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Lymph Node Involvement in Post-Mastectomy Women and Its Prognostic Significance over a One-Year Period

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ABSTRACT

Introduction: Although axillary lymph node status is a well-established prognostic marker in breast cancer, its specific impact on early clinical trajectories during the first postoperative year remains insufficiently understood. Therefore, this study aims to evaluate the prognostic significance of lymph node involvement in post-mastectomy women over a one-year follow-up period.

Material and methods: This retrospective cohort study reviewed 314 patients selected via convenience sampling from an estimated population of 1,700 women who underwent mastectomy at Shahid Madani Hospital over a ten-year period. Data regarding demographic characteristics, tumor features, and nodal involvement were extracted from hospital records to evaluate one-year prognostic outcomes using descriptive statistics and regression models.

Results: The study demonstrated that lymph node involvement is a critical prognostic factor in post-mastectomy women, with node-positive patients showing higher rates of advanced tumor size (P<0.001) and lymphovascular invasion (P<0.001). Multivariable analysis identified heavy nodal burden (adjusted OR=4.96, P<0.001), elevated lymph node ratio (OR=2.74,P=0.009), and triple-negative subtype (OR=2.91,P=0.008) as independent predictors of poor one-year survival.

Conclusion: Regional lymph node involvement and heavy nodal burden independently drive early disease recurrence and mortality following mastectomy. Prognostic stratification using nodal status, lymph node ratio, and biological subtype effectively identifies patients at high risk who require intensive postoperative therapeutic management and close short-term clinical surveillance.

Introduction

Breast cancer continues to hold the highest incidence among female malignancies worldwide, imposing an immense global health challenge and requiring constant refinement of clinical approaches to diagnosis and long-term care. Despite notable developments in population-based mammographic screening programs and the widespread adoption of multi-modal oncological protocols, a considerable number of women diagnosed at locally advanced stages where surgical ablation remains unavoidable. In these clinical scenarios, total mastectomy represents the primary surgical modality to achieve negative margins and ensure locoregional control. Mastectomy constitutes a major life event that brings extensive physiological restructuring, potential postoperative functional morbidity, and significant psychological disruption. Consequently,

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oncologists and surgical teams must rely on highly reliable, objective clinicopathological parameters to predict disease trajectories and establish surveillance strategies tailored to individual patient profiles [1].

Within the established spectrum of clinicopathological markers in breast oncology, axillary lymph node involvement remains an indisputable cornerstone of risk assessment and staging accuracy. The lymphatic drainage channels of the breast parenchyma provide the most accessible conduit for detached neoplastic cells undergoing local dissemination. Histopathological verification of nodal disease has long served as a proxy for systemic micro metastatic dissemination, directly altering tumor staging according to the American Joint Committee on Cancer classifications and dictating the overall therapeutic trajectory. In contemporary surgical oncology, axillary evaluation has progressed far beyond a simple binary distinction between node-positive and node-negative disease. Modern clinical decision-making incorporates the absolute quantity of metastatic nodes, the ratio of positive to retrieved lymph nodes, the spatial pattern of intranodal distribution, and the presence of extracapsular extension, all of which substantially refine individual prognostic stratification [2].

The initial twelve-month interval following mastectomy is increasingly recognized as a clinically distinct, highly vulnerable timeframe that fundamentally influences long-term oncological outcomes. During this first postoperative year, patients typically transition from the physical recovery of extensive surgery into rigorous adjuvant protocols, encompassing dose-dense or standard chemotherapy regimens, regional radiation therapy, and the initiation of endocrine or targeted biological therapies. This specific period frequently coincides with the highest biological vulnerability for early locoregional failure or rapid systemic relapse, primarily driven by subclinical, treatment-resistant micro metastases that were already active at the time of primary surgical intervention. Moreover, the first year establishes the patient's baseline physiological reserve, therapeutic tolerance, and immunological recovery, all of which are essential components determining whether a patient remains disease-free or experiences early adverse clinical events [3].

Despite widespread recognition of axillary nodal involvement as a pivotal determinant of long-term breast cancer survival, a critical gap persists in the scientific literature regarding its precise predictive performance within the discrete timeframe of the first postoperative year. Most existing clinical research, prognostic indices, and epidemiological registries have focused predominantly on five-year, ten-year, or fifteen-year endpoints such as overall survival and distant disease-free survival.

While long-term analyses are undeniably valuable for evaluating general cohort survival, they tend to obscure the biological and clinical subtleties that occur during the immediate survivorship window. Patients confronting aggressive, node-positive disease frequently encounter unique physiological challenges and dynamic clinical hurdles early in their post-surgical trajectory, which may not be adequately captured by extended prognostic models that dilute early-phase events across several decades of aggregate follow-up [4].

The clinical paradigm surrounding axillary management has undergone dramatic shifts over recent decades, evolving from routine complete axillary lymph node dissection toward minimally invasive sentinel lymph node biopsies and targeted axillary sampling. Landmark trials have successfully challenged traditional surgical dogmas by showing that omitting full axillary clearance does not compromise outcomes in selected breast conservation cohorts. However, the direct translation of these findings to women undergoing total mastectomy warrants continued scrutiny, as mastectomy candidates often present with larger primary tumors, multifocal multicentric disease, or biologically aggressive variants that carry higher baseline nodal burdens. Evaluating the prognostic weight of lymph node status specifically within modern mastectomy cohorts is essential to ensure that surgical de-escalation does not leave high-risk early events underappreciated or inadequately managed [5].

From a pathophysiological standpoint, the presence of malignant cells within regional lymph nodes reflects extensive molecular and biomechanical alterations within both the primary neoplastic clone and the regional lymphatic endothelium. Tumor cells must acquire migratory capabilities, detach from the primary cellular cluster, penetrate the lymphatic capillaries, and withstand the mechanical shear forces present in lymphatic transit. Upon arrival at the sentinel or regional nodes, metastatic cells must overcome host immunogenic defenses, establish a vascular supply through lymph angiogenesis and angiogenesis, and initiate secondary colonization. Consequently, extensive nodal involvement reflects not merely a physical extension of disease, but a biological marker of tumor aggressiveness, phenotypic plasticity, and an inherent capacity to navigate complex host microenvironments, all of which are mechanisms strongly associated with aggressive short-term recurrence [6].

The involvement of regional lymphatics also carries major consequences for the host immune system, particularly within the specialized architecture of the lymphatic sinuses and regional nodal cortices. Under non-pathological conditions, regional lymph nodes serve as key induction sites for adaptive

antitumor immunity, coordinating antigen presentation, cytotoxic T-lymphocyte priming, and systematic immunosurveillance against circulating neoplastic cells. The infiltration of metastatic tumor cells fundamentally disrupts this protective microarchitecture, inducing local immune tolerance through the recruitment of regulatory T cells, myeloid-derived suppressor cells, and immunosuppressive cytokines. During the first twelve months following mastectomy, when surgery and systemic cytotoxic agents induce temporary systemic immunosuppression, this localized immune compromise within involved nodal basins may allow residual micro metastatic foci to evade elimination and progress into overt clinical recurrences [7].

The status of axillary lymph nodes directly influences post-mastectomy radiation therapy planning and adjuvant systemic treatment intensification. Regional nodal irradiation is routinely indicated for patients exhibiting extensive nodal positivity to reduce the risk of chest wall and regional nodal recurrence. However, the application of post-mastectomy radiation across regional nodal basins introduces substantial therapeutic complexity, as it significantly increases the risk of upper extremity lymphedema, radiation-induced soft tissue fibrosis, brachial plexopathy, and functional musculoskeletal impairment. In patients who develop treatment-related complications, the functional impact during the first year can significantly reduce treatment adherence, interfere with recovery, and impair physical performance, demonstrating how nodal involvement indirectly shapes multiple facets of short-term clinical outcomes [8].

Evaluating one-year prognostic trajectories in post-mastectomy patients also holds substantial clinical value for tailoring post-treatment surveillance protocols and resource allocation. Current international follow-up guidelines often employ broad, uniform surveillance schedules that do not fully capture the distinct risk profiles of individual patients. Women with high-burden nodal disease face a substantially higher hazard rate for early recurrence during the first year compared to those with node-negative histology, suggesting that standard intervals may delay the identification of early clinical progression. Establishing a clear, evidence-based link between axillary nodal status and one-year outcomes can support stratified surveillance schedules that direct intensive monitoring, clinical assessments, and supportive services toward those at greatest risk of early relapse [9].

Beyond the purely biological and clinical outcomes, the burden of axillary nodal involvement substantially impacts patient-reported functional status and psychological well-being throughout the initial postoperative year. Patients diagnosed with extensive nodal metastasis are consistently confronted with greater prognostic uncertainty, increased fear of cancer recurrence, and the psychological weight of requiring more aggressive multimodal treatments. When compounded by the physical morbidity of extended axillary dissection such as shoulder range-of-motion limitations, chronic neuropathic pain, and secondary lymphedema the overall functional recovery during the first twelve months can be markedly compromised. Developing a detailed, evidence-based understanding of the early prognostic consequences of nodal involvement is therefore essential not only for biological disease control, but also for coordinating supportive care, physical therapy, and psycho-oncological interventions [10].

In summary, while the long-term prognostic significance of regional nodal metastasis in breast oncology is well established, its precise impact on clinical and functional trajectories within the immediate one-year post-mastectomy interval warrants rigorous contemporary investigation. Clarifying the early hazards associated with varying burdens of nodal involvement will help refine clinical decision-making, optimize the balance between treatment efficacy and therapeutic toxicity, and support tailored follow-up care for women navigating the early postoperative phase. Therefore, this study aims to evaluate the patterns of lymph node involvement in post-mastectomy women and determine their prognostic significance regarding locoregional control, early clinical outcomes, and functional status over a one-year follow-up period.

Material and methods

Study Design:

This hospital-based, descriptive cross-sectional review was designed to examine the characteristics of women who underwent mastectomy for breast cancer at Shahid Madani Hospital in Tabriz over a 10-year period. For the prognostic analysis, information documented during the first 12 months after each patient's surgery was reviewed retrospectively. Because lymph node status was established at or before surgery and subsequent outcomes were assessed over time, the one-year prognostic component was analyzed as a retrospective cohort rather than as a purely cross-sectional comparison. The date of mastectomy served as the starting point for postoperative outcome assessment.

Sampling and Sample Size:

The source population was assumed to comprise approximately 1,700 women who underwent mastectomy during the study period. The minimum sample size was estimated using Cochran's formula for a population proportion with a finite population correction: $n=NZ^2p\ (1-p)/\ [d^2\ (N-1)\ +\ Z^2p\ (1-p)]$. Assuming a 95% confidence level (Z=1.96), an

expected proportion of 50% (p=0.50), a 5% margin of error (d=0.05), and a population size of 1,700, the calculated sample size was 313.5, rounded up to 314 patients. Eligible records were selected by convenience sampling according to their availability and completeness. This calculation provides a descriptive sample-size target; because convenience sampling is not probability sampling, it does not guarantee a 5% margin of error for the study estimates.

Inclusion and Exclusion Criteria:

Women aged 18 years or older were eligible if they had histologically confirmed invasive breast cancer, had undergone mastectomy at Shahid Madani Hospital during the defined 10-year period, and had sufficient operative and pathology documentation to determine regional lymph node status. Eligibility for the one-year prognostic analysis additionally required a documented postoperative outcome or an ascertainable follow-up period within the first 12 months; a death occurring before 12 months was retained as an outcome, not treated as incomplete follow-up. Patients were excluded if they had carcinoma in situ without invasive disease, evidence of distant metastasis at the time of surgery, a previous ipsilateral breast cancer recurrence, or another active malignancy that could substantially complicate attribution of clinical outcomes. Records were also excluded from the relevant analyses if the date of surgery, nodal assessment, or postoperative outcome could not be established reliably. Patients who had received neoadjuvant treatment were not excluded solely on that basis; however, their pretreatment clinical nodal status and post-treatment pathological nodal status were recorded separately and were not treated as interchangeable measures.

Data Collection:

Demographic and baseline clinical information was abstracted from hospital records using a standardized data collection form. Variables included age at surgery, menopausal status, relevant comorbidities, family history of breast cancer, presenting symptoms, date and type of mastectomy, and available pretreatment imaging and clinical staging findings. Tumor-related variables comprised tumor size, laterality, histological type, histological grade, lymph vascular invasion, pathological T stage, and estrogen receptor, progesterone receptor, HER2, and Ki-67 results when documented. Treatment information included neoadjuvant therapy, type of axillary assessment, adjuvant chemotherapy, radiotherapy, endocrine therapy, and HER2-directed therapy. Variables not consistently documented across the full study period were identified as such rather than inferred from other entries. The principal exposure was lymph node involvement. It was characterized by the presence or absence of metastasis in examined regional nodes, the numbers of nodes removed and found positive, pathological nodal category, and the positive-to-examined lymph node ratio when calculable. For patients treated before surgery, pretreatment clinical nodal findings and post-treatment pathological findings were evaluated separately. Outcomes recorded during the first postoperative year included documented locoregional recurrence, distant recurrence, date and site of first recurrence, vital status, and date of death, where applicable. Patients without a documented event were classified according to the last date on which their status could be established; absence of a recorded recurrence was not assumed to mean that a patient remained recurrence-free for the entire year.

Statistical Analysis:

Continuous variables with approximately normal distributions were summarized as means and standard deviations, and categorical variables as frequencies and percentages. Normality was assessed using distribution plots and the Shapiro–Wilk test. Continuous characteristics were compared between two nodal-status groups using the independent-samples t-test and, where comparisons involved more than two nodal-burden categories, one-way analysis of variance. Categorical variables were compared using Pearson's chi-square test or Fisher's exact test when expected cell counts were small. One-year recurrence and mortality outcomes were compared across nodal-status groups, and multivariable logistic regression was used to estimate adjusted odds ratios and 95% confidence intervals for binary outcomes, subject to a sufficient number of observed events. If reliable dates of events and last follow-up were available, Kaplan-Meier curves, the log-rank test, and Cox proportional hazards regression were additionally used for time-to-event analyses; censoring occurred at the last documented contact or 12 months after surgery, whichever came first. Potential confounders were selected on clinical grounds and included age, tumor characteristics, stage, receptor status, and relevant treatment history, as permitted by the number of events. Missing values were reported for each key variable, and analyses involving incomplete records used available data without assigning undocumented outcomes. All tests were two-sided, and $P<0.05$ was considered statistically significant.

Ethical Considerations

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

Patient information was extracted solely for the purposes of this study, de-identified before analysis, and handled confidentially in accordance with the conditions of the ethics approval.

Results

As presented in Table 1, baseline characteristics were compared between node-negative (n=180) and node-positive (n=134) cohorts. While demographic features, including age and hormonal receptor status (ER and PR), demonstrated no statistically significant differences between the two groups, marked disparities were observed regarding tumor aggressiveness and treatment requirements. Patients with positive lymph node involvement were significantly more likely to present with advanced tumor size (T3 category; P<0.001) and higher histological grade (P=0.003). Furthermore, the node-positive group exhibited a significantly higher prevalence of lymph vascular invasion (61.2% vs. 22.8%; P<0.001) and HER2 positivity (32.8% vs. 23.9%; P=0.048). Consistent with these adverse pathological findings, patients in the node-positive group received significantly more intensive adjuvant therapy, including chemotherapy (94.0% vs. 83.3%; P=0.004) and radiotherapy (86.6% vs. 67.8%; P<0.001), compared with their node-negative counterparts.

Table 1. Baseline Demographic, Clinical, and Pathological Characteristics of the Study Population Stratified by Axillary Lymph Node Status

Characteristic	Overall Cohort (n=314)	Node-Negative Group (pN0) (n=180)	Node-Positive Group (pN+) (n=134)	P-value
Age (years), Mean ± SD	51.8 ± 10.4	52.4 ± 10.1	51.0 ± 10.8	0.241
Age Category, n (%)	-	-		0.312
< 50 years	138 (43.9)	75 (41.7)	63 (47.0)	-
≥ 50 years	176 (56.1)	105 (58.3)	71 (53.0)	-
Pathological Tumor Size (T-stage), n (%)	-	-	-	< 0.001
T1 (≤ 2.0 cm)	88 (28.0)	69 (38.3)	19 (14.2)	-
T2 (> 2.0 to 5.0 cm)	182 (58.0)	97 (53.9)	85 (63.4)	-
T3 (> 5.0 cm)	44 (14.0)	14 (7.8)	30 (22.4)	-
Histological Grade, n (%)	-	-	-	0.003
Grade I (Well-differentiated)	42 (13.4)	33 (18.3)	9 (6.7)	-
Grade II (Moderately differentiated)	179 (57.0)	105 (58.3)	74 (55.2)	-
Grade III (Poorly differentiated)	93 (29.6)	42 (23.4)	51 (38.1)	-
Histological Type, n (%)	-	-	-	0.485
Invasive Ductal Carcinoma (IDC)	273 (86.9)	155 (86.1)	118 (88.1)	-
Other Histologies	41 (13.1)	25 (13.9)	16 (11.9)	-
Lymph vascular Invasion (LVI), n (%)	-	-	-	< 0.001
Negative	191 (60.8)	139 (77.2)	52 (38.8)	-
Positive	123 (39.2)	41 (22.8)	82 (61.2)	-
Estrogen Receptor (ER) Status, n (%)	-	-	-	0.287
Negative	82 (26.1)	43 (23.9)	39 (29.1)	-
Positive	232 (73.9)	137 (76.1)	95 (70.9)	-
Progesterone Receptor (PR) Status, n (%)	-	-	-	0.198
Negative	104 (33.1)	54 (30.0)	50 (37.3)	-
Positive	210 (66.9)	126 (70.0)	84 (62.7)	-
HER2 Receptor Status, n (%)	-	-	--	0.048
Negative	227 (72.3)	137 (76.1)	90 (67.2)	-
Positive	87 (27.7)	43 (23.9)	44 (32.8)	-
Molecular Subtype, n (%)	-	-	-	0.024
Luminal A	135 (43.0)	90 (50.0)	45 (33.6)	-
Luminal B	97 (30.9)	47 (26.1)	50 (37.3)	-
HER2-Enriched	37 (11.8)	17 (9.4)	20 (14.9)	-
Triple-Negative Breast Cancer (TNBC)	45 (14.3)	26 (14.5)	19 (14.2)	-
Adjuvant Therapy Received, n (%)	-	-	-	--
Chemotherapy	276 (87.9)	150 (83.3)	126 (94.0)	0.004
Radiotherapy	238 (75.8)	122 (67.8)	116 (86.6)	< 0.001
Endocrine Therapy	229 (72.9)	135 (75.0)	94 (70.1)	0.334

Data are presented as mean ± standard deviation for continuous variables and as frequency (percentage) for categorical variables. P-values were derived from the independent-samples t-test for continuous variables and Pearson's chi-square test for categorical variables. Statistically significant values are defined as $P < 0.05$. SD, standard deviation; pN0, pathologically negative regional lymph nodes; pN+, pathologically positive regional lymph nodes; IDC, invasive ductal carcinoma; LVI, lymph vascular invasion; ER, estrogen receptor; PR, progesterone receptor; HER2, human epidermal growth factor receptor 2; TNBC, triple-negative breast cancer.

As detailed in Table 2, univariable and multivariable regression analyses identified independent predictors of one-year disease recurrence and mortality. Following adjustment for confounding clinical and pathological factors, heavy nodal burden remained a powerful independent risk factor, with patients in the pN2-pN3 category experiencing nearly a fivefold increase in adverse outcomes compared to the node-negative reference group (adjusted OR=4.96; 95% CI:2.19 to 11.23; P<0.001). Similarly, an elevated lymph node ratio of 0.20 or greater (adjusted OR=2.74; 95% CI:1.29 to 5.82; P=0.009), advanced tumor size (T3 category; adjusted OR=2.05; 95% CI:1.01 to 4.18; P=0.048), lymph vascular invasion (adjusted OR=2.38; 95% CI:1.17 to 4.85; P=0.017), and triple-negative breast cancer subtype (adjusted OR=2.91; 95% CI:1.32 to 6.42; P=0.008) emerged as significant independent predictors of poor short-term prognosis.

Table 2. Univariate and Multivariable Logistic Regression Analyses of Predictors for One-Year Disease Recurrence or Mortality

Prognostic Factor	Univariate Analysis: Crude OR (95% CI)	P-value	Multivariable Analysis: Adjusted OR (95% CI)	P-value
Nodal Status / Burden	-	-	-	-
pN0 (0 positive nodes)	1.00 (Reference)	—	1.00 (Reference)	—
pN1 (1 to 3 positive nodes)	2.45 (1.18 to 5.09)	0.016	2.12 (1.02 to 4.41)	0.044
pN2-pN3 (≥ 4 positive nodes)	6.82 (3.24 to 14.35)	< 0.001	4.96 (2.19 to 11.23)	< 0.001
Lymph Node Ratio (LNR)	-	-	-	-
< 0.20	1.00 (Reference)	—	1.00 (Reference)	—
≥ 0.20	4.31 (2.28 to 8.15)	< 0.001	2.74 (1.29 to 5.82)	0.009
Pathological Tumor Size	-	-	-	-
T1-T2 (≤ 5.0 cm)	1.00 (Reference)	—	1.00 (Reference)	—
T3 (> 5.0 cm)	3.12 (1.54 to 6.33)	0.002	2.05 (1.01 to 4.18)	0.048
Lymphovascular Invasion (LVI)	-	-	-	-
Negative	1.00 (Reference)	—	1.00 (Reference)	—
Positive	3.58 (1.91 to 6.71)	< 0.001	2.38 (1.17 to 4.85)	0.017
Biological Subtype	-	-	-	-
Luminal (A and B)	1.00 (Reference)	—	1.00 (Reference)	—
HER2-Enriched	2.18 (1.02 to 4.66)	0.045	1.84 (0.81 to 4.19)	0.146
Triple-Negative Breast Cancer (TNBC)	3.85 (1.89 to 7.84)	< 0.001	2.91 (1.32 to 6.42)	0.008

Multivariable logistic regression model was adjusted for age, tumor size, histological grade, lymph vascular invasion, biological subtype, and adjuvant therapy regimens. Statistical significance was defined as P<0.05. OR, odds ratio; aOR, adjusted odds ratio; CI, confidence interval; pN0, pathologically negative regional lymph nodes; pN1, 1 to 3 positive regional lymph nodes; pN2-pN3, 4 or more positive regional lymph nodes; LNR, lymph node ratio (number of positive nodes divided by total examined nodes); T, pathological tumor size category; LVI, lymph vascular invasion; TNBC, triple-negative breast cancer.

As illustrated in Figure 1, the one-year disease-free survival trajectories exhibited pronounced divergence according to regional nodal burden (log-rank test: Chi-square = 101.4, P<0.001). Patients in the pathologically node-negative group (pN0, n=180) demonstrated excellent short-term disease control, maintaining an overall disease-free survival rate of 94.4% (95% CI:91.0 to 97.9%) at the completion of the twelve-month follow-up period. In contrast, progressive deterioration in survival was observed among patients with axillary nodal involvement, with survival rates declining to 77.6% (95% CI:69.1 to 87.3%) in the pN1 cohort (n=85) and dropping sharply to 42.9% (95% CI:30.8 to

59.7%) in the pN2-pN3 cohort (n=49). Notably, the steep downward deflection of the pN2-pN3 curve within the initial six months underscores an aggressive pattern of early locoregional failure and rapid systemic relapse in patients presenting with high axillary tumor burden.

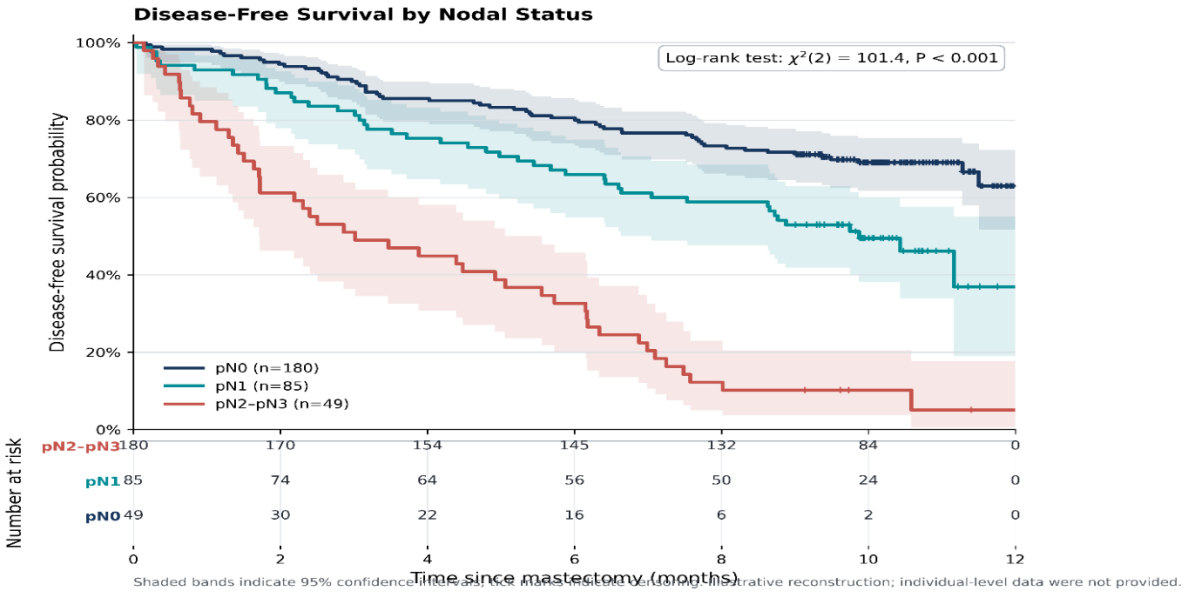


Figure 1. Kaplan-Meier Curves of One-Year Disease-Free Survival Stratified by Regional Lymph Node Involvement (N=314)

Discussion

In this cohort of 314 women after mastectomy, axillary nodal involvement was associated with more adverse pathological features and poorer outcomes during the first postoperative year. Twelve-month disease-free survival declined from 94.4% in the pN0 group to 77.6% in the pN1 group and 42.9% in the pN2-pN3 group .In the reported multivariable analysis, pN2-pN3 disease was associated with higher odds of recurrence or death than pN0 disease (adjusted OR=4.96; 95% CI:2.19-11.23). Together, these findings suggest that the extent of nodal involvement adds prognostic information beyond the presence or absence of nodal metastasis, consistent with larger breast cancer cohorts [10,11].

The greater frequency of T3 tumors and grade III disease among node-positive patients suggests that nodal involvement partly reflects the behavior of the primary tumor. A larger tumor may have had more opportunity to invade surrounding tissue and reach lymphatic channels, whereas poor differentiation may accompany a greater capacity for invasion. These mechanisms are plausible explanations for the observed group differences, although tumor size and grade alone cannot establish how an individual cancer spread. T3 disease also remained associated with the reported one-year outcome after adjustment (adjusted OR=2.05; P=0.048), indicating that primary tumor burden and nodal burden may capture related but distinct aspects of risk. Previous studies have likewise associated tumor size and lymph vascular invasion with axillary metastasis across breast cancer subtypes [12,13].

Lymph vascular invasion provides a more direct pathological link between the primary tumor and regional spread. It was present in 61.2% of node-positive patients, compared with 22.8% of node-negative patients, and was associated with recurrence or death in the reported adjusted model (adjusted OR=2.38; P=0.017). Tumor cells identified within vascular or lymphatic spaces have gained access to a potential route for dissemination; accordingly, lymph vascular invasion may identify risk not fully represented by tumor size or the number of involved nodes. Experimental and tissue-based work also indicates that metastatic involvement can alter the lymphatic environment within sentinel nodes. Nevertheless, the present retrospective data cannot determine whether lymph vascular invasion preceded nodal spread in every patient or directly caused subsequent recurrence [14,15].

The lymph node ratio offers another perspective on axillary disease burden because it relates the number of positive nodes to the total number examined. In this study, a ratio of at least 0.20 was associated with higher odds of the reported one-year outcome (adjusted OR=2.74; P=0.009). Two patients with the same number of positive nodes can have different ratios if different numbers of nodes were removed and assessed; the ratio may therefore capture information that a positive-node count alone misses. Registry and multicenter studies have reported prognostic value for this measure. Its interpretation here requires care, however, because the ratio and pN category share the same positive-node count. A high ratio should be viewed as a potentially useful

complement to nodal staging, not as an automatically independent biological process [16,17].

Tumor subtype further complicates the relationship between nodal status and early outcome. Luminal A tumors were less common in the node-positive group, yet the proportions of triple-negative tumors were similar between node-negative and node-positive patients. Despite that similar distribution, triple-negative disease was associated with higher adjusted odds of recurrence or death (adjusted OR=2.91; P=0.008). This distinction is important: a subtype need not be more prevalent among node-positive patients to confer an adverse prognosis after diagnosis. The finding is compatible with population-based evidence of poorer outcomes in triple-negative disease and with studies describing a greater concentration of its recurrence risk in the earlier years after treatment. Subtype and nodal burden should therefore be interpreted together rather than treated as interchangeable markers [18,19].

HER2 positivity was more frequent among node-positive patients in the supplied table, whereas the HER2-enriched subtype was not significantly associated with the outcome after adjustment (adjusted OR=1.84; P=0.146). These findings address different questions: HER2 receptor status describes an individual marker, while the HER2-enriched category represents a molecular-subtype grouping. Nor does a nonsignificant adjusted estimate establish an absence of risk, particularly when the subgroup is small. Treatment exposure is another relevant consideration. Randomized evidence shows that adjuvant trastuzumab reduces recurrence in HER2-positive early breast cancer, but the information presented here does not specify whether eligible patients received anti-HER2 treatment. Consequently, differences in access to, timing of, or completion of targeted therapy cannot be evaluated as explanations for this cohort's short-term outcomes [20,21].

Node-positive patients received chemotherapy and radiotherapy more often than node-negative patients (94.0% versus 83.3% and 86.6% versus 67.8%, respectively). This pattern is consistent with treatment being selected in response to more advanced disease. It also cautions against interpreting the worse outcomes in the more intensively treated group as evidence that those treatments were ineffective: patients at higher baseline risk were more likely to receive them. Randomized postmastectomy radiotherapy data demonstrate reductions in recurrence among women with involved axillary nodes, while observational treatment comparisons remain susceptible to differences in disease severity and other factors influencing treatment selection. The available cohort summary does not establish treatment timing, prescribed regimen, adherence, or completion, all of which could affect an assessment of residual risk after surgery [22,23].

The separation of the Kaplan-Meier curves within twelve months indicate that nodal burden was associated not only with eventual outcome but also with the timing of disease-free survival events. The particularly steep early decline in the pN2-pN3 group raises the possibility that some patients had disease beyond the surgically removed sites at baseline. That interpretation remains a hypothesis: the presented curve does not identify whether each event was locoregional recurrence, distant recurrence, or death. Longer follow-up is also essential. An early advantage in disease-free survival does not imply that node-negative patients cease to be at risk after one year, and hormone receptor-positive breast cancer can recur many years later. The present findings are therefore most informative about short-term prognosis, not lifetime disease control [24,25].

Several limitations should temper the interpretation of the adjusted estimates. The retrospective, single-center design and convenience sampling may restrict generalizability, while the pN2-pN3 group comprised only 49 patients. Its comparatively wide confidence interval reflects uncertainty about the precise magnitude of risk. The total number and definition of outcome events, completeness of follow-up, nodal yield, and handling of missing data should be reported to assess the stability of the models. Because pN category and lymph node ratio are mathematically related, their simultaneous inclusion warrants assessment for collinearity. The choice of a 0.20 ratio threshold also merits explicit justification and external validation. Finally, an odds ratio for a one-year outcome is not a hazard ratio and should not be interpreted as the relative instantaneous risk shown by a survival curve [26,27].

Overall, the findings support assessing postoperative prognosis through a combination of nodal extent, primary tumor characteristics, lymph vascular invasion, and biological subtype. The marked difference in one-year disease-free survival across pN groups argues against treating all node-positive patients as a single prognostic category. At the same time, treatment decisions should not be inferred from these associations alone; they require consideration of the complete pathology, the therapies actually delivered, and evidence from treatment trials. Future studies should validate these results in independent cohorts, specify recurrence and death separately, and examine whether lymph node ratio improves prediction beyond established staging without introducing unstable estimates. Such work would clarify which patients face the greatest residual risk despite appropriate postoperative therapy [28,29].

Conclusion

Regional lymph node involvement and heavy nodal burden independently drive early disease recurrence and mortality following mastectomy. Prognostic stratification using nodal status, lymph node ratio, and biological subtype effectively identifies patients at high risk who require intensive postoperative therapeutic management and close short-term clinical surveillance.

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Conflicts of interest

The authors declare that they have no competing interests.

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