ORIGINAL ARTICLE

Preoperative Axillary Ultrasound to Detect Lymph Node Metastasis in Early Breast Cancer: A Prospective Trial

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Background: De-escalation of axillary surgery has become an important focus in early-stage breast cancer management. While sentinel lymph node biopsy (SLNB) remains the standard for clinically node-negative patients, it provides no therapeutic benefit and carries potential complications. Axillary ultrasound has emerged as a less invasive modality for nodal assessment, although criteria for defining suspicious lymph nodes vary across studies.

Objective: To evaluate the value of preoperative axillary ultrasound for detecting lymph node metastasis in early breast cancer.

Materials and Methods: The present study was a prospective study enrolled 81 women with early-stage breast cancer and clinically negative axilla at Chao Phraya Abhaibhubej Hospital, Thailand between March 2022 and April 2024. Preoperative axillary ultrasound was performed one day prior to surgery, with cortical thickness greater than 3 mm or absence of fatty hilum defined as suspicious. All patients underwent breast surgery with SLNB, followed by frozen section and completion axillary lymph node dissection (ALND) if positive. Clinical, pathological, and imaging data were analyzed.

Results: The mean age was 55.7 years, and the mean tumor size was 2.5 cm. Preoperative ultrasound identified suspicious nodes in 36 patients (44.4%). Pathology confirmed sentinel lymph node metastasis in 30 patients (37.0%). Axillary ultrasound demonstrated a sensitivity of 93.3% (95% CI 85.9 to 100.0), specificity of 84.3% (95% CI 74.6 to 94.0), positive predictive value (PPV) of 77.8%, and negative predictive value (NPV) of 95.6%. Subgroup analysis revealed that cortical thickening and loss of fatty hilum were significant predictors of nodal metastasis.

Conclusion: Preoperative axillary ultrasound, when applying cortical thickness and fatty hilum criteria, achieved high sensitivity and NPV in detecting nodal metastasis in early breast cancer. These findings support its role as a practical and minimally invasive tool to guide surgical decision-making and potentially reduce the need for axillary surgery, particularly in resource-limited settings.

Keywords: Breast cancer; Axillary ultrasound; Lymph node metastasis

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De-escalation of axillary surgery has become a key focus in the management of early-stage breast cancer. Large prospective trials, including the SOUND[1], ISEMA[2], and BOOG[3] studies, have recently demonstrated that omission of axillary surgery results in oncologic outcomes non-inferior to those of sentinel lymph node biopsy (SLNB) or axillary lymph node dissection (ALND).

Nevertheless, axillary nodal status remains a pivotal determinant for disease staging and treatment planning, particularly in guiding systemic therapy and radiation[4]. Accordingly, accurate preoperative nodal assessment continues to be clinically relevant.

Axillary ultrasound is widely employed as a non-invasive tool for breast cancer evaluation. In addition to assessing tumor size, it enables characterization of axillary lymph nodes and provides guidance for biopsy when indicated[5]. Recent studies have examined its utility, with or without tissue sampling, for nodal staging. However, the criteria for defining suspicious lymph nodes remain heterogeneous[6-8]. In real-world practice, particularly in resource-limited settings, features such as cortical thickness greater than 3 mm and absence of the fatty hilum are frequently used, though their diagnostic validity has not been consistently validated.

The present study investigated the clinical value of preoperative axillary ultrasound in early breast cancer by applying these criteria to predict

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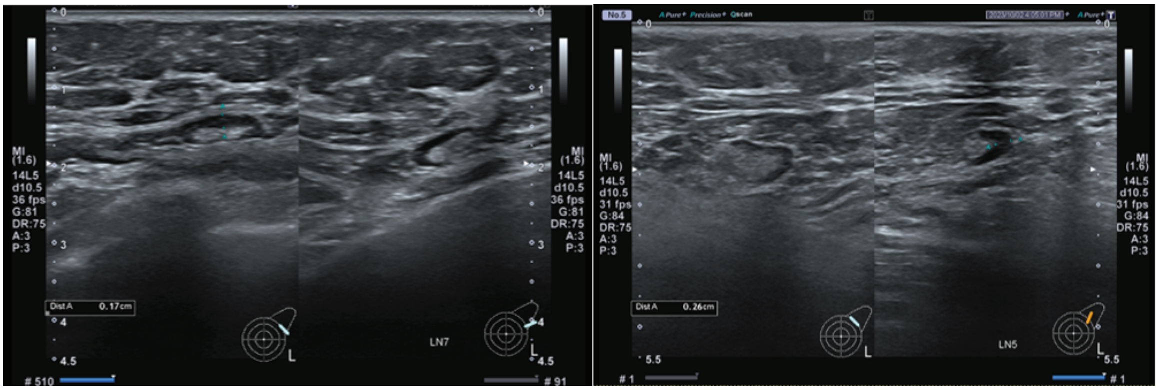

Figure 1. Normal lymph node from ultrasound.

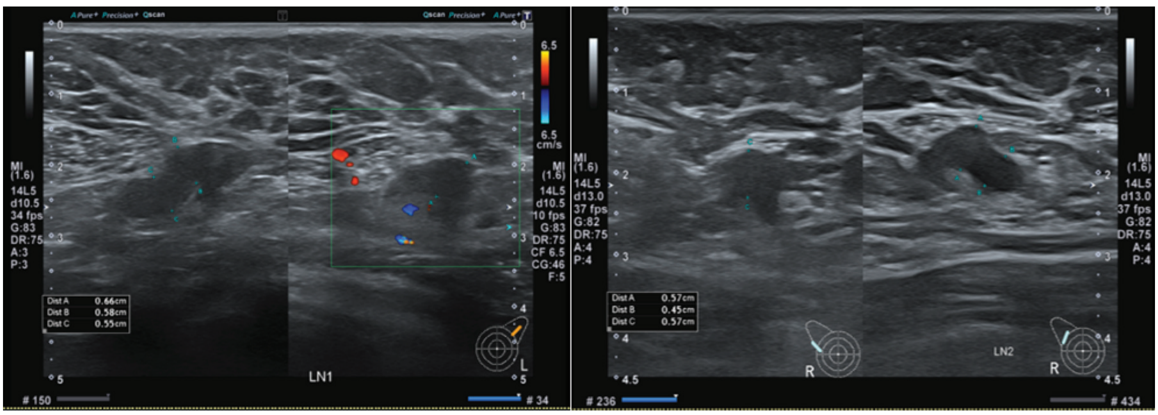

Figure 2. Suspicious lymph node with cortical thickening.

lymph node metastasis, benchmarking against pathological findings, and exploring its potential role in minimizing the need for axillary surgery.

Materials and Methods

The present study was a prospective study conducted at Chao Phraya Abhaibhubej Hospital, a provincial hospital in Thailand. Eligible participants were women aged older than 20 years with early-stage breast cancer, thus a tumor size of 5 cm or less, including ductal carcinoma in situ (DCIS) confirmed by core needle biopsy and clinically impalpable axillary lymph nodes. All patients were scheduled for breast surgery, either for breast-conserving surgery or mastectomy, with SLNB.

Preoperative axillary ultrasound was performed one day before surgery to assess ipsilateral axillary lymph nodes. A single radiologist conducted all examinations, classifying nodes as normal or suspicious. Suspicious criteria included cortical thickness greater than 3 mm, focal or diffuse, or absence of the central hyperechoic hilum (Figure 1-3).

Surgical procedures, including mastectomy or wide excision, were performed according to clinical indications and patient preference. All surgeries were conducted by a single breast surgeon. SLNB was performed using 1% isosulfan blue dye of 2 mL, injected beneath the nipple-areolar complex. Blue-stained nodes and adjacent nodes were excised and examined by frozen section. In cases with positive frozen section results, ALND was performed.

Patient demographic and clinical data, including age, body weight, height, body mass index (BMI), tumor size, and surgical procedures, were recorded. The number of sentinel nodes removed was documented. Tumor subtypes were classified according to receptor status, which are estrogen receptor (ER), progesterone receptor (PR), and human epidermal growth factor receptor 2 (HER2). Patients were grouped into four categories as ER/PR positive, ER/PR/HER2 positive, HER2 positive, and triple negative.

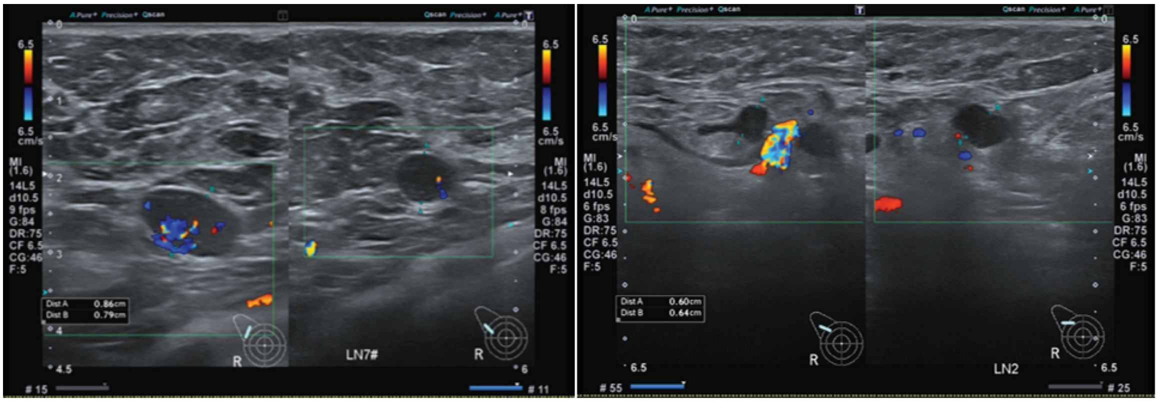

Figure 3. Suspicious lymph node with loss of hilum.

Statistical analysis

Statistical analyses were performed using Stata Statistical Software, version 18 (StataCorp LLC, College Station, TX, USA). Descriptive statistics were expressed as mean (range) for continuous variables and number (percentage) for categorical variables. Diagnostic performance of axillary ultrasound was assessed by calculating sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV). Subgroup analysis was performed using the Cox regression test to evaluate the association between sonographic features and nodal metastasis.

Ethics approval

The present study was approved by the Ethics Committee of Chao Phraya Abhaibheubajhr Hospital under document number IRB-BHUBEJHR-351.

Results

Between March 2022 and April 2024, 81 female patients were enrolled. The mean age was 55.7 years (range 29 to 84), and the mean BMI was 26.2 kg/m² (range 17.5 to 40.5). Histopathological diagnoses included invasive ductal carcinoma in 69 patients, mucinous carcinoma in five, and pure DCIS in five. The mean tumor size was 2.5 cm (range 0.5 to 5.0) (Table 1).

Table 1. Patients' characteristic (n=81)

Baseline characteristics	
Age (years); mean (range)	55.7 (29 to 84)
BMI (kg/m^2); mean (range)	26.2 (17.5 to 40.47)
Tumor size (cm); mean (range)	2.5 (0.5 to 5.0)
Histology; n (%)	
Invasive ductal carcinoma	69 (85.2)
Mucinous carcinoma.	5 (6.2)
DCIS	5 (6.2)
Tumor subtype; n (%)	
Luminal (ER/PR+, HER2–)	40 (49.4)
Luminal HER2 (ER/PR+, HER2+)	22 (27.2)
Triple negative	13 (16.1)

BMI=body mass index; DCIS=ductal carcinoma in situ; ER=estrogen receptor; PR=progesterone receptor; HER2=human epidermal growth factor receptor 2

Preoperative axillary ultrasound identified suspicious lymph nodes in 36 patients (44.4%), whereas 45 patients (55.6%) showed no suspicious findings.

With respect to surgical procedures, 60 patients (74.1%) underwent mastectomy with SLNB, while 21 patients (25.9%) received breast-conserving surgery. SLNB was technically successful in all cases, with a mean of 3.7 lymph nodes excised per patient (range 2 to 7). Pathological analysis revealed positive sentinel lymph nodes in 30 patients (37.0%).

Regarding molecular subtypes, 40 patients (49.4%) had ER/PR-positive and HER2-negative tumors, 22 (27.2%) had ER/PR-positive and HER2-positive tumors, six (7.4%) had HER2-positive tumors, and 13 (16.1%) had triple-negative breast cancer.

Preoperative axillary ultrasound demonstrated a sensitivity of 93.3% (95% CI 77.9 to 99.2) and specificity of 84.3% (95% CI 71.4 to 93.0) for predicting nodal metastasis. The PPV and NPV were 77.8% and 95.6%, respectively. The false-negative rate was 6.7%, and the false-positive rate was 15.7% (Table 2). Subgroup analysis revealed that both cortical thickness greater than 3 mm and loss of fatty hilum were significantly associated with nodal metastasis (Figure 4).

Discussion

SLNB remains the standard procedure for

Table 2. Diagnostic performance of axillary ultrasound

Parameter	Value (%)	95% CI
Sensitivity	93.3	77.9 to 99.2
Specificity	84.3	71.4 to 93.0
PPV	77.8	60.8 to 89.9
NPV	95.6	84.9 to 99.5
False negative rate	6.7	
False positive rate	15.7	

PPV=positive predictive value; NPV=negative predictive value; CI=confidence interval

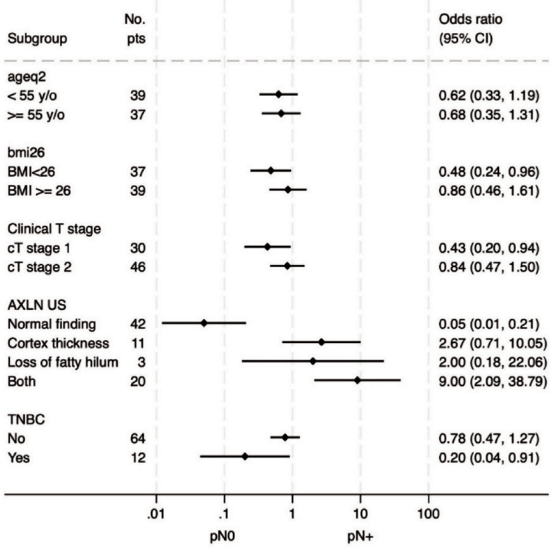

Figure 4. Subgroup analysis for prognostic factor in pathologic lymph node.

AXLN US=axillary lymph node ultrasound, TNBC=triple negative breast cancer

managing clinically node-negative breast cancer. Evidence from randomized controlled trials has demonstrated no significant differences in locoregional control, disease-free survival, or overall survival between SLNB and ALND[9-14] in patients with negative SLNB results, suggesting that the therapeutic benefit of axillary surgery is minimal. While SLNB is valuable for anatomic staging, it provides no therapeutic advantage and still carries risks of complications[15,16], prompting investigations into less invasive alternatives.

Axillary ultrasound has emerged as a promising tool for detecting nodal metastasis. Meta-analyses have reported sensitivities ranging from 48.8% to 87.1% and specificities from 55.6% to 97.3%, with further improvement in specificity when fine-needle aspiration (FNA) is performed[17-19]. Variation in diagnostic accuracy is attributable to differences in criteria for defining suspicious lymph nodes. Notably, large clinical trials such as SOUND[1], INSEMA[2], and BOOG 2013-08[3] demonstrated non-inferiority of omitting axillary surgery in selected patients with negative axillary ultrasound, though each employed different morphologic criteria.

In the present study, cortical thickness greater than 3 mm and loss of fatty hilum were used as sonographic criteria, consistent with prior evidence identifying these features as significant indicators of nodal metastasis. Using these definitions, axillary ultrasound achieved high sensitivity of 93.3% and NPV of 95.6%, underscoring its reliability in excluding nodal disease. However, the moderate PPV highlights a risk of overestimating suspicious findings, suggesting that FNA or core needle biopsy may be useful for confirmation in selected patients.

The present study results also demonstrated concordance between axillary ultrasound and SLNB, despite resource limitations that necessitated the use of blue dye alone for mapping. This approach, previously validated by studies in the authors' institution[20], achieved detection rates comparable to those reported elsewhere. Furthermore, subgroup analysis confirmed that both cortical thickening and hilar effacement were significant predictors of nodal metastasis, supporting their role as practical sonographic markers in routine practice.

The present study had limitations. It was conducted at a single provincial hospital with a small sample size, which may limit the generalizability of the findings. In addition, all examinations were performed by a single radiologist and surgeon, potentially introducing observer bias. Future multicenter studies with larger populations and standardized ultrasound protocols are warranted to validate these results.

Conclusion

Preoperative axillary ultrasound, when applying specific morphologic criteria, demonstrated high sensitivity and NPV for detecting nodal metastasis in early breast cancer. These findings support its role as a valuable adjunct to surgical decision-making, particularly in settings where resources are limited and invasive procedures should be minimized.

What is already known about this topic?

Axillary ultrasound is commonly used to assess axillary lymph node status prior to breast cancer surgery. However, its diagnostic reliability varies due to heterogeneity in the criteria used to define nodal metastasis.

What does this study add?

The present study demonstrates that axillary ultrasound achieves high sensitivity and specificity when using cortical thickness greater than 3 mm and loss of fatty hilum as diagnostic criteria for suspicious lymph nodes. These findings suggest that axillary ultrasound may serve as a valuable tool to reduce the need for axillary surgery in selected patients.

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Conflicts of interest

The author declares no conflict of interest.

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