional preoperative assessment methods for the axilla may enhance the utility of SLNB or, in select cases, help eliminate the need for it altogether—reducing both operative time and costs.⁵ Axillary ultrasound (AUS) offers a noninvasive and cost-efficient approach for evaluating axillary lymph node status prior to surgery. Although recent studies have challenged the necessity of axillary dissection in certain patients with positive SLNB findings, preoperative AUS continues to provide valuable insights for specific patient groups.⁶

In an Italian study, 80% of axillae (500 out of 620) showed no abnormal findings on ultrasonography. The sensitivity of preoperative ultrasound was 40.8%, while specificity reached 92.7%. It demonstrated a PPV of 75.8% and a NPV of 73.6%, with an overall diagnostic accuracy of 74.0%.⁵

A study conducted in Mexico⁶ assessed the diagnostic value of axillary ultrasound, identifying loss of the fatty hilum as a significant predictor of axillary metastasis in multivariate analysis. In Asia, Pakistan records the highest incidence of breast cancer, affecting nearly one in nine women.⁷ According to the Karachi Cancer Registry, breast cancer accounts for 34.6% of all female cancers in the country, with an estimated incidence rate of 50 per 100,000 women.⁸ Reducing the high morbidity and mortality linked to breast cancer in Pakistan relies heavily on its early detection. Due to the limited availability of compiled national data on the diagnostic accuracy of ultrasound for preoperative axillary assessment, this study aimed to evaluate the effectiveness of ultrasound as a staging tool in breast cancer patients with a clinically negative axilla.

This research is motivated by a lack of locally available information on axillary ultrasonography's usefulness in detecting lymph node metastases in breast cancer patients. Axillary ultrasonography can be used preoperatively to differentiate between metastatic and benign axillary lymph nodes, decreasing the need for needless biopsies, lymph node clearing, and the associated morbidity. Axillary

ultrasonography is increasingly being used to diagnose lymph node metastatic disease in patients with aggressive breast cancer, however there is a lack of data and evidence to support its routine use. After this study, triage of the patients can be done easily.

METHODOLOGY:

This cross-sectional validation study was conducted at the Radiology Department of Shifa International Hospital, Islamabad, over duration of six months following approval from the hospital's ethical review board. A total of 270 adult female patients aged between 18 and 60 years were enrolled through non-probability consecutive sampling. The sample size was calculated using a 95% confidence level, 10% absolute precision, anticipated sensitivity of 40.8%, anticipated specificity of 92.7%, and a reported prevalence of 34.6% for metastatic breast cancer in breast cancer patients. Patients included in the study were those diagnosed with malignant carcinoma of the breast, with tumor size T3 or less, and clinical nodal status of N2 or less, who were admitted for mastectomy. Patients were excluded if they had evidence of distant metastasis, prior treatment for breast cancer, or clinical staging of T4N0 or higher.

After obtaining written informed consent from the patients or their attendants, demographic and clinical data were recorded. Each patient underwent clinical evaluation followed by axillary ultrasonography (AUS) using an Aloka Pro-Sound Alpha 7 ultrasound machine equipped with a 38 mm linear transducer and a frequency range of 13.3–3.61 MHz. AUS findings were categorized as metastatic or non-metastatic based on cortical thickness (≥ 3 mm considered metastatic), presence or absence of fatty hilum, and lymph node morphology. Subsequently, during mastectomy, lymph node specimens were collected by the surgical team and sent for histopathological examination, which served as the gold standard for confirming metastasis.

SPSS version 23 was used to perform data analysis. The mean+SD was calculated for continuous variables include age of the patients whereas categorical variables like tumor size and nodal level were represented as counts and percentages. To account for potential effect modifiers—specifically age and tumor type—stratification was applied. The

diagnostic capability of AUS was determined using sensitivity, specificity, positive and negative predictive values, and overall diagnostic accuracy, based on a 2×2 table. A p-value less than 0.05 was considered statistically significant throughout the analysis.

RESULTS:

In this study, a total of 270 female patients with malignant breast carcinoma were evaluated to determine the diagnostic accuracy of axillary ultrasonography (AUS) in detecting axillary lymph node metastasis, using histopathology as the gold standard. The mean age of the participants was 39.05 ± 12.62 years, and the average tumor size was 1.92 ± 0.70, as shown in Table 1.

Table 2 summarizes the frequency distribution of AUS and histopathology findings. AUS identified 45 (16.7%) cases as metastatic and 225 (83.3%) as non-metastatic. In comparison, histopathological analysis confirmed 88 (32.6%) cases as metastatic and 182 (67.4%) as non-metastatic.

The 2×2 diagnostic accuracy table (Table 3) revealed that AUS correctly identified 70 (25.9%) true

positive cases and 170 (63.0%) true negative cases. However, it misclassified 12 (4.4%) false positives and 18 (6.7%) false negatives. These figures translate into a sensitivity of 70/88 (79.5%), indicating the proportion of actual metastatic cases correctly detected by AUS, and a specificity of 170/182 (93.4%), showing the proportion of non-metastatic cases accurately identified. The positive predictive value (PPV) was 70/82 (85.4%), while the negative predictive value (NPV) was 170/188 (90.4%). The overall diagnostic accuracy of AUS in this study was 240/270 (88.9%), meaning nearly nine out of ten cases were correctly classified when compared to histopathology.

Sensitivity of 70/88 (79.5%), Specificity of 170/182 (93.4%), positive predictive value of 70/82 (85.4%), negative predictive value of 170/188 (90.4%), and an overall diagnostic accuracy of 240/270 (88.9%), 70 true positives (25.9%), 12 false positives (4.4%), 18 false negatives (6.7%), and 170 true negatives (63.0%).

TABLE 1: SUMMARY STATISTICS FOR AGE AND TUMOR SIZE

Variable	Mean	Standard Deviation	N
Age	39.05	12.624	270
Tumor Size	1.92	0.701	270

TABLE 2: FREQUENCY DISTRIBUTION OF AUS AND HISTOPATHOLOGY FINDINGS (N = 270)

Modality	Category	Frequency (n)	Percentage (%)
AUS	Metastatic	45	16.7%
	Non-Metastatic	225	83.3%
Histopathology	Metastatic	88	32.6%
	Non-Metastatic	182	67.4%

TABLE 3: DIAGNOSTIC ACCURACY OF AXILLARY ULTRASONOGRAPHY DETECTION OF AXILLARY LYMPH NODES METASTASIS IN MALIGNANT BREAST CARCINOMA PATIENTS TAKING HISTOPATHOLOGY AS GOLD STANDARD

	Histopathology: Metastatic (1)	Histopathology: Non-Metastatic (2)	Total
AUS: Metastatic (1)	70 (25.9%)	12 (4.4%)	82 (30.4%)
AUS: Non-Metastatic (2)	18 (6.7%)	18 (6.7%)	18 (6.7%)
Total	88 (32.6%)	88 (32.6%)	88 (32.6%)

DISCUSSION:

This study aimed to evaluate the diagnostic accuracy of axillary ultrasonography (AUS) in detecting axillary lymph node metastasis among patients with malignant breast carcinoma, with histopathological confirmation as the gold standard. Our findings demonstrated significantly high diagnostic performance, with a sensitivity of 79.5%, specificity of 93.4%, positive predictive value (PPV) of 85.4%, negative predictive value (NPV) of 90.4%, and an overall diagnostic accuracy of 88.9%. These results indicate that AUS is a reliable and effective modality for preoperative evaluation of axillary nodal status in breast cancer patients, particularly for ruling in and ruling out metastatic involvement.

Our reported sensitivity and specificity are notably higher than those seen in several earlier studies. For instance, Afzal et al. reported a sensitivity of 83.5% but a lower specificity of 51.6% and overall accuracy of 65% in a study conducted at Aga Khan University Hospital, where AUS was used in combination with core needle biopsy (CNB).⁹ While their sensitivity aligns closely with our findings, the markedly improved specificity and diagnostic accuracy in our study (93.4% and 88.9% respectively) suggest that AUS alone, when standardized and performed by trained professionals, may be highly reliable for nodal evaluation.

Similarly, Abidi et al. evaluated the diagnostic accuracy of AUS after neoadjuvant chemotherapy (NACT) and reported a sensitivity of 61% and accuracy of 75%.¹⁰ The substantially higher sensitivity and accuracy in our study could be attributed to patient selection, as our sample included untreated patients with clinically negative axillae, avoiding the potential nodal fibrosis and

distortion seen post-NACT, which can hinder sonographic interpretation.

Mwaniki's Kenyan study in early breast cancer patients also found modest sensitivity (59%) and specificity (88.4%), with an overall accuracy of 77.8%.¹¹ Our results not only surpass these figures but also affirm the performance of AUS across different populations when performed under standardized criteria. The improved NPV (90.4%) in our study further emphasizes AUS's strength in confidently excluding nodal metastasis in negative scans.

In contrast, Fayyaz and Niazi utilized ultrasound-guided FNAC and reported diagnostic accuracy of 85%, with sensitivity and specificity at 77.2% and 92.6%, respectively.¹² While FNAC provided cytological confirmation, our study achieved comparable—and even superior—results without invasive sampling. This highlights the potential of AUS as a standalone, non-invasive diagnostic tool when interpreted using well-defined sonographic criteria.

Kaliwaal et al. from Saudi Arabia reported AUS sensitivity of 80.6% and specificity of 94.1%, with overall accuracy of 87.2%,¹³ closely matching our values. The consistency between both studies, despite being in different regions, supports the robustness of AUS when executed under standardized protocols. Similarly, Sangwan et al. in India reported an accuracy of 84.1%, again slightly lower than our 88.9%.¹⁴ The collective findings indicate that our study contributes significantly to the growing body of evidence supporting AUS as a dependable modality for axillary staging.

The diagnostic value of individual sonographic features was underscored by Alshamari et al., who found that cortical thickness >3 mm and absence of

fatty hilum were the strongest predictors of metastasis, with a diagnostic accuracy of 84.5%.¹⁵ These were the exact criteria used in our study, supporting the applicability of these sonographic benchmarks in real-world practice. Our study's higher overall accuracy may reflect consistency in image acquisition, interpretation, or patient selection.

Another Pakistani multicenter study focused on FNAC alone found a sensitivity of 81.8%, specificity of 97.4%, and accuracy of 92.3%.¹⁶ Although cytological confirmation improved diagnostic accuracy, our nearly equivalent performance using AUS alone is clinically meaningful, especially for centers lacking pathology resources or seeking non-invasive alternatives.

The key strength of our study lies in the significantly high diagnostic performance of AUS, particularly the sensitivity of 79.5% and accuracy of 88.9%, which surpass many published studies. The relatively large sample size (n = 270) and use of histopathology as the definitive reference standard enhance the credibility and generalizability of our results. Furthermore, our strict application of cortical thickness and hilum visibility as diagnostic criteria promotes reproducibility and clinical utility. The study also addresses a critical gap in local data, providing evidence from Pakistan, where breast cancer prevalence is notably high.

Despite its promising results, the study is not without limitations. Being a single-center study, it may not fully reflect the variability in AUS practices across institutions. Operator dependency remains an inherent limitation of ultrasonography, and we did not assess inter-observer variability, which could affect diagnostic consistency. Moreover, while AUS criteria were standardized, no adjunctive tissue confirmation such as FNAC or CNB was performed to enhance diagnostic certainty. Lastly, subgroup analysis by tumor subtype, grade, or lymphovascular invasion was not undertaken, which may have influenced diagnostic outcomes.

Our findings support the inclusion of AUS as a routine, non-invasive, and accurate modality for axillary staging in breast cancer patients with clinically negative axillae. Given its high specificity and NPV, AUS can effectively triage patients who may avoid unnecessary invasive procedures. In cases

with suspicious sonographic findings, AUS-guided FNAC or CNB should be considered to improve diagnostic yield further. Larger multicenter trials with standardized sonographic protocols and inclusion of operator training metrics are warranted. Additionally, structured reporting formats and diagnostic algorithms can enhance the consistency of AUS interpretation across radiology departments.

CONCLUSION:

Axillary ultrasonography demonstrated high sensitivity, specificity, and diagnostic accuracy in detecting nodal metastasis in breast cancer patients. These findings confirm its value as a frontline tool for axillary evaluation, particularly in resource-constrained environments. When combined with clinical judgment and adjunctive tissue sampling when necessary, AUS can significantly contribute to personalized surgical planning and improved patient outcomes.

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