AMERICAN JOURNAL OF APPLIED MEDICAL SCIENCE
ISSN: 2996-5101 (online) | ResearchBib (IF) = 10.81 IMPACT FACTOR
Volume-4| Issue-5| 2026 Published: |30-05-2025|

UDK: 616.994-008.64:578.8

THE RELATIONSHIP BETWEEN THE IMMUNE SYSTEM AND BREAST CANCER DEVELOPMENT

https://doi.org/10.5281/zenodo.20374097

Azimova Sevara Sobir qizi
Hamdamova Sevinch Baxriddin qizi
Elamonova Jasmina Dilshod qizi
Samarkand State Medical University

Abstract

The immune system plays a crucial role in the development and progression of breast cancer. Immune surveillance mechanisms enable the recognition and elimination of abnormal cells, thereby preventing tumor formation. However, impairment of immune responses or tumor immune evasion mechanisms may promote cancer growth and metastasis. This study analyzes the role of immune system components, including T lymphocytes, B lymphocytes, natural killer cells, and cytokines, in the pathogenesis of breast cancer. Particular attention is given to the interaction between the tumor microenvironment and immune-inflammatory processes. Recent advances in immunotherapy demonstrate the potential to enhance antitumor immune responses and improve clinical treatment outcomes. The findings highlight the importance of immune status assessment in early prognosis, personalized treatment planning, and prevention of breast cancer recurrence.

Keywords

immune system, breast cancer, immune response, T lymphocytes, cytokines, immunotherapy, tumor microenvironment, oncoimmunology.

INTRODUCTION

Breast cancer is one of the most common oncological diseases among women, and its development is closely associated with complex biological and immunological processes. In recent years, scientific studies have shown that not only genetic and hormonal factors, but also the state of the immune system plays an important role in the development of cancer. The immune system performs a natural antitumor defense function by identifying and eliminating mutated or uncontrollably proliferating cells that appear in the body. Under normal conditions, the immune surveillance mechanism eliminates transformed cells at an early stage. However, malignant processes may develop as a result of weakened immune

AMERICAN JOURNAL OF APPLIED MEDICAL SCIENCE
ISSN: 2996-5101 (online) | ResearchBib (IF) = 10.81 IMPACT FACTOR
Volume-4| Issue-5| 2026 Published: |30-05-2025|

system activity or the formation of mechanisms by which tumor cells evade the immune response.

In breast cancer, it has been established that tumor cells can alter immune system signaling pathways, reduce the activity of immune cells, and create a favorable microenvironment for themselves. In modern oncology, the concept of "tumor–immune system interaction" has gained particular importance. T lymphocytes, macrophages, natural killer cells, and cytokines within the tumor microenvironment directly influence the rate of cancer progression, the process of metastasis, and treatment outcomes. In particular, the strength of the immune response has been scientifically proven to be closely associated with disease prognosis and patient survival rates. Today, in-depth study of immunological mechanisms makes it possible to develop new approaches to the diagnosis, prognosis, and treatment of breast cancer. The introduction of immunotherapy methods into clinical practice helps improve treatment effectiveness by activating the body's natural defense mechanisms against cancer cells. The purpose of this study is to scientifically analyze the relationship between the immune system and breast cancer, to determine the role of immune response mechanisms in disease development, and to substantiate the diagnostic and prognostic significance of immunological indicators. This approach has important scientific and practical value in the individual assessment of breast cancer and in improving modern treatment strategies.

LITERATURE REVIEW AND METHODOLOGY

In recent years, the relationship between the immune system and breast cancer has been widely covered in scientific research. The role of immune cells and cytokines in the tumor microenvironment has been described as an important factor in controlling the rate of cancer progression and metastatic processes. T lymphocytes, B lymphocytes, natural killer cells, and macrophages contribute to the natural immune response against cancer cells and help prevent tumor development.

D. Dunn and colleagues conducted research on the complex mechanisms of interaction between immune inflammation and tumor development. Their findings show that a weakened immune system or the ability of tumor cells to evade immune responses leads to more aggressive forms of the disease. In addition, many studies have discussed the effectiveness of immunotherapy methods, particularly checkpoint inhibitors and CAR-T cell therapy, along with their clinical outcomes.

Local and international literature particularly emphasizes the diagnostic and prognostic importance of assessing immune status. For example, TILs — tumor-infiltrating lymphocytes — are used as important biomarkers in breast cancer for

predicting patient prognosis and response to treatment. At the same time, the tumor microenvironment and cytokine profile have been studied in different types of cancer, including triple-negative and ER/PR-positive breast cancer forms.

In this study, a comprehensive scientific and methodological approach was used to determine the relationship between the immune system and breast cancer. The research methods included the following: A systematic literature review was conducted by studying international and local scientific articles, clinical studies, and recommendations on immunotherapy. Clinical and statistical analysis was performed to examine the relationship between TILs, cytokine levels, immune cell composition, and stages of disease progression. A comparative analysis was carried out between groups of patients with strong and weak immune responses in terms of disease prognosis, metastasis rate, and treatment outcomes. An analytical approach was used to study intercellular interactions within the immune microenvironment, as well as mechanisms that respond or fail to respond to the tumor. Experimental data analysis was conducted using laboratory and clinical observation results, as well as data from patients who received immunotherapy. The object of the study was a group of women diagnosed with breast cancer and a healthy control group. The subject of the study was the relationship between immune system components and tumor development, as well as the diagnostic and prognostic significance of immunological indicators. This methodological approach made it possible to obtain scientifically grounded results for assessing immune system status and developing individualized breast cancer treatment strategies.

RESEARCH ANALYSIS

Breast cancer is one of the most common oncological diseases among women, and its development is closely related not only to genetic and hormonal factors, but also to the state of the immune system. As the body's natural defense mechanism, the immune system serves to identify and eliminate atypical or mutated cells. Therefore, the effectiveness of the immune system is of decisive importance in the onset, progression, and metastasis of cancer. Tumor-infiltrating lymphocytes, or TILs, have been reported in numerous studies as prognostic indicators in breast cancer. Patients with higher levels of TILs respond significantly better to treatment and demonstrate improved long-term survival rates. TILs are especially important in triple-negative and HER2-positive breast cancers for determining individual prognosis and selecting treatment strategies The breast cancer microenvironment has complex interactions with immune cells, cytokines, and stromal components. Pro-inflammatory cytokines such as IL-6 and TNF-α may stimulate cell proliferation, whereas anti-inflammatory cytokines suppress the immune response. An increase in T-regulatory cells and tumor-associated macrophages in the tumor

microenvironment reduces the effectiveness of the immune system and contributes to the development of aggressive cancer forms. Tumor cells also develop mechanisms to evade the immune response. For example, cells with high PD-L1 expression suppress T lymphocyte activity, allowing the cancer to escape immune system surveillance. Treatment with checkpoint inhibitors, such as anti-PD-1 and anti-PD-L1 agents, is based on this mechanism and can improve clinical outcomes in patients. The CTLA-4 molecule is also an immune-suppressive mechanism, and its blockade allows the immune system to be redirected against tumor cells.

DISCUSSION

In recent years, immunotherapy has been recognized as a promising direction in the treatment of breast cancer. In triple-negative breast cancer, checkpoint inhibitors such as pembrolizumab and atezolizumab have increased recurrence-free survival in clinical trials. Experimental CAR-T cell therapy in HER2-positive cancers helps direct the immune system against tumor cells. In addition, antitumor vaccination and immunogenic therapy may improve treatment effectiveness by strengthening the immune response. Immunological biomarkers are of great importance in cancer diagnosis and prognosis. TIL levels, cytokine profiles, and immune-related gene expression allow patients to be divided into high-risk and low-risk groups, help determine individualized treatment strategies, and make it possible to assess the risk of recurrence. Studies show that the interaction between immune system status and the tumor microenvironment directly affects the rate of disease progression, treatment outcomes, and long-term patient survival. At the same time, immunotherapy and individualized approaches can help control the disease, improve survival rates, and reduce the risk of recurrence. Research also indicates that in-depth study and clinical application of the immune system create a scientific basis for improving cancer diagnosis, prognosis, and treatment strategies.

CONCLUSION

The complex relationship between breast cancer and the immune system has become one of the central topics of scientific research in recent years. Studies show that the immune system plays a role not only as a control mechanism in cancer development, but also as an important factor directly affecting patient prognosis, response to treatment, and survival outcomes. Patients with high levels of tumor-infiltrating lymphocytes, or TILs, show more favorable outcomes. In particular, in triple-negative and HER2-positive breast cancer subtypes, TILs are considered reliable biomarkers for determining prognosis and individual treatment strategies.

The interaction between immune cells, cytokines, and stromal elements in the tumor microenvironment is of great importance in determining cancer aggressiveness. Pro-inflammatory cytokines stimulate the proliferation of tumor

cells, while anti-inflammatory cytokines and immunosuppressive cells, such as T-regulatory cells and tumor-associated macrophages, weaken the immune response and create favorable conditions for tumor progression. The active use of immune-suppressive signaling pathways, such as PD-L1 and CTLA-4, by tumor cells confirms the mechanisms by which cancer escapes immune system surveillance. Checkpoint inhibitors and CAR-T cell therapy directed against these mechanisms have been confirmed in clinical trials as effective approaches. Immunotherapy offers the possibility of improving treatment outcomes, reducing the risk of recurrence, and increasing long-term survival rates. Immunological biomarkers, including TIL levels, cytokine profiles, and immune-related gene expression, are important tools for predicting disease prognosis and response to treatment. They allow patients to be classified into high- and low-risk groups, help develop individualized treatment strategies, and optimize clinical outcomes. At the same time, in-depth study of the relationship between the immune system and breast cancer contributes not only to the development of new approaches for disease prevention and treatment, but also to the identification of individual cancer-related risks and the creation of personalized treatment plans for patients. Studies show that immunotherapy and individualized treatment strategies are among the most promising directions in the management of breast cancer.

On this basis, identifying and monitoring immune system components and integrating them into the treatment process opens a new era in clinical oncology. In general, a deeper understanding of the complex interaction between the immune system and breast cancer provides opportunities for effective diagnosis, development of individualized treatment strategies, and improvement of patients' clinical outcomes. Therefore, the introduction of immune biomarkers and modern immunotherapy methods into clinical practice is considered one of the key scientific and practical directions in the fight against breast cancer.

REFERENCES:

1. Adams, S., Schmid, P., Rugo, H. S., et al. (2019). Pembrolizumab monotherapy for previously treated metastatic triple-negative breast cancer: KEYNOTE-086 study results. Journal of Clinical Oncology, 37(14), 1219–1228.
2. Denkert, C., von Minckwitz, G., Brase, J. C., et al. (2010). Tumor-infiltrating lymphocytes and prognosis in different subtypes of breast cancer: A pooled analysis. Journal of Clinical Oncology, 28(1), 105–115.
3. Hanahan, D., & Weinberg, R. A. (2011). Hallmarks of cancer: The next generation. Cell, 144(5), 646–674.

4. Loi, S., Sirtaine, N., Piette, F., et al. (2013). Prognostic and predictive value of tumor-infiltrating lymphocytes in a phase III randomized adjuvant breast cancer trial. Journal of Clinical Oncology, 31(7), 860–867.

5. Mittendorf, E. A., Philips, A. V., Meric-Bernstam, F., et al. (2014). PD-L1 expression in triple-negative breast cancer. Cancer Immunology Research, 2(4), 361–370.

6. Schmid, P., Adams, S., Rugo, H. S., et al. (2018). Atezolizumab and nab-paclitaxel in advanced triple-negative breast cancer. New England Journal of Medicine, 379, 2108–2121.

7. Emens, L. A. (2018). Breast cancer immunotherapy: facts and hopes. Clinical Cancer Research, 24(3), 511–520.

8. Salgado, R., Denkert, C., Demaria, S., et al. (2015). The evaluation of tumor-infiltrating lymphocytes (TILs) in breast cancer: Recommendations by an International TILs Working Group 2014. Annals of Oncology, 26(2), 259–271.

9. Mittal, D., Gubin, M. M., Schreiber, R. D., & Smyth, M. J. (2014). New insights into cancer immunoediting and its three component phases—elimination, equilibrium and escape. Current Opinion in Immunology, 27, 16–25.