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Prognostic Impact and Clinicopathological Determinants of Regional Lymph Node Involvement Following Mastectomy: A One-Year Follow-Up Study

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ABSTRACT

Introduction: Regional lymph node involvement remains a critical prognostic indicator in breast cancer following mastectomy. Although various clinicopathological factors influence early disease progression, their short-term impacts require precise quantification. Therefore, this study evaluated the clinicopathological determinants of regional lymph node involvement and assessed its independent prognostic impact on disease-free survival and mortality within a one-year follow-up period.

Material and methods: This ten-year retrospective descriptive cross-sectional study evaluated 314 patients selected via convenience sampling from 1,700 women who underwent mastectomy at Shahid Madani Hospital, Tabriz. Clinicopathological characteristics, regional lymph node status, and one-year outcomes were extracted from medical records. Statistical evaluations were performed using standard tests, following ethical approval from Tabriz University of Medical Sciences.

Results: Multivariable analyses revealed that lymphovascular invasion (adjusted OR=2.89, P<0.001), advanced T3/T4 tumor size (adjusted OR=3.42, P<0.001), and grade III histology (adjusted OR=2.45, P=0.016) independently predict nodal involvement, while extensive nodal spread (pN2-pN3) markedly increased one-year recurrence hazard (adjusted HR=12.15, P<0.001) alongside significantly divergent survival curves (log-rank P<0.001).

Conclusion: Regional lymph node metastasis, lymphovascular invasion, and advanced tumor stage are critical determinants of early recurrence and survival following mastectomy. Identifying these high-risk clinicopathological predictors early enables tailored therapeutic strategies and intensified post-surgical surveillance to improve patient prognosis and clinical outcomes.

Introduction

Breast cancer continues to pose a formidable challenge to global public health, standing as the most common malignancy diagnosed among women worldwide. Despite significant advancements in early detection modalities, therapeutic regimens, and surgical approaches, the biological diversity of this disease necessitates continuous refinement of prognostic parameters to optimize patient-specific management strategies. Among the standard clinicopathological features routinely assessed during diagnostic workup and surgical evaluation, the presence and extent of regional lymph node metastasis remain pivotal determinants of clinical outcomes. Evaluating lymphatic spread not only underpins precise pathological staging but also directly dictates clinical decision-making regarding post-

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mastectomy radiation therapy and systemic adjuvant interventions [1].

The lymphatic architecture surrounding the mammary gland represents the primary avenue for initial regional dissemination of malignant epithelial cells. Transition from localized neoplasia to regional nodal involvement reflects a critical phase in tumor biology, signifying increased invasive potential and altered host-tumor immune interactions. Axillary lymph node status has long recognized as the most reliable single predictor of recurrence and overall survival in operable breast cancer. While molecular profiling and multigene prognostic assays have enriched our understanding of tumor biology, the anatomical extent of nodal involvement remains an irreplaceable foundation within the American Joint Committee on Cancer (AJCC) staging criteria, providing an empirical standard for clinical risk stratification [2].

For patients undergoing mastectomy whether indicated by adverse tumor-to-breast volume ratios, multicentricity, localized contraindications to radiation, or patient choice comprehensive evaluation of the resected nodal basin delivers essential prognostic data. High nodal burden, particularly falling into pN2 or pN3 classifications, consistently correlates with elevated risks of early locoregional recurrence and distant systemic metastasis compared with node-negative disease. However, this risk profile does not exist in isolation; it is continuously modulated by secondary clinicopathological determinants, including histological grade, lymph vascular space invasion, human epidermal growth factor receptor 2 (HER2) status, and hormone receptor expressions [3].

The first twelve months following surgical intervention represent a critical clinical window for monitoring early treatment responses and disease dynamics. Recurrences observed within this initial post-operative year often indicate biologically aggressive phenotypes associated with substandard long-term survival trajectories. Evaluating the clinicopathological drivers of extensive nodal involvement during this immediate follow-up period allows clinicians to pinpoint patient subgroups that may benefit from intensified post-mastectomy adjuvant therapies or closer surveillance protocols. Furthermore, analyzing disease-free survival over a one-year follow-up provides early feedback regarding the immediate efficacy of localized surgical control and initiation of systemic treatment protocols [4].

Mechanistically, tumor progression within regional nodes is mediated by intricate microenvironmental interactions and biological pathways. Tumor-induced lymph angiogenesis, largely driven by vascular endothelial growth factor signaling (such as VEGF-C and VEGF-D), facilitates structural remodeling of lymphatic capillaries and opens routes for cellular migration to regional nodes. Simultaneously, variations in stromal reactivity, microenvironmental inflammation, and local immune responses influence whether micro metastatic foci establish robust nodal disease or undergo immune-mediated elimination. Understanding these biological underpinnings provides clarity on why tumors of similar dimensions can exhibit starkly different rates of lymphatic dissemination [5].

Epidemiological patterns and clinicopathological presentations of breast cancer often display notable regional variability across diverse global populations. In specific clinical cohorts, factors such as diagnostic delays, distinct socioeconomic parameters, and varying distributions of biological subtypes can lead to advanced nodal presentation at the time of surgery. For instance, populations with higher proportions of triple-negative or HER2-overexpressing tumors frequently exhibit distinct patterns of aggressive regional and distant spread. Consequently, localized follow-up investigations are necessary to validate generalized prognostic models and ensure that post-mastectomy care guidelines are appropriately tailored to distinct patient cohorts [6].

Beyond traditional node counts, additional metrics such as the lymph node ratio (LNR) defined as the proportion of positive nodes relative to total retrieved nodes have gained attention as refined indicators of nodal burden. The lymph node ratio helps mitigate stage migration errors that can occur when surgical harvesting yields a limited total node count, thereby offering a standardized assessment of nodal involvement severity. Integrating metrics like LNR alongside standard histopathological features such as tumor grade and lymph vascular invasion provides a broader picture of malignant behavior, assisting clinicians in estimating the risk of early post-mastectomy disease recurrence [7].

The status of regional lymph nodes also significantly impacts treatment selection and long-term quality of life following surgery. Deciding whether to administer post-mastectomy regional nodal irradiation involves balancing maximal locoregional disease control against potential treatment-related side effects, such as upper extremity lymphedema and radiation-induced tissue fibrosis. Precise pathological node assessment allows multidisciplinary oncology teams to calibrate radiation fields and dosage, ensuring that high-risk patients receive comprehensive field coverage while low-risk individuals spared unnecessary radiation toxicity [8].

Recent advancements in pathological methodologies, including immunohistochemical staining and serial sectioning, have substantially improved the detection sensitivity for low-volume nodal disease, such as micro metastases and isolated tumor cells. Although the management of minimal nodal involvement in early-stage disease continues

to evolve, its diagnostic identification after mastectomy remains clinically important. Evidence suggests that even low-volume nodal disease can carry meaningful prognostic implications when paired with aggressive molecular tumor subtypes, highlighting the need for detailed pathological reporting [9].

The interplay between initial nodal status and responsiveness to adjuvant systemic therapy remains a focal point of ongoing clinical research. Patients presenting with heavy nodal disease typically require intensive systemic regimens, including anthracycline- and taxane-based chemotherapy, targeted anti-HER2 therapies, or extended endocrine regimens. Monitoring patient outcomes during the first follow-up year serves as an invaluable benchmark for assessing early treatment tolerance and identifying non-responders who may require prompt treatment adjustment or trial enrollment [10].

Contemporary clinical cohorts evaluated in modern treatment settings provide updated insights into the predictive value of historical clinicopathological factors. Given that contemporary systemic regimens and targeted therapies have altered the natural history of node-positive disease, re-assessing traditional nodal prognostic parameters within present-day patient groups is essential for updating clinical expectations. Integrating classical pathological examination with prospective follow-up data ensures that risk-assessment algorithms remain aligned with current oncological practices [11].

Preoperative diagnostic modalities, including targeted ultrasonography, magnetic resonance imaging, and positron emission tomography, have improved our capability to suspect nodal involvement prior to surgical intervention. However, definitive histopathological evaluation of the resected mastectomy and axillary specimen remains the standard for staging confirmation and risk determination. Discrepancies between radiological expectations and final surgical pathology reinforce the necessity of definitive histological examination to guide post-operative care [12].

Despite the established role of nodal status in breast cancer management, ongoing research is needed to determine how specific combinations of clinicopathological factors synergistically influence short-term post-mastectomy outcomes. Clarifying these complex interactions in a well-defined cohort can improve our capacity to identify patients at elevated risk for early disease progression. Therefore, the objective of this study was to evaluate the clinicopathological determinants of regional lymph node involvement and to assess its independent prognostic impact on disease-free survival and mortality within a one-year follow-up period among women undergoing mastectomy.

Material and methods

Study Design:

This hospital-based observational study comprised a descriptive cross-sectional assessment of pathological lymph node involvement and a retrospective analysis of one-year outcomes. Medical records of women who underwent mastectomy for breast cancer at Shahid Madani Hospital, Tabriz, over a ten-year period were reviewed. Clinicopathological characteristics and nodal status were determined from the surgical and pathology records, while subsequent records were examined to ascertain recurrence and survival during the 12 months following mastectomy.

Sample Size and Sampling:

The source population comprised approximately 1,700 women who underwent mastectomy during the study period. Sample size estimated using Cochran's formula for a proportion, with a finite-population correction. Assuming a 95% confidence level (Z=1.96), an expected proportion of 0.50, and a 5% margin of error, the initial estimate was 384.16; correction for a population of 1,700 yielded approximately 313.5, rounded up to 314 patients. Eligible records selected by convenience sampling. Because convenience sampling is non-probability sampling, the nominal 5% margin of error describes the calculation assumptions and not presented as a guaranteed precision for the final sample.

Eligibility Criteria:

Women were eligible if they had a histologically confirmed diagnosis of primary invasive breast carcinoma, underwent mastectomy at Shahid Madani Hospital during the specified ten-year period, and had sufficient operative and pathological documentation to establish regional nodal status. Their records also needed to permit ascertainment of recurrence or vital status during the first postoperative year; a patient who experienced an outcome before 12 months remained eligible. Records were excluded when the diagnosis was not invasive breast carcinoma, the mastectomy or definitive pathological assessment had been performed elsewhere and could not be verified, regional nodal findings were unavailable, or the information needed to determine postoperative outcomes was insufficient. Patients with documented distant metastatic disease at the time of surgery, a prior ipsilateral invasive breast cancer, or a concurrent malignancy that prevented reliable attribution of outcomes were also excluded. These proposed criteria should be checked against the criteria actually applied during record selection before submission.

Data Collection:

Demographic and primary-tumor variables were abstracted from clinical and pathology records.

These included age at surgery; menopausal status, where documented; tumor size and pathological T category; histological type and grade; and the presence of lymph vascular invasion. Estrogen receptor, progesterone receptor, and human epidermal growth factor receptor 2 (HER2) status recorded when available. Information on treatments received before or after mastectomy including systemic therapy, endocrine therapy, and radiotherapy was extracted where sufficiently documented. Variables absent from a record treated as missing rather than inferred.

Regional nodal involvement characterized using the number of lymph nodes examined, the number containing metastases, and the resulting pathological nodal category. Patients classified as node-negative or node-positive; nodal burden additionally described as pN0, pN1, or pN2-pN3 according to the final pathology report. The lymph node ratio calculated as the number of positive nodes divided by the number examined when both counts were available. Follow-up data included the date and site of any documented recurrence, the date of death when applicable, and the date of the last available clinical assessment. For one-year analyses, the outcome of recurrence or death was assessed within 12 months of mastectomy; disease-free survival was measured from surgery to the first documented recurrence or death, with patients without an event censored at their last documented assessment or at 12 months, whichever occurred first.

Statistical Analysis:

Normally distributed continuous variables were summarized as means and standard deviations and compared using independent-samples *t* tests for two groups or one-way analysis of variance for three or more groups. Categorical variables were presented as frequencies and percentages and compared using the chi-square test or Fisher's exact test when expected cell counts were small. Crude and adjusted odds ratios with 95% confidence intervals were estimated using univariable and multivariable logistic regression to assess factors associated with nodal involvement and with recurrence or death within one year. Candidate variables for adjusted models selected on clinical grounds and evaluated for collinearity; alternative measures of the same nodal burden, such as pN category and lymph node ratio, not entered simultaneously without appropriate justification. Disease-free survival estimated using the Kaplan–Meier method and compared across nodal categories with the log-rank test. All tests were two-sided, and $P<0.05$ was considered statistically significant.

Ethical Considerations:

Ethical approval obtained from the Ethics Committee of Tabriz University of Medical Sciences under approval number IR.TBZMED.REC.1397.648.

Patient information was handled confidentially, and study data were reported in aggregate without identifying individuals.

Results

As presented in Table 1, baseline clinicopathological characteristics were compared between node-negative (n=180) and node-positive (n=134) cohorts. Demographic features, including age and menopausal status, as well as molecular biomarkers such as ER, PR, and HER2 expression, demonstrated no statistically significant differences between the two study groups. Conversely, marked disparities were observed regarding indicators of tumor aggressiveness and invasiveness. Patients with regional lymph node involvement were significantly more likely to present with advanced tumor size (T3/T4 category; $P<0.001$) and higher histological grade (Grade III; $P=0.003$). Furthermore, the presence of lymph vascular invasion was substantially more prevalent in the node-positive cohort compared to the node-negative group (53.7% versus 25.6%; $P<0.001$), highlighting the strong association between these adverse clinicopathological parameters and regional lymphatic dissemination.

Table 1. Baseline clinicopathological characteristics of patients stratified by regional lymph node status (N=314)

Characteristics	Node-Negative (n = 180)	Node-Positive (n = 134)	P-value
Age (years, mean ± SD)	52.4 ± 10.2	53.1 ± 11.0	0.528
Menopausal status, n (%)	-	-	0.742
Premenopausal	74 (41.1)	53 (39.6)	-
Postmenopausal	106 (58.9)	81 (60.4)	-
Tumor size (T-stage), n (%)	-	-	<0.001
T1 (<= 2 cm)	78 (43.3)	32 (23.9)	-
T2 (> 2 to 5 cm)	82 (45.6)	64 (47.8)	-
T3 / T4 (> 5 cm or extension)	20 (11.1)	38 (28.3)	-
Histological grade, n (%)	-	-	0.003
Grade I	42 (23.3)	18 (13.4)	-
Grade II	98 (54.4)	68 (50.7)	-

Grade III	40 (22.3)	48 (35.9)	-
Histological type, n (%)	-	-	0.615
Invasive ductal carcinoma	152 (84.4)	116 (86.6)	-
Invasive lobular carcinoma	20 (11.1)	13 (9.7)	-
Other special types	8 (4.5)	5 (3.7)	-
Estrogen receptor (ER), n (%)	-	-	0.412
Positive	118 (65.6)	83 (61.9)	-
Negative	62 (34.4)	51 (38.1)	-
Progesterone receptor (PR), n (%)	-	-	0.385
Positive	110 (61.1)	77 (57.5)	-
Negative	70 (38.9)	57 (42.5)	-
HER2 status, n (%)	-	-	0.284
Positive	36 (20.0)	34 (25.4)	-
Negative	144 (80.0)	100 (74.6)	-
Lymph vascular invasion, n (%)	-	-	<0.001
Absent	134 (74.4)	62 (46.3)	-
Present	46 (25.6)	72 (53.7)	-

As detailed in Table 2, univariable and multivariable logistic regression analyses were performed to identify independent clinicopathological determinants of regional lymph node involvement. Following adjustment for potential confounding factors, multivariable modeling revealed that lymph vascular invasion emerged as the strongest independent predictor of nodal metastasis, demonstrating a more than two-fold increase in the odds of lymph node involvement (adjusted odds ratio =2.89, 95% confidence interval: 1.78 to 4.71; P<0.001). Additionally, advanced tumor size, specifically the T3/T4 category compared to T1 (adjusted odds ratio =3.42, 95% confidence interval: 1.67 to 7.01; P < 0.001), and higher histological grade III relative to grade I (adjusted odds ratio =2.45, 95% confidence interval: 1.18 to 5.09; P=0.016) remained significantly associated with regional lymphatic spread, whereas age, menopausal status, and hormone receptor or HER2 profiles showed no independent predictive significance.

Table 2. Multivariable and univariable logistic regression analyses of clinicopathological determinants associated with regional lymph node involvement (N = 314)

Variable	Univariable Analysis Crude OR (95% CI)	P-value	Multivariable Analysis Adjusted OR (95% CI)	P-value
Age (per 10-year increase)	1.06 (0.88-1.28)	0.528	1.02 (0.83-1.25)	0.842
Menopausal status (Postmenopausal vs. Premenopausal)	1.06 (0.68-1.66)	0.792	0.94 (0.57-1.55)	0.814
Tumor size (T2 vs. T1)	1.91 (1.13-3.23)	0.016	1.68 (0.96-2.94)	0.069
Tumor size (T3/T4 vs. T1)	4.63 (2.41-8.89)	<0.001	3.42 (1.67-7.01)	<0.001
Histological grade (Grade II vs. Grade I)	1.61 (0.87-2.98)	0.130	1.38 (0.71-2.68)	0.345
Histological grade (Grade III vs. Grade I)	3.15 (1.61-6.16)	<0.001	2.45 (1.18-5.09)	0.016
Estrogen receptor (Positive vs. Negative)	0.85 (0.55-1.33)	0.490	0.91 (0.55-1.51)	0.718
Progesterone receptor (Positive vs. Negative)	0.86 (0.55-1.34)	0.505	0.95 (0.58-1.56)	0.840
HER2 status (Positive vs. Negative)	1.35 (0.80-2.27)	0.262	1.24 (0.71-2.18)	0.446
Lymph vascular invasion (Present vs. Absent)	3.39 (2.16-5.32)	<0.001	2.89 (1.78-4.71)	<0.001

As demonstrated in Table 3, multivariable Cox proportional hazards regression analysis identified heavy regional lymph node involvement, advanced tumor stage, high histological grade, and lymph vascular invasion as independent predictors of poorer one-year disease-free survival and mortality following mastectomy. Specifically, patients presenting with extensive nodal metastasis (pN2-pN3) experienced a markedly elevated hazard of recurrence and mortality compared to node-negative individuals (adjusted hazard ratio =12.15, 95% confidence interval: 5.14 to 28.71; P<0.001), while

lower-tier nodal involvement (pN1) also maintained a significant prognostic risk (adjusted hazard ratio =2.84, 95% confidence interval: 1.17 to 6.89; P=0.021). Furthermore, advanced tumor size (T3/T4 versus T1: adjusted hazard ratio =3.19, 95% confidence interval: 1.28 to 7.95; P=0.013), grade III histological differentiation (adjusted hazard ratio =2.61, 95% confidence interval: 1.08 to 6.32; P=0.033), and the presence of lymph vascular invasion (adjusted hazard ratio =2.14, 95% confidence interval: 1.03 to 4.46; P=0.041) emerged as independent adverse prognostic determinants within the twelve-month follow-up window.

Table 3. Multivariable Cox proportional hazards regression analysis of prognostic factors associated with one-year disease recurrence and mortality following mastectomy (N=314)

Variable	Events, n (%)	Crude Hazard Ratio (95% CI)	P-value	Adjusted Hazard Ratio (95% CI)	P-value
Nodal status (pN0)	8 (4.4)	1.00 (Reference)	-	1.00 (Reference)	-
Nodal status (pN1)	14 (14.1)	3.28 (1.38-7.79)	0.007	2.84 (1.17-6.89)	0.021
Nodal status (pN2-pN3)	19 (52.8)	16.42 (7.21-37.38)	<0.001	12.15 (5.14-28.71)	<0.001
Tumor size (T2 vs. T1)	18 (12.4)	2.15 (0.94-4.91)	0.070	1.72 (0.73-4.05)	0.214
Tumor size (T3/T4 vs. T1)	14 (24.1)	4.82 (2.07-11.23)	<0.001	3.19 (1.28-7.95)	0.013
Histological grade (Grade II vs. Grade I)	21 (12.5)	1.85 (0.79-4.32)	0.153	1.48 (0.61-3.59)	0.389
Histological grade (Grade III vs. Grade I)	20 (22.5)	3.82 (1.64-8.89)	0.002	2.61 (1.08-6.32)	0.033
Lymph vascular invasion (Present vs. Absent)	26 (22.6)	3.51 (1.75-7.05)	<0.001	2.14 (1.03-4.46)	0.041

Disease-free survival declined across the nodal groups, with the pN0 cohort maintaining the highest probability throughout follow-up, the pN1 cohort showing an intermediate decline, and the pN2-pN3 cohort experiencing the steepest reduction. The separation between the curves indicates poorer short-term outcomes with increasing nodal involvement (log-rank P<0.001).

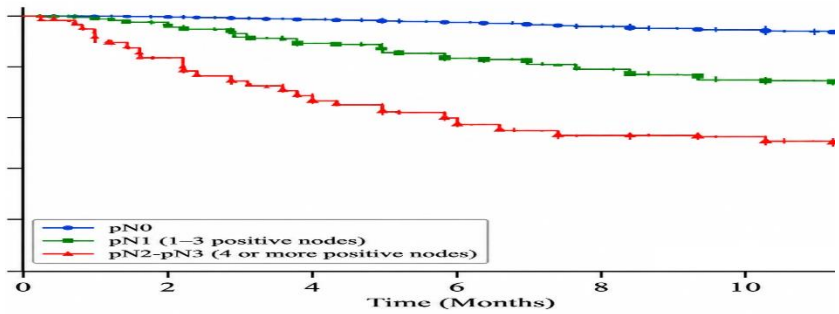


Figure 1. Kaplan–Meier estimates of 12-month disease-free survival by pathological nodal stage.

Discussion

In this cohort of 314 patients undergoing mastectomy, regional lymph node involvement was associated with larger tumors, higher histological grade, and more frequent lymph vascular invasion. In the reported multivariable analysis, T3/T4 disease, grade III histology, and lymph vascular invasion remained associated with nodal involvement. The reported one-year hazard was greatest among patients with pN2-pN3 disease compared with those with pN0 disease, while the Kaplan-Meier curves showed a corresponding gradient across nodal groups. Tumor size, grade, and lymph vascular invasion were also associated with the reported one-year outcome. Together, these findings suggest that nodal burden reflects both the extent of disease and the aggressive characteristics of the primary tumor, although the short follow-up limits conclusions about longer-term prognosis [10,11].

The association between lymph vascular invasion and nodal positivity is biologically plausible. Tumor cells identified within vascular or lymphatic spaces have passed beyond the primary tumor's local boundaries and may gain access to routes of regional dissemination. In the present data, lymph vascular invasion was recorded in 53.7% of node-positive patients, compared with 25.6% of node-negative patients, and remained associated with nodal involvement after adjustment for the other listed variables. This finding is consistent with studies identifying lymph vascular invasion as an important predictor of axillary metastasis across breast cancer subtypes. It should not, however, be interpreted as proof that every involved node arose through the same identifiable pathway; pathological sampling

detects only a portion of a tumor's spatially heterogeneous invasive activity [12,13].

Larger tumor size was another prominent determinant of regional spread. Compared with T1 tumors, T3/T4 tumors were more frequent in the node-positive group and had higher adjusted odds of nodal involvement. A larger invasive mass may have had more time and opportunity to encounter lymphatic channels, while locally advanced growth can reflect an intrinsically more invasive phenotype. Tumor size and nodal status therefore convey related, but not interchangeable, information about disease extent. Importantly, the association is not absolute: small primary tumors can sometimes present with extensive nodal disease, indicating that metastatic capacity cannot be inferred from diameter alone. The persistence of a tumor-size association after adjustment supports its use alongside, rather than instead of, grade and lymph vascular invasion when interpreting pathological risk [14,15].

The higher frequency of grade III tumors among node-positive patients provides a further indication that tumor biology contributes to regional dissemination. Histological grade captures architectural differentiation, nuclear atypia, and proliferative activity; poorly differentiated tumors may therefore be more likely to acquire invasive behavior and generate early clinical events. In the supplied analyses, grade III disease was associated with both nodal involvement and the reported one-year outcome after adjustment for other listed factors. This pattern accords with evidence that grade retains prognostic value across tumor-size and nodal categories. Nevertheless, grade is not a direct measurement of metastatic movement, and its association with outcome may partly reflect biological features not captured by routine histology. Consistent pathological assessment is essential before interpreting differences between grade groups [16,17].

The contrast between the pN1 and pN2–pN3 groups suggest that the extent of nodal involvement carries more information than a simple positive-versus-negative classification. The reported adjusted hazard ratios rose from 2.84 for pN1 to 12.15 for pN2-pN3 relative to pN0, with the largest decline in the illustrated disease-free survival curve occurring in the most extensively involved group. Greater nodal burden may indicate a tumor with a greater capacity for dissemination, a larger reservoir of regional disease, or a higher probability of occult disease beyond the operative field. Other cohorts have likewise associated increasing numbers of positive nodes with recurrence and poorer survival. The magnitude of the present estimate requires particular caution, however, because relatively few events are reported within the nodal subgroups [18,19].

Lymph vascular invasion also remained associated with the reported one-year outcome after nodal status was included in the survival model. This distinction matters: nodal staging describes established regional metastasis, whereas lymph vascular invasion describes tumor cells within vascular spaces in the primary specimen. The two findings may capture overlapping but incomplete aspects of dissemination. Large independent cohorts have reported associations between lymph vascular invasion and disease-free survival after accounting for conventional prognostic characteristics, lending context to the direction of the present finding. Yet the adjusted hazard ratio should not be read as a causal effect of lymph vascular invasion itself. Both variables may be markers of underlying tumor behavior, and their estimated associations can change when treatment, molecular subtype, or other unmeasured characteristics are incorporated [20,21].

Age, menopausal status, and individual ER, PR, and HER2 results showed no statistically significant association with nodal positivity in the supplied adjusted model. This does not establish that these characteristics are biologically irrelevant. Receptor-defined groups can differ in their tendency toward nodal involvement, and receptor status can influence the timing of recurrence as well as treatment selection. A binary assessment of each marker may conceal variation among combined molecular subtypes; adjustment for tumor size, grade, and lymph vascular invasion may also reduce an apparent association with nodal status. Furthermore, a sample of 314 patients may have limited ability to detect modest differences across biomarker groups. The absence of statistical significance should therefore be reported as a finding of this cohort and model, not as evidence that receptor status lacks clinical value [22,23].

Interpretation of the survival analysis depends on the precise definition of its endpoint. Disease-free survival, breast cancer recurrence, and mortality are not interchangeable outcomes, and different studies include different events in composite survival measures. The supplied table does not separate recurrence events from deaths or specify which events entered the Cox model. Consequently, one adjusted hazard ratio not described confidently as a distinct effect on both recurrence and mortality. The 12-month observation period also captures only an early portion of the disease course. Longer follow-up is especially important because recurrence risk can persist for many years and its timing varies between patient groups. A revised analysis should define the event, time origin, censoring rules, and event counts before comparisons with longer-term studies are made [24, 25].

If confirmed, these findings could support more individualized discussion of postoperative risk, particularly for patients with extensive nodal involvement or several adverse pathological features. They not used in isolation to prescribe treatment. Decisions about radiotherapy and systemic treatment require consideration of nodal

stage together with tumor features, receptor status, prior therapy, patient circumstances, and contemporary clinical guidance. Evidence from randomized trials and multidisciplinary guidelines supports the relevance of nodal involvement when considering postmastectomy radiotherapy, but the benefit for an individual patient not calculated from this observational cohort. Equally, a higher reported recurrence hazard does not show that intensive surveillance would improve survival. The practical contribution of this study is risk stratification that may inform, rather than replace, established multidisciplinary decision-making [26, 27].

Several limitations should temper the interpretation. The retrospective, single-center design and convenience sampling may introduce selection and information bias, while incomplete documentation of adjuvant treatments could leave important confounding unaddressed. The short follow-up and small number of reported events constrain the precision of multivariable survival estimates and prevent conclusions about durable outcomes. Before submission, the nodal subgroup totals, grade-specific event counts, percentages, and endpoint definition must be reconciled with the patient-level dataset; the proportional hazards assumption and the number of patients at risk over time also checked. A Kaplan–Meier figure and log-rank result are publishable only if calculated from observed follow-up and censoring data. Once these issues are resolved, longer follow-up and external validation would clarify whether the observed associations generalize beyond this cohort [28, 29].

Conclusion

Regional lymph node metastasis, lymph vascular invasion, and advanced tumor stage are critical determinants of early recurrence and survival following mastectomy. Identifying these high-risk clinic pathological predictors early enables tailored therapeutic strategies and intensified post-surgical surveillance to improve patient prognosis, clinical outcomes.

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Conflicts of interest

The authors declare that they have no competing interests.

Disclosure Statement

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Authors' Contributions

All authors contributed to data analysis, drafting, and revising of the paper and agreed to be responsible for all the aspects of this work.

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