

Analysis of the Clinical Value of Immunohistochemical Testing in the Pathological Diagnosis of Breast Cancer

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Abstract: *Objective:* To investigate the clinical value of immunohistochemistry (IHC) detection in the pathological diagnosis of breast cancer. *Methods:* Eighty breast cancer patients admitted to Baoding No. 1 Central Hospital from June 2022 to June 2023 were selected as study subjects. The samples were divided into a positive group (40 cases) and a negative group (40 cases) according to ER and PR test results. Immunohistochemistry was performed on all patients to compare the differences between the two groups in C-erbB-2 positive expression and axillary lymph node metastasis. *Results:* The positive expression rate of C-erbB-2 in the positive group (35.00%) was significantly lower than that in the negative group (80.00%), with a highly significant difference ($P < 0.001$). The axillary lymph node metastasis rate in the positive group (40.00%) was significantly lower than that in the negative group (75.00%), with a significant difference ($P < 0.05$). *Conclusion:* Immunohistochemical detection in breast cancer pathology enhances diagnostic accuracy, predicts prognosis, and supports personalized treatment by identifying ER, PR, and C-erbB-2. It is worth being widely adopted in clinical practice.

Keywords: Breast cancer; Pathological diagnosis; Immunohistochemical detection

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1. Introduction

Breast cancer, as a malignant tumor in general surgery, has a very high incidence rate, particularly affecting women, with more than 90% of breast cancer cases occurring in female patients. This malignant tumor originates from the epithelial tissues of the mammary glands, which not only threatens women's health but also directly affects their quality of life ^[1]. Regarding the prognosis of breast cancer, the current research consensus indicates that early diagnosis and treatment often result in a better prognosis, higher survival rate, and more optimistic quality of life. However, once the disease progresses to an advanced stage, it becomes significantly more difficult to treat, and the prognosis is often less favorable.

The specific challenge of advanced breast cancer lies in the extensive metastasis of cancer cells, with lymphatic metastasis being the most common pathway. If not controlled in time, cancer cells can invade the local

lymphatic system, such as the thoracic lymph nodes, and may even migrate to various organs throughout the body, posing a serious threat to the patient's health and even life ^[2]. Therefore, early screening and accurate diagnosis of breast cancer, as well as timely and effective treatment strategies, are of great significance for improving the prognosis of patients.

At present, the level of medical technology in China is constantly improving, and immunohistochemistry (IHC) testing has been widely used in clinical diagnosis due to its significant advantages, such as high diagnostic accuracy and specificity. Immunohistochemistry is a powerful biochemical technique used to detect specific protein molecules in tissue sections. The technique relies on antibodies to identify and label target proteins and subsequently visualize these molecules through a chromogenic reaction, enabling the study of localization and expression patterns of biomolecules at the tissue level. This technique is effective in providing accurate diagnostic results in the early stages of disease and can accurately classify different types of disease, thus providing a scientific basis for subsequent personalized treatment.

Through immunohistochemistry testing, it is possible to improve the accuracy of disease management, shorten the diagnostic cycle, enhance treatment efficiency, and win valuable treatment time for patients. This positively affects the improvement of patients' quality of life and survival rate ^[3]. Based on this, the purpose of this paper is to discuss the clinical application value of immunohistochemistry in the pathological diagnosis of breast cancer, and to provide a more scientific and efficient method for the diagnosis and treatment of breast cancer.

2. Materials and methods

2.1. General information

Between June 2022 and June 2023, 80 cases of breast cancer patients admitted to Baoding No. 1 Central Hospital were selected as study subjects. Inclusion criteria: (1) Patients were diagnosed with breast cancer by pathological examination ^[4], and the pathological data were complete; (2) All participants voluntarily joined the study and understood the content of the study; (3) The study was approved by the Ethics Committee of the hospital. Exclusion criteria: (1) The presence of other serious diseases or pathological states that affect the diagnosis and treatment decisions of breast cancer; (2) Those with severe organic diseases, abnormal liver and kidney functions; (3) Those with severe cognitive impairment that prevented them from collaborating in the study; (4) Those who were involved in specific treatments that may affect the results of immunohistochemistry detection, such as immunotherapy, radiotherapy, chemotherapy.

2.2. Methods

Breast cancer was diagnosed using consistent immunohistochemistry methods in both groups, utilizing archived hospital wax slice samples. After selecting the samples, 4-micron sections were prepared. The steps are as follows: (1) Fix the lesion tissue in 10% formalin to maintain cell structure; (2) Treat the specimen with paraffin to complete the embedding; (3) Use a microtome to create 4-micron continuous sections; (4) Apply the ABC method and HE staining, followed by DAB color development and hematoxylin re-staining for a comprehensive observation of the pathological characteristics of the samples.

2.3. Observation indexes

- (1) C-erbB-2 positive expression rate: According to standard guidelines, the presence of positive cells below 10% was judged as negative, while a proportion of positive cells reaching or exceeding 10% was confirmed as positive C-erbB-2 expression. The C-erbB-2 positive expression rate between the two groups of samples was compared to reveal differences in physiological or pathological characteristics.

(2) Assessment of axillary lymph node metastatic status: The axillary lymph node metastasis status of the two groups of patients was compared by analyzing the size of the metastasis, the degree of damage to the lymph node structure, and the number of metastases. This quantification of metastasis between different groups helps to understand the extent and severity of metastasis in-depth and provides a scientific basis for clinical decision-making.

2.4. Statistical methods

SPSS 26.0 software was used to process the data analysis, and data were expressed as either [*n* (%)] or mean \pm standard deviation (SD), and compared using the *t* or chi-squared test. When the *P* value was less than 0.05, it indicated that the observed differences were statistically significant.

3. Results

3.1. General information

As shown in **Table 1**, the general information of patients in the two groups (including gender, average duration of disease, and average age) was compared with *P* values of 0.369, 0.398, and 0.446, respectively, which was greater than 0.05, hence the groups were comparable.

Table 1. Comparison of general information of patients in two groups

Group	Gender		Average duration of illness (mean \pm SD, months)	Average age (mean \pm SD, years)
	Male	Female		
Control group (<i>n</i> = 40)	20	20	1.81 \pm 0.53	54.37 \pm 10.67
Observation group (<i>n</i> = 40)	24	16	1.90 \pm 0.41	56.17 \pm 10.34
χ^2 / t -value	0.808		0.850	0.766
<i>P</i> -value	0.369		0.398	0.446

3.2. C-erbB-2 positive expression rate

The rate of C-erbB-2 positive expression in the positive group (14/40, 35.00%) was significantly lower than that in the negative group (32/40, 80.00%), and the difference showed a highly significant relationship ($\chi^2 = 16.573$, *P* < 0.001), as shown in **Table 2**.

Table 2. Comparison of C-erbB-2 positive expression rate between the two groups of patients [*n* (%)]

Group	C-erbB-2 positive	C-erbB-2 negative
Negative group (<i>n</i> = 40)	32 (80.00%)	8 (20.00%)
Positive group (<i>n</i> = 40)	14 (35.00%)	26 (65.00%)
χ^2 -value	16.573	
<i>P</i> -value	< 0.001	

3.3. Axillary lymph node metastasis

Table 3 shows that the axillary lymph node metastasis in the positive group (16/40, 40.00%) was significantly lower than that in the negative group (30/40, 75.00%), and the difference showed a significant correlation ($\chi^2 =$

10.026, $P < 0.002$).

Table 3. Comparison of axillary lymph node metastasis between the two groups of patients [n (%)]

Group	Transferred	Non-transferred
Negative group ($n = 40$)	30 (75.00%)	10 (25.00%)
Positive group ($n = 40$)	16 (40.00%)	24 (60.00%)
χ^2 -value		10.026
P -value		0.002

4. Discussion

The implementation of immunohistochemistry testing varies significantly across regions, healthcare institutions, departments, and even among testers. This variability is mainly due to the lack of uniform and specific protocols in the field. Such variability reflects a lack of standardization, leading to practical issues such as reagent incompatibility, inconsistent interpretation of results, and non-standardized procedures. Therefore, to ensure the efficacy and reliability of immunohistochemistry testing, standardization, normalization, and traceability should be core objectives. Key aspects such as quality control, tissue testing operations, and result evaluation should be strictly managed to ensure each step is properly executed [5].

When analyzing the antigenic expression of normal tissues, physiological characteristics and developmental stages should be considered. It is essential to recognize that fluctuations in the expression of the estrogen receptor (ER) and progesterone receptor (PR) during the normal cycle are largely influenced by the menstrual cycle. During HE staining, where any omission may impact the results, it is crucial to note that proteins within the cells of pathological tissues are often prone to cross-linking with aldehyde groups. This cross-linking can result in the closure of antigenic determinants, preventing antibodies from binding to them [6]. This process affects the specific binding of antibodies to the corresponding antigens and may cause important information to be overlooked in subsequent immunohistochemical tests, reducing the accuracy of the test results.

In clinical medicine, research on the *C-erbB-2* gene oncogene and its product P185 has primarily focused on breast cancer because *C-erbB-2* plays a crucial role in the diagnosis and pathological analysis of breast cancer. Such studies allow early and accurate determination of the pathological type of breast cancer, which is essential for selecting therapeutic regimens, assessing disease prognosis, and developing personalized diagnostic and treatment strategies [7]. Protein P185, encoded by the *C-erbB-2* gene, is not only an important regulator of the proliferation, survival, and metastasis of breast cancer cells but also plays a key role in the cell cycle regulation of breast cancer. Therefore, studying this protein contributes to the early diagnosis of breast cancer and provides important clues to its biological mechanisms, offering new possibilities for the development of clinical medicine and the enhancement of cancer treatment effectiveness. It is widely recognized in clinical practice that the positive expression of the *C-erbB-2* gene protein product can serve as an independent indicator marker, providing an important reference for the prognosis of breast cancer treatment [8]. The expression level of this gene product significantly impacts breast cancer growth, progression, and sensitivity to specific treatments, making it an important biomarker for clinical screening and prediction of patient prognosis. By detecting and analyzing the expression of the *C-erbB-2* gene protein product, physicians can more accurately assess the response of different breast cancer patients to therapeutic strategies, as well as the expected disease progression and quality of patient survival.

In this study, the rate of positive *C-erbB-2* expression was significantly lower in the positive group compared to the negative group. This finding suggests that immunohistochemistry may provide an important prognostic tool

in assessing breast cancer patients, and the significant variability in C-erbB-2 expression indicates that this marker may be valuable in understanding the behavior of cancer cells and the variability in patient response to treatment. Therefore, by quantifying the expression of C-erbB-2 using immunohistochemistry, it is possible to more accurately assess the prognostic status of patients and help optimize treatment strategies, providing a scientific basis for the diagnosis and treatment of breast cancer.

The results of this study showed that the rate of axillary lymph node metastasis in the positive group was significantly lower than in the negative group. This finding points to an important inference: breast cancer patients with positive ER (estrogen receptor) and PR (progesterone receptor) have a relatively low risk of axillary lymph node metastasis. This suggests that the expression levels of ER and PR are not only closely related to the pathogenesis of breast cancer but also serve as effective diagnostic and prognostic assessment tools. By detecting ER and PR expression levels in patients, clinicians can more accurately predict the prognosis of patients. Relevant studies suggest that when the expression of ER and PR is positive in breast cancer patients, it usually indicates a more optimistic prognosis^[9]. This is mainly due to the positive effects of ER and PR, which can influence tumor growth and differentiation and promote cell cycle regulation, thus slowing down the aggressiveness and spread of tumors to a certain extent. On the contrary, if the expression of ER and PR is negative, it may indicate a higher degree of malignancy of breast cancer, and the prognosis of patients may be less satisfactory.

In conclusion, the application of immunohistochemistry in the pathological diagnosis of breast cancer not only improves diagnostic accuracy but also provides scientific guidance for the formulation of personalized treatment plans and anticipates the possible direction of the patient's condition. This approach is of great value in improving the therapeutic efficacy and prognostic management of breast cancer patients.

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References

- [1] Li J, Shi Z, Hou Y, et al., 2019, Clinical, Pathological and Immunohistochemical Basis of Ultrasound Features in Invasive Triple-Negative Breast Cancer. *Chinese Journal of Cancer*, 29(1): 37–44.
- [2] Wang L, Ren F, Fan Y, et al., 2023, Correlation Analysis of VEGF, ALDH1, BCRP Expression in Breast Cancer Tissues and Pathological Features of Breast Cancer. *Clinical Medical Engineering*, 30(5): 721–722.
- [3] Chen Y, Li H, Wang C, 2022, Diagnostic Efficacy of Ultrasound Elastography and Ultrasonography for Breast Cancer and Its Correlation with Immunohistochemical Parameters. *Journal of Clinical and Pathological Sciences*, 42(10): 2420–2426.
- [4] Oncology Committee of Chinese Association of Integrative Medicine, Integrative Medicine Committee of Beijing Breast Disease Prevention and Treatment Association, Beijing Integrative Medicine Chronic Disease Prevention and Control, et al., 2021, Consensus on Diagnosis and Treatment of Breast Cancer with Integration of Traditional and Western Medicine. *Chinese Journal of Frontiers of Medicinal Science (Electronic Edition)*, 13(7): 44–64.
- [5] Huang Q, Huang Y, Li M, et al., 2019, Analysis of the Correlation between High Expression of Vascular Endothelial

Growth Factor (VEGF) and Low Expression of Platelet-Responsive Protein 1 (TSP-1) and the Prognosis of Breast Cancer Patients. *Journal of Cellular and Molecular Immunology*, 35(9): 828–831.

- [6] Li W, Bai J, Xie X, et al., 2020, Effect of Neutrophil-to-Lymphocyte Ratio on Clinical Prognosis of Triple-Negative Breast Cancer and with Ki-67 Expression. *Modern Preventive Medicine*, 47(12): 2287–2291 + 2304.
- [7] Wei J, Xing X, Wang F, et al., 2022, Comparison of the Value of Immunocytochemical P16/Ki-67 Double Staining, P16INK4 α Single Staining and High-Risk Human Papillomavirus Test for Screening High-Grade Cervical Lesions. *Oncology Research and Clinics*, 34(3): 180–183.
- [8] Wang Z, Zhou H, Wu H, et al., 2020, Impact of Epidermal Growth Factor Receptor Protein and Clinicopathological Features on the Effect and Prognosis of Neoadjuvant Chemotherapy for Breast Cancer. *Hebei Medicine*, 42(3): 325–329.
- [9] Yu X, Qin H, 2018, Expression of ER, PR, C-erbB-2, P53, and Ki-67 in Breast Cancer Tissues and Correlation with Their Clinicopathological Features. *Journal of Practical Cancer*, 33(1): 39–42.

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