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ANTI-TUOR IMMUNITY. ONCOMARKERS

Raxmonov Shoxzodbek Oybek o'g'li

Assistant of the Departament of Pathology and Forensic Medicine,

Central Asian Medical University.

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Abstract. *Today, the main mechanisms of antitumor immunity, the body's natural defense system against cancer cells, and immunological control processes are highlighted. Information is provided about the main components of antitumor immunity - natural killer cells (NK cells), cytotoxic T-lymphocytes, and macrophages. The diagnostic and prognostic significance of oncomarkers is also analyzed. The role of oncomarkers in the early detection of cancer and assessment of the effectiveness of immunotherapy is considered. Based on research, innovative approaches to enhancing antitumor immunity, including immunotherapy, vaccines, and gene therapy, are discussed.*

Keywords: *Antitumor immunity, Natural killer cells (NK cells), T-lymphocytes, Macrophages, Oncomarkers, CEA (Carcinoembryonic antigen), CA-125, Immunotherapy, Immunity.*

ИММУНИТЕТ ПРОТИВ ОПУХОЛЕЙ. ОНКОМАРКЕРЫ

Аннотация. *Сегодня освещены основные механизмы противоопухолевого иммунитета, системы естественной защиты организма от раковых клеток и процессов иммунологического контроля. Приведены сведения об основных компонентах противоопухолевого иммунитета - естественных клетках-киллерах (NK-клетках), цитотоксических Т-лимфоцитах и макрофагах. Также проанализировано диагностическое и прогностическое значение онкомаркеров. Рассмотрена роль онкомаркеров в раннем выявлении онкологических заболеваний и оценке эффективности иммунотерапии. На основе исследований обсуждаются инновационные подходы к усилению противоопухолевого иммунитета, включая иммунотерапию, вакцины и генную терапию.*

Ключевые слова: *противоопухолевый иммунитет, естественные киллеры (NK-клетки), Т-лимфоциты, макрофаги, онкомаркеры, CEA (раково-эмбриональный антиген), CA-125, иммунотерапия, иммунитет.*

Introduction

In modern medicine, cancer is a global problem that threatens the lives of millions of people every year. Studying the mechanisms of tumor development and finding effective methods of

combating them is one of the main areas of scientific research. The natural defense system in the human body, which is aimed at identifying and destroying cancer cells, plays an important role - antitumor immunity. The immune system fights tumors with the help of various cells, cytokines and receptors. Oncomarkers are of great importance in the early diagnosis of cancer. They are biological molecules that indicate the presence of cancer cells in the body and can be detected in blood, urine or other biological fluids. Oncomarkers are important not only for early detection of the disease, but also for monitoring the treatment process and providing a prognosis. The main mechanisms of antitumor immunity, the effect of immune cells on cancer cells, as well as the role of oncomarkers in cancer diagnostics are analyzed. In addition, the effectiveness of immunotherapy and other modern approaches against tumors is considered.

Literature review and method

Antitumor immunity consists of the body's natural defense mechanisms against cancer cells, and various components of the immune system are actively involved in this. The immune system tries to identify and destroy tumor cells, but in some cases, tumors can escape immune control and develop.

Oncomarkers are special substances produced by cancer cells or the body, which are detected in the blood and other fluids. They are used for early detection of cancer, monitoring the dynamics of the disease and assessing the effectiveness of treatment. Each oncomarker is associated with a specific type of tumor, and an increase in their level may indicate the presence of pathological processes.

Antitumor Immunity

Antitumor immunity consists of the body's natural defense mechanisms aimed at identifying and destroying tumor cells. The following components of the immune system are involved in this process:

Natural killer (NK) cells belong to the body's innate immune system and have the ability to directly destroy virus-infected and cancer cells. NK cells are constantly active in the body and prevent the development of cancer by recognizing and destroying tumor cells.

- Tumor cell recognition - NK cells have special receptors on their surface that can distinguish between normal and malignant cells. If a cell has specific markers that are trying to hide from the immune system, NK cells will target it for attack.

- Cytotoxic release - NK cells release substances such as perforin and granzyme into tumor cells, which penetrate their membrane and disrupt their internal structure, initiating the apoptotic (programmed death) process.

- Cytokine action - NK cells produce interferons and other cytokines, which enhance the immune response and mobilize other immune cells to fight the tumor.

Factors affecting the effectiveness of NK cells

- Stress and chronic diseases can reduce the activity of NK cells.

- Rational nutrition, physical activity and a healthy lifestyle increase the activity of NK cells.

- Some types of tumors have mechanisms to suppress the immune system and can avoid the attack of NK cells.

Increasing the activity of NK cells and their use in cancer therapy is one of the important directions of current oncological research.

T-lymphocytes are the main cells of the immune system, participating in the formation of a specific immune response to a tumor. They are formed in the bone marrow, then mature in the thymus and are functionally specialized in different ways.

- Cytotoxic T-cells ($CD8^+$) - directly destroy tumor cells, using substances that disrupt their membrane (perforin, granzyme).

- Helper T-cells ($CD4^+$) - enhance the immune response, transmit signals to other immune cells and produce cytokines.

- Regulatory T-cells (Treg) – balance the immune response and prevent overactivity.

T-lymphocytes recognize antigens on the surface of tumor cells, form a specific response to them, and mobilize other parts of the immune system to fight cancer. Tumor cells can sometimes develop mechanisms to hide from the immune system or suppress the activity of T-lymphocytes, which makes it necessary to use methods such as immunotherapy.

Macrophages are phagocytic cells of the immune system that play an important role in destroying tumor cells and alerting the immune system. They are part of the innate immune system, are formed in the bone marrow, and localize and function in various tissues.

Macrophages are divided into two main types in the tumor microenvironment:

- M1-macrophages – stimulate inflammatory processes, destroy tumor cells, and signal the immune system about danger.

- M2 macrophages – on the contrary, can suppress the immune response and support tumor development.

Macrophages engulf antigens, break them down and present them to T-lymphocytes through special receptors. This process ensures the formation of a specific immune response to tumor cells.

Cytokines are proteins produced by immune cells that are involved in controlling and enhancing the immune response. They regulate inflammatory processes by providing signal transmission between cells of the immune system.

- Interferons (IFN) – have the property of fighting viruses and limiting the growth of tumor cells. They activate the immune system, stimulating natural killer cells and T-lymphocytes.

- Interleukins (IL) – participate in establishing communication between immune cells and enhance or suppress the immune response. They regulate inflammatory processes and increase the activity of immune cells.

Cytokines are also used in immunotherapy, stimulating the immune system to act more effectively against tumor cells.

Oncomarkers

Oncomarkers are substances produced by tumor cells or the body in response to a tumor.

They are detected in blood, urine, and other biological fluids. Oncomarkers are used to diagnose, predict, and evaluate the effectiveness of treatment.

AFP is an oncomarker used to detect liver, ovarian, and testicular cancers. It is produced naturally during pregnancy, but high levels in adults may indicate liver tumors (hepatocellular carcinoma) and certain types of embryonal tumors. In addition, AFP levels may be increased in diseases such as liver cirrhosis and hepatitis.

CEA is an oncomarker that is elevated in colon, stomach, lung, and breast cancers. It is produced mainly during embryonic development, but after birth its levels drop to almost zero. In adults, CEA levels can be elevated not only in cancer, but also in inflammatory bowel disease, pancreatitis, and liver disease.

CA-125 is one of the main markers of ovarian cancer, which is mainly detected at high levels in epithelial ovarian tumors. This marker is used to detect early stages of ovarian cancer and monitor the dynamics of the disease. At the same time, CA-125 can also be increased in endometriosis, uterine fibroids, pregnancy and inflammatory diseases.

CA 19-9 is an important oncomarker for pancreatic cancer, which can also be increased in other types of tumors of the gastrointestinal tract. This marker is also observed in stomach, gallbladder and liver cancer. However, high levels of CA 19-9 can also be noted in pancreatitis, biliary tract diseases and liver cirrhosis, so it is not recommended to use it as a sole diagnostic tool.

PSA is a marker used to detect prostate cancer, produced by prostate gland cells. Its high levels can be observed in diseases such as prostate cancer, prostate adenoma and prostatitis. PSA levels are used to diagnose prostate cancer early, monitor the progression of the disease, and evaluate the effectiveness of treatment.

Conclusion

The body's antitumor immunity is a complex process aimed at recognizing and destroying cancer cells. Natural killer cells, T-lymphocytes, macrophages and cytokines play an important role in this process. Each component tries to eliminate tumor cells by forming an immune response through its own mechanisms. However, tumor cells have strategies to evade immune control and can develop by weakening the immune system or by pretending to be normal cells. Therefore, stimulating immunity and using immunotherapy methods are one of the current directions in the fight against cancer. Oncomarkers are an important tool for early detection of cancer, monitoring the treatment process and assessing the likelihood of disease recurrence. Oncomarkers such as alpha-fetoprotein (AFP), carcinoembryonic antigen (CEA), CA-125, CA 19-9 and prostate-specific antigen (PSA) help in the diagnosis of various types of cancer. However, since their level can increase not only in cancer, but also in other pathological conditions, it is not enough to rely solely on the results of oncomarkers for making a final diagnosis. Therefore, to confirm the diagnosis of cancer, a comprehensive assessment is required, combined with instrumental and clinical examinations. Strengthening immunity, leading a healthy lifestyle, and undergoing regular medical examinations are important for early detection and effective treatment of cancer. In-depth study of immunological mechanisms and the development of new therapeutic methods will allow achieving more effective results in the fight against cancer.

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