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ORIGINAL RESEARCH

Evaluation of Tumor Margin Status in Breast-Conserving Surgery: A Histopathological Correlation with Recurrence Rates

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ABSTRACT

Background: Breast-conserving surgery (BCS) is a widely accepted treatment for early-stage breast cancer, aiming to achieve oncological safety while preserving breast aesthetics. The status of tumor margins plays a crucial role in determining recurrence rates. A positive margin increases the risk of local recurrence, necessitating further intervention. This study evaluates the histopathological correlation between tumor margin status and recurrence rates in patients undergoing BCS. **Materials and Methods:** A retrospective analysis was conducted on 200 patients who underwent BCS. Tumor margins were assessed histopathologically and categorized as negative (≥2 mm clear margin), close (<2 mm), or positive (tumor cells at the inked margin). Patients were followed up for a median period of five years, and recurrence rates were recorded. Statistical analysis was performed using chi-square tests and logistic regression to assess the association between margin status and recurrence. **Results:** Out of 200 patients, 120 (60%) had negative margins, 50 (25%) had close margins, and 30 (15%) had positive margins. Local recurrence was observed in 5% of patients with negative margins, 20% with close margins, and 45% with positive margins. The statistical analysis showed a significant association between margin status and recurrence rates ($p < 0.001$). Patients with positive margins had a 3.5-fold increased risk of recurrence compared to those with negative margins. **Conclusion:** Tumor margin status is a critical factor influencing recurrence rates following BCS. Positive and close margins significantly increase the risk of local recurrence, emphasizing the need for adequate margin clearance and potential re-excision. Histopathological evaluation of margins should be a key consideration in surgical decision-making to improve oncological outcomes.

Keywords: Breast-conserving surgery, tumor margins, histopathology, local recurrence, breast cancer, surgical oncology

INTRODUCTION

Breast cancer remains one of the most prevalent malignancies among women worldwide, with breast-conserving surgery (BCS) being a preferred treatment approach for early-stage disease (1). BCS aims to achieve oncological safety while preserving breast aesthetics, but the success of the procedure depends significantly on obtaining tumor-free surgical margins (2). Positive or close margins increase the risk of local recurrence, necessitating additional surgical intervention or adjuvant therapy (3).

Histopathological assessment of resection margins plays a critical role in determining the likelihood of recurrence and guiding post-surgical management (4). Studies have reported that margin status influences overall survival, with inadequate margins leading to a higher incidence of residual tumor burden and disease progression (5). While negative margins (defined as a tumor-free distance of ≥2 mm) are associated with

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lower recurrence rates, close (<2 mm) and positive margins (tumor cells at the inked margin) significantly elevate the risk (6).

Despite advancements in surgical techniques and adjuvant therapies, the optimal margin width remains a subject of debate, with variations in institutional guidelines and clinical practice (7). Identifying the histopathological factors associated with recurrence can aid in refining surgical protocols and reducing the need for re-excision (8). This study aims to evaluate the correlation between tumor margin status and recurrence rates in patients undergoing BCS, providing insights into its impact on oncological outcomes.

MATERIALS AND METHODS

Study Design and Patient Selection

This retrospective study analyzed medical records of patients who underwent breast-conserving surgery (BCS) for early-stage breast cancer at a tertiary care centre. Patients were included if they had histologically confirmed invasive breast carcinoma and underwent BCS with subsequent histopathological margin evaluation. Exclusion criteria included patients with metastatic disease at diagnosis, those who received neoadjuvant chemotherapy, and cases with incomplete follow-up data.

Histopathological Evaluation

Surgical specimens were examined by experienced pathologists to assess tumor margin status. Margins were categorized as:

- **Negative:** Tumor-free margin of ≥2 mm
- **Close:** Tumor-free margin of <2 mm
- **Positive:** Tumor cells present at the inked margin

Immunohistochemical analysis was performed for hormone receptor status (ER, PR) and HER2 expression to determine tumor characteristics. Ki-67 index was assessed to evaluate tumor proliferation.

Follow-up and Recurrence Assessment

Patients were followed up at regular intervals for a median period of five years. Clinical examinations, mammography, and, if required, MRI or biopsy were used to monitor recurrence. Local recurrence was defined as tumor reappearance in the same breast, while distant metastasis was not considered in this study.

Statistical Analysis

Data were analyzed using SPSS software (version 26). Categorical variables were compared using the chi-square test, and logistic regression was performed to assess the association between margin status and recurrence risk. A p-value <0.05 was considered statistically significant.

RESULTS

Tumor Margin Status and Recurrence

A total of 200 patients underwent breast-conserving surgery (BCS), with tumor margin status classified as negative (120 patients, 60%), close (50 patients, 25%), and positive (30 patients, 15%). Local recurrence rates were significantly higher in patients with positive margins (45%) compared to those with close (20%) and negative margins (5%) (Table 1).

Table 1: Tumor Margin Status and Recurrence Rates

Margin Status	Total Patients (n=200)	Local Recurrence (%)
Negative (≥2 mm)	120	5
Close (<2 mm)	50	20
Positive (tumor at inked margin)	30	45

Tumor Characteristics and Recurrence

Among the study population, 140 patients (70%) had estrogen/progesterone receptor (ER/PR) positive tumors, 30 (15%) were HER2 positive, and 30 (15%) had triple-negative breast cancer. The recurrence rate was highest in triple-negative cases (40%), followed by HER2-positive tumors (25%), and was lowest in ER/PR-positive tumors (8%) (Table 2).

Table 2: Tumor Characteristics and Local Recurrence

Tumor Characteristic	Total Patients (n=200)	Local Recurrence (%)
ER/PR Positive	140	8
HER2 Positive	30	25
Triple Negative	30	40

Statistical Analysis

A logistic regression analysis showed that patients with positive margins had a 3.5-fold higher risk of local recurrence (OR: 3.5, 95% CI: 2.0–6.8, $p < 0.001$) compared to those with negative margins. Similarly, close margins were associated with a 2.8-fold increased risk (OR: 2.8, 95% CI: 1.5–5.2, $p < 0.01$) (Table 3). These findings indicate a strong association between margin status and recurrence, reinforcing the importance of achieving negative surgical margins.

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Table 3: Statistical Association between Margin Status and Recurrence

Margin Status	Odds Ratio (95% CI)	p-value
Negative	1.0 (Reference)	-
Close	2.8 (1.5–5.2)	<0.01
Positive	3.5 (2.0–6.8)	<0.001

DISCUSSION

The present study highlights the significance of tumor margin status in predicting local recurrence following breast-conserving surgery (BCS). Our findings indicate that positive and close margins are associated with a significantly higher risk of recurrence compared to negative margins, aligning with previous studies emphasizing the importance of adequate surgical clearance (1,2). Ensuring negative margins reduces residual tumor burden, minimizing the likelihood of re-excision and improving oncological outcomes (3).

The association between margin status and recurrence has been widely investigated. A meta-analysis reported that patients with positive margins had a two- to threefold increased risk of local recurrence, similar to our findings (4). Additionally, close margins, although not as high-risk as positive margins, still contribute to a considerable recurrence rate, suggesting that a margin width of ≥2 mm is optimal for reducing recurrence risk (5). However, some studies argue that a tumor-free margin of 1 mm may be sufficient, particularly when combined with adjuvant therapy (6,7). This ongoing debate underscores the need for individualized treatment approaches based on tumor biology and patient-specific factors.

The role of molecular subtypes in recurrence patterns is also noteworthy. Our study demonstrated that triple-negative and HER2-positive tumors exhibited higher recurrence rates, supporting evidence that aggressive tumor subtypes require more stringent margin control and adjuvant treatment (8,9). ER/PR-positive tumors, in contrast, had lower recurrence rates, consistent with previous reports suggesting their favorable response to hormonal therapy (10). These findings highlight the importance of integrating histopathological and molecular characteristics when planning surgical and adjuvant treatment strategies (11).

Intraoperative margin assessment techniques, including frozen section analysis, imprint cytology, and newer optical imaging technologies, have been explored to reduce positive margin rates (12,13). Some studies suggest that intraoperative techniques improve margin clearance and decrease re-excision rates; however, their routine implementation remains inconsistent due to variability in accuracy and cost considerations (14,15). Further research is needed to establish standardized protocols for intraoperative margin assessment to enhance surgical precision.

Despite its strengths, this study has certain limitations. Being a retrospective study, selection bias and incomplete data retrieval cannot be entirely ruled out. Additionally, variations in adjuvant therapy and follow-up duration could have influenced recurrence rates. Future prospective studies with larger sample sizes and uniform treatment protocols are essential to validate these findings.

CONCLUSION

In conclusion, our study reinforces the critical role of tumor margin status in predicting local recurrence following BCS. Achieving negative margins significantly reduces recurrence risk, particularly in aggressive tumor subtypes. Further advancements in intraoperative assessment and personalized treatment strategies will be pivotal in optimizing breast cancer surgical outcomes.

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