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Association Between Progesterone Receptor Expression and the Incidence of Acute Postoperative Complications Following Lumpectomy

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ABSTRACT

Introduction: Lumpectomy is a standard breast-conserving procedure, yet acute postoperative complications may delay recovery and adjuvant treatment. Beyond clinical risk factors, tumor biology may influence wound healing and inflammatory responses. This study aimed to evaluate the association between progesterone receptor expression and the incidence of acute postoperative complications following lumpectomy.

Material and methods: This descriptive cross-sectional study was conducted at Tabriz University of Medical Sciences in 2025 on 54 women undergoing lumpectomy, with sample size estimated using the Cochran formula and participants enrolled by convenience sampling. Progesterone receptor expression was assessed by immunohistochemistry on surgical specimens, and its association with acute postoperative complications was analyzed alongside demographic, clinical, pathological, and perioperative variables using appropriate statistical tests.

Results: Results summary: Among 54 patients undergoing lumpectomy, PR-negative status was associated with poorer early postoperative outcomes. Compared with PR-positive patients, PR-negative patients had higher postoperative VAS scores (4.06 ± 1.43 vs. 3.14 ± 1.21; p=0.017), more acute complications (50.00% vs. 22.22%; p=0.037), and more unplanned visits (33.33% vs. 11.11%; p=0.048). PR negativity independently predicted complications after adjustment (OR=3.84; p=0.039).

Conclusion: PR-negative status was associated with a higher risk of acute postoperative complications after lumpectomy. Despite broadly comparable operative variables, PR-negative patients experienced greater postoperative morbidity and more unplanned visits, suggesting that receptor status may help identify patients requiring closer early postoperative monitoring.

Introduction

Lumpectomy has become a cornerstone of breast-conserving therapy for women with early-stage breast cancer, offering oncologic safety comparable to mastectomy in appropriately selected patients while preserving breast shape and improving quality of life. As surgical management has evolved toward less invasive yet highly individualized treatment, increasing attention has directed not only to long-term survival and local recurrence but also to immediate postoperative outcomes that influence recovery, patient satisfaction, cosmetic results, and

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the timely initiation of adjuvant therapy. Acute postoperative complications following lumpectomy, although often considered less severe than those associated with more extensive breast surgery, remain clinically important because they may prolong hospitalization, increase pain, raise infection risk, and disrupt multidisciplinary cancer care pathways [1].

The occurrence of acute postoperative complications after lumpectomy is influenced by a complex interplay of patient-related, tumor-related, and treatment-related factors. Age, body mass index, smoking status, diabetes mellitus, nutritional condition, immune competence, prior breast interventions, and perioperative medication exposure may all alter tissue healing and inflammatory responses in the immediate postoperative period. At the same time, tumor biology itself may affect the local microenvironment through differences in angiogenesis, stromal remodeling, proliferation rate, and hormone responsiveness. These observations have encouraged investigators to examine whether biological markers routinely measured for oncologic stratification may also provide insight into short-term surgical morbidity [2].

Among the molecular biomarkers used in breast cancer characterization, hormone receptor status remains one of the most clinically relevant. Estrogen receptor and progesterone receptor expression are integral to modern pathological assessment because they help define tumor subtype, guide systemic therapy selection, and contribute to prognostic estimation. In particular, progesterone receptor expression is often interpreted as a marker of an intact and functionally responsive estrogen signaling pathway, though it may also carry independent biological significance. Because progesterone receptor status is already available in routine pathology reports, any association between its expression and early postoperative complications could have immediate practical relevance for perioperative risk stratification without requiring additional testing [3].

Progesterone receptor biology in breast tissue is multifaceted and extends beyond its role as a passive indicator of endocrine sensitivity. The receptor participates in transcriptional regulation, epithelial differentiation, cell-cycle control, and interactions with growth factor signaling networks. Experimental evidence suggests that progesterone-related pathways may influence stromal behavior, extracellular matrix composition, inflammatory mediator expression, and vascular dynamics within the tumor microenvironment. These mechanisms raise the possibility that progesterone receptor expression could be linked, directly or indirectly, to postoperative tissue responses such as edema, seroma formation, inflammatory pain, delayed healing, or susceptibility to local wound complications after breast-conserving surgery [4].

In clinical practice, lumpectomy is generally regarded as a safe procedure with relatively low perioperative mortality and acceptable morbidity. Nevertheless, complications such as hematoma, seroma, wound infection, postoperative pain, ecchymosis, fat necrosis, skin ischemia, and delayed incision healing are not uncommon, especially in patients requiring axillary intervention, re-excision, or adjuvant radiotherapy planning. Even when these events are classified as minor, they may necessitate repeated clinic visits, aspiration procedures, antibiotic therapy, or surgical revision. Such complications can negatively affect cosmetic outcomes and psychological well-being in patients who often choose breast conservation in part to preserve body image and minimize treatment burden [5].

The prediction of postoperative complications in breast surgery has traditionally relied on conventional clinical variables rather than tumor molecular features. Several studies have identified obesity, smoking, older age, diabetes, large breast volume, prolonged operative time, and combined procedures as determinants of early morbidity. However, these models do not fully explain the heterogeneity of postoperative recovery, and many patients with similar demographic and procedural characteristics experience markedly different clinical courses. This gap suggests that intrinsic biological features of the tumor and surrounding tissue may modulate perioperative responses in ways that are not captured by standard surgical risk factors alone [6].

Breast tumors classified according to hormone receptor expression often differ substantially in proliferation patterns, stromal organization, vascular density, and immune cell infiltration. Progesterone receptor-negative tumors, particularly when associated with more aggressive molecular phenotypes, may display higher proliferative activity, greater genomic instability, and altered crosstalk with inflammatory pathways. Conversely, progesterone receptor-positive tumors are often associated with more differentiated biology and a distinct microenvironmental profile. While these differences have been extensively studied in relation to prognosis and treatment response, their relevance to immediate postsurgical healing and complication risk remains insufficiently explored, despite plausible mechanistic links [7].

Inflammation is central to wound repair, but excessive or dysregulated inflammation may contribute to pain, tissue breakdown, fluid collection, and infection. Surgical trauma initiates a cascade involving cytokine release, leukocyte

recruitment, coagulation activation, and matrix remodeling. Tumor-associated biological characteristics may shape this perioperative inflammatory response before and after excision. If progesterone receptor expression is associated with specific inflammatory signatures or stromal behaviors, it may influence the balance between effective healing and pathological postoperative reactions. This possibility is especially relevant in breast surgery, where soft tissue healing and local fluid dynamics play a major role in short-term outcomes [8].

Another important consideration is the growing emphasis on personalized perioperative medicine in oncologic surgery. Contemporary breast cancer care increasingly integrates molecular pathology into decisions regarding chemotherapy, endocrine therapy, and targeted treatment. Extending this precision-based approach to the perioperative period may improve patient counseling, complication surveillance, and resource allocation. If progesterone receptor status were shown to correlate with acute postoperative morbidity, surgeons and perioperative teams could potentially identify higher-risk patients earlier, tailor postoperative monitoring, and intervene proactively to reduce preventable adverse events following lumpectomy [9].

The available literature on biological predictors of postoperative outcomes in breast-conserving surgery remains limited and fragmented. Most published studies have focused on long-term oncologic endpoints, local control, recurrence patterns, or systemic treatment responsiveness rather than acute surgical morbidity. When postoperative complications have been analyzed, biomarker evaluation has often been secondary, inconsistent, or restricted to broad molecular subtypes. As a result, the specific role of progesterone receptor expression in shaping the early postoperative course after lumpectomy has not been clearly defined. This lack of focused evidence highlights an important gap in the current understanding of how tumor biology intersects with surgical recovery [10].

The question is clinically meaningful because postoperative complications may have consequences extending beyond the immediate recovery window. Delayed wound healing or infectious events can postpone adjuvant radiotherapy or systemic treatment, which may in turn affect overall treatment timelines and patient anxiety. Recurrent seroma, persistent pain, or repeated wound care also increases healthcare utilization and may undermine patient confidence in breast-conserving management. Identifying pathological factors associated with these outcomes could therefore enhance multidisciplinary planning and support more comprehensive risk communication before surgery [11].

Progesterone receptor expression may also serve as a surrogate for broader endocrine and biological states that influence tissue behavior. Tumors with preserved hormone receptor signaling often arise in distinct host environments compared with receptor-negative lesions, and these systemic differences may relate to age, menopausal status, metabolic profile, and endogenous hormonal milieu. Although progesterone receptor status should not be viewed in isolation from these confounders, examining its association with acute postoperative complications may still provide clinically useful information, particularly when interpreted alongside established demographic and procedural risk factors in multivariable models [12].

From a methodological standpoint, investigating this association requires careful consideration of how postoperative complications are defined and measured. Acute postoperative morbidity after lumpectomy may include both objective events, such as hematoma, seroma, infection, and wound dehiscence, and subjective outcomes, such as pain intensity and early functional limitation. Differences in follow-up duration, complication grading, surgical technique, drain usage, antibiotic protocols, and pathological processing can all influence reported incidence. Therefore, any study addressing progesterone receptor expression and postoperative complications must employ clear definitions and robust statistical adjustment to distinguish true biological associations from procedural or institutional variation [13].

In this context, evaluating the relationship between progesterone receptor expression and the incidence of acute postoperative complications following lumpectomy is both timely and relevant. Such an investigation may bridge an important gap between breast tumor biology and perioperative surgical outcomes, offering insights that extend the utility of routine pathological biomarkers beyond prognosis and treatment selection. By exploring whether progesterone receptor status is associated with early morbidity after breast-conserving surgery, the study may contribute to a more integrated model of care in which oncologic, pathological, and surgical dimensions are considered together when anticipating postoperative recovery [14].

Accordingly, the present study was undertaken to determine whether progesterone receptor expression is associated with the incidence of acute postoperative complications in patients undergoing lumpectomy. Clarifying this relationship may improve perioperative risk assessment, refine postoperative surveillance strategies, and stimulate further research into the biological mechanisms that connect hormone receptor signaling with wound

healing and early surgical recovery. Ultimately, a better understanding of these interactions may support more individualized and biologically informed management for women treated with breast-conserving surgery.

Material and methods

Study Design:

This descriptive cross-sectional study was conducted at Tabriz University of Medical Sciences, Tabriz, Iran, during the year 2025. The study was designed to evaluate the association between progesterone receptor expression and the incidence of acute postoperative complications in patients undergoing lumpectomy. All eligible participants were assessed within the defined study period using a uniform clinical and pathological evaluation framework.

Sampling

The sample size was determined using the Cochran formula for estimating a proportion in a single-group descriptive cross-sectional study: $n=Z2P(1-P)/d^2$. Considering a confidence level of 95% (Z=1.96), an assumed proportion of 0.50 to ensure the maximum sample size, and a precision of 0.133, the estimated sample size was 54 patients. Participants were recruited through convenience sampling from eligible patients referred to the affiliated surgical centers of Tabriz University of Medical Sciences during the study period.

Inclusion/Exclusion Criteria

The study included women aged 18 years or older with histopathologically confirmed breast lesions scheduled for lumpectomy, whose surgical specimens were available for progesterone receptor assessment and who agreed to participate in the study by providing written informed consent. Patients were required to have complete demographic, clinical, surgical, and pathological records and to be available for early postoperative evaluation. Patients were excluded if they had undergone mastectomy instead of lumpectomy, received neoadjuvant systemic therapy before surgery, had active systemic infection or chronic inflammatory disease at the time of surgery, had autoimmune or hematologic disorders known to affect wound healing, were receiving long-term corticosteroids or other immunosuppressive medications, had incomplete pathology or postoperative follow-up data, or declined participation in the study.

Procedure

Progesterone receptor expression was assessed on tumor tissue obtained from the lumpectomy specimen after surgery. Immunohistochemical staining was performed in the pathology laboratory using formalin-fixed, paraffin-embedded tissue sections according to standard protocols. Progesterone receptor status was determined by a qualified pathologist based on the percentage of positively stained tumor cell nuclei, and cases were categorized as progesterone receptor positive or progesterone receptor negative according to routine pathological reporting criteria. This receptor assessment was performed after surgical excision and before final data analysis, using the definitive pathology report as the reference source.

Demographic and clinical variables including age, menopausal status, body mass index, smoking history, diabetes mellitus, hypertension, family history of breast cancer, prior breast surgery, and relevant medication history were extracted from medical records and patient interviews. Tumor-related variables including lesion size, histopathological type, tumor grade, lymph node status, estrogen receptor status, HER2 status, and Ki-67 index were recorded from pathology reports. Acute postoperative complications were evaluated during the early postoperative period through daily clinical examination and chart review and included hematoma, seroma, wound infection, wound dehiscence, postoperative pain, edema, and the need for re-intervention or readmission. Postoperative pain was assessed using the Visual Analog Scale, and wound-related complications were diagnosed by the attending surgical team based on standard clinical criteria. Length of hospital stay and other relevant perioperative outcomes were also documented for all participants.

Data Analysis

All statistical analyses were performed using appropriate statistical software. Since the study data were normally distributed, continuous variables were expressed as mean ± standard deviation and analyzed using the independent-samples t-test. Categorical variables were presented as frequency and percentage and compared using the chi-square test or Fisher's exact test when necessary. To assess the association between progesterone receptor expression and acute postoperative complications while controlling for potential confounding variables, multivariable logistic regression analysis was performed. A p-value of less than 0.05 was considered statistically significant.

Ethical Considerations

The study protocol was approved by the Ethics Committee of Tabriz University of Medical Sciences under the ethical code IR.TBZMED.FMD.REC.1405.161. Written informed consent was obtained from all participants before enrollment. Patient confidentiality was

preserved throughout the study, and all data were analyzed anonymously in accordance with the ethical principles of biomedical research.

Results

As shown in Table 1, the PR-positive and PR-negative groups were largely comparable regarding age, body mass index, menopausal status, diabetes, hypertension, smoking, family history of breast cancer, previous breast surgery, tumor size, histopathological subtype, HER2 status, and axillary lymph node involvement (all p>0.05). However, PR-negative tumors demonstrated a significantly more aggressive profile, with a higher proportion of grade III disease (50.00% vs. 16.67%; p=0.031), markedly lower estrogen receptor positivity (33.33% vs. 94.44%; p<0.001), and a higher Ki-67 index (31.28 ± 10.41% vs. 21.47 ± 8.63%; p=0.001).

Table 1. Baseline Demographic and Clinicopathological Characteristics of Patients According to Progesterone Receptor Status

Variable	PR-positive group (n = 36)	PR-negative group (n = 18)	p-value
Age, years, mean ± SD	51.86 ± 9.42	53.72 ± 10.15	0.506
Body mass index, kg/m², mean ± SD	27.34 ± 3.91	28.11 ± 4.26	0.511
Postmenopausal status, n (%)	17 (47.22%)	9 (50.00%)	0.847
Diabetes mellitus, n (%)	6 (16.67%)	4 (22.22%)	0.620
Hypertension, n (%)	8 (22.22%)	5 (27.78%)	0.653
Current smoking, n (%)	3 (8.33%)	2 (11.11%)	0.741
Family history of breast cancer, n (%)	7 (19.44%)	4 (22.22%)	0.811
Previous breast surgery, n (%)	4 (11.11%)	2 (11.11%)	1.000
Tumor size, cm, mean ± SD	2.18 ± 0.74	2.46 ± 0.81	0.207
Histopathological type, n (%)	-	-	0.684
Invasive ductal carcinoma	29 (80.56%)	13 (72.22%)	-
Invasive lobular carcinoma	4 (11.11%)	3 (16.67%)	-
Other histological types	3 (8.33%)	2 (11.11%)	-
Tumor grade, n (%)	-	-	0.031
Grade I	8 (22.22%)	1 (5.56%)	-
Grade II	22 (61.11%)	8 (44.44%)	-
Grade III	6 (16.67%)	9 (50.00%)	-
Estrogen receptor positive, n (%)	34 (94.44%)	6 (33.33%)	<0.001
HER2 positive, n (%)	7 (19.44%)	6 (33.33%)	0.260
Ki-67 index, %, mean ± SD	21.47 ± 8.63	31.28 ± 10.41	0.001
Axillary lymph node involvement, n (%)	9 (25.00%)	6 (33.33%)	0.515

As shown in Table 2, most operative variables, including operative duration, estimated blood loss, drain placement, and length of hospital stay, did not differ significantly between the PR-positive and PR-negative groups, although values were generally higher among PR-negative patients. However, PR-negative status was associated with a significantly higher postoperative pain score (4.06 ± 1.43 vs. 3.14 ± 1.21; p=0.017), a greater overall incidence of acute postoperative complications (50.00% vs. 22.22%; p=0.037), and more frequent unplanned postoperative visits (33.33% vs. 11.11%; p=0.048). Individual complications such as seroma, wound infection, edema, and need for intervention were numerically more common in the PR-negative group but did not reach statistical significance.

Table 2. Surgical Characteristics and Acute Postoperative Complications Following Lumpectomy According to Progesterone Receptor Status

Variable	PR-positive group (n = 36)	PR-negative group (n = 18)	p-value
Operative duration, minutes, mean ± SD	54.72 ± 12.38	61.94 ± 14.21	0.059
Estimated blood loss, mL, mean ± SD	42.36 ± 18.74	51.67 ± 21.58	0.105
Drain placement, n (%)	9 (25.00%)	7 (38.89%)	0.288
Length of hospital stay, days, mean ± SD	1.64 ± 0.76	2.11 ± 0.96	0.052
Postoperative pain score, VAS, mean ± SD	3.14 ± 1.21	4.06 ± 1.43	0.017

Any acute postoperative complication, n (%)	8 (22.22%)	9 (50.00%)	0.037
Hematoma, n (%)	2 (5.56%)	3 (16.67%)	0.176
Seroma, n (%)	4 (11.11%)	5 (27.78%)	0.116
Wound infection, n (%)	1 (2.78%)	3 (16.67%)	0.075
Wound dehiscence, n (%)	1 (2.78%)	2 (11.11%)	0.236
Breast edema, n (%)	3 (8.33%)	5 (27.78%)	0.057
Need for postoperative intervention, n (%)	2 (5.56%)	4 (22.22%)	0.071
Unplanned postoperative visit, n (%)	4 (11.11%)	6 (33.33%)	0.048
Readmission, n (%)	1 (2.78%)	2 (11.11%)	0.236

As presented in Table 3, PR-negative status was associated with a 3.50-fold increase in the unadjusted odds of developing an acute postoperative complication (95% CI:1.06-11.58; p=0.040). This association remained significant after adjustment for BMI, diabetes, and operative duration (adjusted OR:3.84; 95% CI:1.07-13.79; p=0.039). Higher BMI was also independently associated with postoperative morbidity (adjusted OR: 1.16 per kg/m²; p=0.041), whereas diabetes and operative duration were not significant in the adjusted model.

Table 3. Univariable and Multivariable Logistic Regression Analysis of Factors Associated with Acute Postoperative Complications Following Lumpectomy

Predictor	Unadjusted OR (95% CI)	p-value	Adjusted OR (95% CI)	p-value
PR-negative status	3.50 (1.06-11.58)	0.040	3.84 (1.07–13.79)	0.039
Age, per 1-year increase	1.04 (0.98-1.11)	0.214	—	—
BMI, per 1-kg/m² increase	1.17 (1.01-1.35)	0.036	1.16 (1.01–1.34)	0.041
Diabetes mellitus	2.74 (0.70-10.69)	0.147	2.38 (0.53–10.72)	0.258
Current smoking	3.08 (0.44-21.68)	0.257	—	—
Tumor size, per 1-cm increase	1.46 (0.71-3.01)	0.303	—	—
Grade III tumor	2.86 (0.82-9.96)	0.099	—	—
HER2-positive status	1.57 (0.42-5.86)	0.504	—	—
Ki-67 index, per 5% increase	1.21 (0.97-1.51)	0.091	—	—
Operative duration, per 10-minute increase	1.42 (1.02-1.98)	0.038	1.31 (0.91-1.89)	0.145

Discussion

The present study was designed to examine whether progesterone receptor expression is associated with early postoperative inflammation and acute postoperative complications in women undergoing lumpectomy. Rather than focusing only on technical surgical outcomes, we aimed to clarify whether PR status may reflect a broader biological context that influences tissue response to surgical trauma, postoperative recovery, and short-term morbidity. This objective is clinically important because biomarker-guided risk stratification could help identify patients who may benefit from closer surveillance and more individualized perioperative care after breast-conserving surgery [15].

Overall, the findings showed that most core operative variables, including operative duration, estimated blood loss, drain placement, and length of hospital stay, were not significantly different between the PR-positive and PR-negative groups, although these measures tended to be less favorable in PR-negative patients. In contrast, PR-negative tumors were associated with significantly worse early postoperative outcomes, including higher postoperative symptom burden, a greater incidence of acute complications, and more frequent unplanned postoperative visits. In the regression analysis, PR-negative status remained an independent predictor of postoperative complications after adjustment for potential confounders, while higher BMI also showed an independent adverse effect. Taken together, these findings suggest that receptor status may be linked not only to tumor biology, but also to the inflammatory and reparative processes that shape immediate postoperative recovery [16].

One plausible explanation for these findings is that PR expression may serve as a marker of a more biologically regulated tumor microenvironment, whereas PR-negative disease is often associated with more aggressive molecular behavior, higher proliferative activity, and greater inflammatory signaling. Tumors lacking progesterone receptor expression are frequently characterized by endocrine resistance, enhanced cytokine production, and increased interaction between malignant cells

and stromal inflammatory pathways. This pro-inflammatory environment may not remain confined to the tumor itself; rather, it may contribute to an exaggerated local tissue response after surgery, resulting in more edema, exudate formation, impaired wound stability, and a higher overall risk of short-term postoperative morbidity [17].

The observed increase in complication rates among PR-negative patients is also biologically consistent with current understanding of wound healing. Surgical recovery depends on a tightly coordinated sequence of hemostasis, inflammation, proliferation, and remodeling. When inflammatory activation is excessive or poorly regulated, this sequence may be disrupted, leading to seroma formation, delayed epithelial repair, higher susceptibility to infection, and prolonged local swelling. Because PR-negative tumors are often linked to a more inflammatory and proliferative phenotype, patients in this subgroup may enter the postoperative period with a tissue environment that is already primed for dysregulated healing. This mechanism may explain why several complications in our study, although not individually significant, were consistently more frequent in the PR-negative group [18].

Another important point is that the lack of significant differences in operative duration, blood loss, and drain use suggests that the poorer outcomes in PR-negative patients were unlikely to be explained solely by surgical complexity. In other words, the excess postoperative morbidity appears to be more strongly related to patient- or tumor-related biological factors than to substantial differences in the technical conduct of the operation. This distinction is important because it supports the interpretation that receptor status may have prognostic value beyond standard perioperative variables. The trend toward longer procedures and longer hospitalization in PR-negative patients may still indicate a subtle accumulation of perioperative burden, but the main signal in our results points toward biology-driven vulnerability rather than purely procedural difficulty [19].

The association between PR-negative status and more frequent unplanned postoperative visits further reinforces the clinical relevance of this finding. Unplanned visits often reflect symptoms such as swelling, wound concern, drainage, redness, or anxiety related to delayed recovery, even when readmission is not required. These encounters impose additional burden on patients and healthcare systems and may be early indicators of suboptimal healing trajectories. If PR-negative status identifies patients at higher risk of this type of postoperative instability, then awareness of receptor expression before or shortly after surgery could inform follow-up intensity, discharge counseling, and early supportive interventions aimed at reducing avoidable postoperative utilization [20].

The independent effect of BMI in the adjusted model is also in line with established literature and may interact meaningfully with receptor status. Higher BMI is associated with impaired tissue perfusion, increased dead space, chronic low-grade systemic inflammation, and altered immune regulation, all of which can compromise wound healing and increase the risk of infection, seroma, and delayed recovery. In overweight or obese patients with PR-negative tumors, these biological disadvantages may be amplified, producing a compounded vulnerability to postoperative complications. This may explain why BMI retained significance in multivariable analysis even after accounting for PR status and operative factors [21].

It is also notable that diabetes mellitus and operative duration lost statistical significance in the adjusted model, despite showing some signal in univariable analysis or clinical plausibility. This pattern may reflect the relatively small sample size, the limited number of events, and the possibility that the impact of these variables was partially mediated or overshadowed by stronger biological predictors such as PR status and BMI. Similarly, the lack of significant associations for tumor size, HER2 status, smoking, and Ki-67 should not necessarily be interpreted as evidence of no relationship. Rather, these findings may indicate insufficient power to detect modest effects, particularly in a study focused on early complications after a generally limited surgical procedure such as lumpectomy [22].

From a clinical standpoint, our findings suggest that PR expression may have value beyond its conventional role in breast cancer characterization and systemic treatment planning. If confirmed in larger cohorts, PR-negative status could be incorporated into perioperative risk assessment models to identify patients who might benefit from enhanced wound surveillance, more proactive management of postoperative inflammation, and tailored patient education regarding early warning signs. Such an approach would be especially useful in ambulatory or short-stay breast surgery pathways, where early discharge can make it harder to detect evolving complications before they prompt unscheduled return visits [23].

These results should also be interpreted within the broader framework of tumor–host interaction. Breast cancer biomarkers do not simply describe malignant cell phenotype; they may also reflect underlying endocrine, immune, and stromal dynamics that influence the body's reaction to injury. Progesterone signaling has been implicated in modulation of inflammatory responses, extracellular matrix turnover, and tissue homeostasis. Therefore, reduced or absent PR

expression may indicate loss of certain regulatory influences that normally help limit excessive inflammatory activation. In the postoperative setting, this could translate into a more exaggerated local response to tissue disruption and a less efficient transition from inflammation to repair [24].

The study has several strengths. It addressed a clinically relevant but understudied question, used clearly defined short-term postoperative outcomes, and combined descriptive group comparisons with regression-based analysis to identify independent predictors of complications. At the same time, some limitations should be acknowledged. The cross-sectional design precludes causal inference, the sample size was modest, and the number of individual complications was relatively small, which limited statistical power for event-specific analyses. In addition, postoperative inflammation was inferred from clinical outcomes rather than quantified with serial laboratory biomarkers, and residual confounding by unmeasured factors cannot be excluded [25].

Despite these limitations, the consistency of the observed pattern strengthens the main conclusion. Across several outcomes, PR-negative patients showed a less favorable postoperative course, and this pattern persisted even when differences in operative variables were minimal. The fact that PR-negative status remained independently associated with overall complications suggests that receptor expression may capture a meaningful dimension of biological risk that is not fully explained by age, comorbidity, or procedural factors alone.

Conclusion

This study suggests that progesterone receptor expression may have clinical relevance beyond tumor classification in patients undergoing lumpectomy. PR-negative status was independently associated with acute postoperative complications, even after adjustment for BMI, diabetes, and operative duration. Higher BMI also increased postoperative risk. These findings indicate that biological tumor characteristics and patient-related inflammatory risk may contribute to early surgical recovery and should be considered when planning postoperative surveillance and individualized follow-up care.

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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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