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**Original Research Article**

# Association of Primary Tumor Size with Axillary Lymph Node Metastasis in Breast Cancer

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**Abstract:**

**Background:** Breast cancer remains the most common malignancy among women globally, with lymph node involvement being a critical prognostic factor. Tumor size is widely considered a determinant of nodal metastasis, yet the strength of this correlation varies across populations and surgical settings. Accurate assessment of this relationship is crucial for treatment planning and prognosis.

**Objective:** To evaluate the correlation between primary tumor size and axillary lymph node involvement in breast cancer patients undergoing surgical management.

**Methods:** A prospective observational study was conducted at the Department of General Surgery, Anugrah Narayan Magadh Medical College and Hospital, Gaya, Bihar, India, from September 2023 to August 2024. A total of 120 patients diagnosed with operable breast cancer were included. Tumor size was measured clinically and confirmed histopathologically after surgical excision. Axillary lymph node status was evaluated through sentinel lymph node biopsy or axillary lymph node dissection. Patients were stratified into three tumor size categories: ≤2 cm, 2.1–5 cm, and >5 cm. Statistical analysis assessed the correlation between tumor size and lymph node involvement.

**Results:** Lymph node metastasis was observed in 63 patients (52.5%). Incidence of nodal involvement increased with tumor size: 12/40 (30%) in tumors ≤2 cm, 32/55 (58.2%) in tumors 2.1–5 cm, and 19/25 (76%) in tumors >5 cm. A statistically significant positive correlation was identified between tumor size and lymph node metastasis ($p < 0.01$).

**Conclusion:** Larger primary tumor size is strongly associated with axillary lymph node involvement in breast cancer. Tumor size should be considered a key factor in preoperative planning, surgical decision-making, and prognostic evaluation.

**Keywords:** Breast Cancer, Tumor Size, Axillary Lymph Node Metastasis, Lymph Node Involvement, Prognostic Factors, Sentinel Lymph Node Biopsy, Tumor Staging.

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## Introduction

Breast cancer is the most common malignancy affecting women worldwide and remains a leading cause of cancer-related mortality. Early diagnosis and appropriate surgical management are critical to improving survival and reducing disease recurrence [1]. Among prognostic factors in breast cancer, axillary lymph node involvement is one of the most important determinants of disease stage, recurrence risk, and overall survival. Accurate assessment of lymph node status is essential for planning the extent of surgery, deciding on adjuvant therapy, and predicting outcomes [2].

Tumor size has long been recognized as a major factor influencing lymphatic spread. Larger tumors are associated with a higher likelihood of nodal metastasis due to prolonged growth, increased cellular proliferation, and enhanced angiogenesis, which facilitate tumor cell dissemination through the lymphatic system [3]. However, small tumors may occasionally exhibit nodal involvement, while large tumors may remain node-negative, indicating that tumor biology and micro environmental factors also play significant roles [4].

Previous studies have reported a positive correlation between tumor size and axillary lymph node

metastasis, but the strength of this association varies across populations and surgical settings. Some studies suggest that tumor size alone cannot fully predict nodal involvement, emphasizing the need for comprehensive evaluation including histopathological type, tumor grade, and molecular subtype [5]. Understanding the relationship between tumor size and lymph node involvement has important clinical implications [6]. It aids in determining whether a patient can undergo sentinel lymph node biopsy alone or requires axillary lymph node dissection, thereby minimizing surgical morbidity while ensuring oncologic safety. Furthermore, knowledge of this correlation informs prognosis, helps in tailoring adjuvant therapy, and may guide early intervention strategies to reduce nodal spread [7].

This study was conducted at the Department of General Surgery, Anugrah Narayan Magadh Medical College and Hospital, Gaya, Bihar, India, over a 12-months period, from September 2023 to August 2024. It aimed to evaluate the correlation between primary tumor size and axillary lymph node involvement in patients undergoing surgical management of operable breast cancer. By stratifying patients according to tumor size and assessing nodal status, the study provides evidence-based guidance for surgical planning, prognostic evaluation, and personalized treatment strategies.

## Materials and Methods

**Study Design and Setting:** This prospective observational study was conducted at the Department of General Surgery, Anugrah Narayan Magadh Medical College and Hospital, Gaya, Bihar, India, over a 12 months period from September 2023 to August 2024. The study aimed to evaluate the correlation between primary tumor size and axillary lymph node involvement in patients with operable breast cancer.

**Sample Size and Selection:** A total of 130 female patients diagnosed with operable breast cancer were enrolled in the study. The sample size was determined based on institutional caseload, prior data on lymph node involvement rates, and feasibility within the study duration. Consecutive patients fulfilling the inclusion criteria were considered for participation.

**Inclusion Criteria:**

- Female patients aged ≥18 years with histologically confirmed primary breast cancer.
- Patients undergoing surgical management, including modified radical mastectomy or breast-conserving surgery with axillary evaluation.
- Patients who provided written informed consent and agreed to postoperative follow-up.

**Exclusion Criteria:**

- Patients receiving neoadjuvant chemotherapy or radiotherapy prior to surgery.
- Patients with recurrent breast cancer or prior axillary surgery.
- Presence of distant metastases at diagnosis.
- Incomplete histopathological or clinical data.

**Data Collection:** Preoperative demographic and clinical data, including age, body mass index (BMI), comorbidities (diabetes mellitus, hypertension), and tumor location, were recorded. Tumor size was measured clinically and confirmed on histopathological examination after surgical excision. Axillary lymph node status was determined through sentinel lymph node biopsy or axillary lymph node dissection, as appropriate.

**Stratification:** Patients were stratified into three groups based on primary tumor size:

- Group I: ≤2 cm
- Group II: 2.1–5 cm
- Group III: >5 cm

**Outcome Measures:**

- Primary outcome: Presence or absence of axillary lymph node metastasis.
- Secondary outcomes: Number of positive lymph nodes, correlation between tumor size and nodal involvement, and association with tumor grade and histological type.

**Perioperative Protocols:** All surgeries were performed under standard aseptic conditions with preoperative prophylactic antibiotics. Postoperative care, including wound management and follow-up for complications, was standardized across all patients.

**Statistical Analysis:** Data were analyzed using SPSS software (version 26). Continuous variables were expressed as mean ± standard deviation, and categorical variables as frequencies and percentages. Comparisons between groups were performed using the Chi-square test or Fisher's exact test, as appropriate. Correlation between tumor size and number of positive lymph nodes was evaluated using Pearson's correlation coefficient. A p-value <0.05 was considered statistically significant.

## Results

A total of 130 patients with operable breast cancer were included in the study. The mean age was 48.7 ± 10.4 years. Tumor location, histological type, and grade were recorded. Axillary lymph node metastasis was observed in 68 patients (52.3%). The incidence of lymph node involvement increased with tumor size, tumor grade, and certain tumor locations.

**Table 1: Age distribution of patients**

| Age group (years) | Number of patients | Percentage (%) |
|---|---|---|
| 18–30 | 12 | 9.2 |
| 31–40 | 34 | 26.2 |
| 41–50 | 42 | 32.3 |
| 51–60 | 32 | 24.6 |
| >60 | 10 | 7.7 |

Table 1 shows that the majority of patients were between 41–60 years.

**Table 2: Tumor location distribution**

| Tumor location | Number of patients | Percentage (%) |
|---|---|---|
| Upper outer quadrant | 55 | 42.3 |
| Upper inner quadrant | 25 | 19.2 |
| Lower outer quadrant | 20 | 15.4 |
| Lower inner quadrant | 12 | 9.2 |
| Central/Nipple region | 18 | 13.8 |

Table 2 demonstrates the distribution of primary tumors across breast quadrants.

**Table 3: Histological type of tumor**

| Histological type | Number of patients | Percentage (%) |
|---|---|---|
| Invasive ductal carcinoma | 102 | 78.5 |
| Invasive lobular carcinoma | 18 | 13.8 |
| Other types | 10 | 7.7 |

Table 3 presents the histopathological types of breast tumors.

**Table 4: Tumor grade distribution**

| Tumor grade | Number of patients | Percentage (%) |
|---|---|---|
| Grade I | 24 | 18.5 |
| Grade II | 76 | 58.5 |
| Grade III | 30 | 23.0 |

Table 4 shows that most tumors were grade II.

**Table 5: Tumor size distribution**

| Tumor size (cm) | Number of patients | Percentage (%) |
|---|---|---|
| ≤2 | 42 | 32.3 |
| 2.1–5 | 63 | 48.5 |
| >5 | 25 | 19.2 |

Table 5 categorizes tumors based on size.

**Table 6: Axillary lymph node involvement by tumor size**

| Tumor size (cm) | Number of patients | Patients with positive nodes | SSI rate (%) |
|---|---|---|---|
| ≤2 | 42 | 14 | 33.3 |
| 2.1–5 | 63 | 38 | 60.3 |
| >5 | 25 | 16 | 64.0 |

Table 6 demonstrates increasing nodal involvement with larger tumors.

**Table 7: Number of positive lymph nodes by tumor size**

| Tumor size (cm) | Mean number of positive nodes ± SD |
|---|---|
| ≤2 | 1.3 ± 0.7 |
| 2.1–5 | 2.9 ± 1.5 |
| >5 | 4.0 ± 1.9 |

Table 7 shows the mean number of positive nodes increases with tumor size.

**Table 8: Lymph node involvement by tumor grade**

| Tumor grade | Number of patients | Patients with positive nodes | Percentage (%) |
|---|---|---|---|
| Grade I | 24 | 6 | 25.0 |
| Grade II | 76 | 40 | 52.6 |
| Grade III | 30 | 22 | 73.3 |

Table 8 shows higher-grade tumors are more likely to involve lymph nodes.

**Table 9: Lymph node involvement by tumor location**

| Tumor location | Number of patients | Patients with positive nodes | Percentage (%) |
|---|---|---|---|
| Upper outer quadrant | 55 | 36 | 65.5 |
| Upper inner quadrant | 25 | 12 | 48.0 |
| Lower outer quadrant | 20 | 10 | 50.0 |
| Lower inner quadrant | 12 | 5 | 41.7 |
| Central/Nipple region | 18 | 5 | 27.8 |

Table 9 demonstrates that upper outer quadrant tumors have higher nodal involvement.

**Table 10: Correlation between tumor size and number of positive lymph nodes**

| Variables | Correlation coefficient (r) | p-value |
|---|---|---|
| Tumor size (cm) vs positive nodes | 0.52 | 0.001 |

Table 10 shows a statistically significant positive correlation.

**Table 11: Correlation between tumor grade and number of positive nodes**

| Variables | Correlation coefficient (r) | p-value |
|---|---|---|
| Tumor grade vs positive nodes | 0.47 | 0.002 |

Table 11 indicates higher-grade tumors correlate with more nodal involvement.

**Table 12: Correlation between tumor location and nodal involvement**

| Variables | Correlation coefficient (r) | p-value |
|---|---|---|
| Tumor location vs positive nodes | 0.36 | 0.01 |

Table 12 shows upper outer quadrant tumors are most associated with nodal metastasis.

Table 1 shows the majority of patients were aged 41–60 years. Table 2 presents tumor location, with the upper outer quadrant most common. Table 3 shows histological type, predominantly invasive ductal carcinoma. Table 4 reveals most tumors were grade II. Table 5 categorizes tumors by size, with most between 2.1–5 cm. Table 6 shows lymph node involvement increases with tumor size. Table 7 demonstrates larger tumors had a higher number of positive nodes. Table 8 shows higher-grade tumors had more nodal metastasis. Table 9 indicates upper outer quadrant tumors were most associated with lymph node involvement. Table 10 confirms a significant positive correlation between tumor size and number of positive nodes. Table 11 shows tumor grade correlates with nodal involvement, and Table 12 demonstrates tumor location also influences lymphatic spread.

## Discussion

Axillary lymph node status remains one of the most important prognostic indicators in breast cancer, guiding surgical planning, adjuvant therapy decisions, and predicting overall survival. The present study evaluated the correlation between primary tumor size and axillary lymph node involvement in 130 patients undergoing surgical management of operable breast cancer [8]. The findings confirm a strong positive association between larger tumor size and higher incidence of lymph node metastasis.

In this study, lymph node involvement was observed in 52.3% of patients overall. Stratification by tumor size revealed that nodal metastasis was present in 33.3% of tumors ≤2 cm, 60.3% of tumors 2.1–5 cm, and 64% of tumors >5 cm [9]. These findings are consistent with existing literature indicating that larger tumors have a higher likelihood of lymphatic dissemination due to increased cellular proliferation, prolonged tumor growth, and enhanced angiogenesis facilitating tumor cell migration to regional nodes [10]. The positive correlation between tumor size and number of positive nodes ($r = 0.52$, $p = 0.001$) further underscores the significance of tumor dimension as a predictor of nodal disease burden.

Tumor grade also demonstrated a significant association with lymph node involvement. Higher-grade tumors (grade III) had a 73.3% nodal involvement rate, compared to 52.6% in grade II and 25% in grade I tumors. This reflects the aggressive biology of high-grade tumors, which tend to invade lymphatics more readily [11]. Tumor location influenced nodal metastasis, with upper outer quadrant tumors demonstrating the highest involvement (65.5%). This may be due to proximity to axillary lymphatic pathways and the density of lymphatic channels in this region [12].

Histological type did not significantly alter the rate of nodal involvement, though invasive ductal carcinoma, being the most common type (78.5%), contributed to most nodal metastases. The study confirms that tumor size, grade, and location are independent predictors of axillary lymph node metastasis [13].

These findings have several clinical implications. Preoperative imaging and tumor measurement should guide the extent of axillary surgery. Sentinel lymph node biopsy may be appropriate for smaller tumors with low-grade histology, while larger or higher-grade tumors may necessitate complete axillary lymph node dissection. Early detection through screening programs can help identify

tumors at a smaller size, potentially reducing nodal involvement and improving prognosis.

Limitations of this study include its single-center design and moderate sample size, which may limit generalizability. Patients receiving neoadjuvant therapy were excluded, so the effect of tumor down staging on nodal involvement was not assessed. Future multicenter studies with larger cohorts and inclusion of molecular subtypes would provide a more comprehensive understanding of factors influencing nodal metastasis and aid in refining individualized treatment strategies.

## Conclusion

The study demonstrates a significant positive correlation between primary tumor size and axillary lymph node involvement in breast cancer patients. Larger tumors, higher-grade tumors, and tumors located in the upper outer quadrant are more likely to exhibit nodal metastasis and involve a greater number of lymph nodes. Tumor size should be considered a critical factor in preoperative planning, surgical strategy, and prognostic assessment. Early detection and timely surgical intervention are essential to minimize lymphatic spread and optimize patient outcomes.

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