Interaction between the mother and the fetus in the aspect of immunology

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Abstract
The article deals with the interaction between the mother and the fetus in the aspect of immunology. The immunological problems which the maternal immune system may encounter in pregnancy and their potential negative effects on the fetal health are also of interest to us. Therefore, it is necessary to consider the features of the interaction between the fetus and the mother, which will allow assessing the prospects for future research in the field of the interaction between the maternal and fetal immune systems for more effective prevention and treatment of immunological problems in pregnancy.

Keywords
Immune system, Pregnancy, Fetus, Autoimmune diseases, Immunodeficiencies, Rh conflict, Antiphospholipid syndrome, Pre-eclampsia, Immunology

Imprint

An interaction between the mother and the fetus is a unique process that begins at the moment of conception and continues until the birth of the child. This process includes not only the physical connection between the mother and the fetus, but also an interaction of their immune systems.

The immune system in this type of the interaction will perform a protective function both for the fetus and the mother. The fetus is an antigenic foreign object against the mother, so the mother’s body would try to reject the child. However, despite the constant aggressive response by the mother’s immune system to the fetus, there are some immune suppression mechanisms available, which allow the fetus to properly exist and develop.

In the context of the mother-fetal interaction, the study of immunological aspects is extremely important. Immunology allows us understanding how the maternal and fetal immune systems interact with each other and how this makes its influence on the health of the child. In addition, the study of immunology allows properly understanding what problems can occur in pregnancy and how they can be successfully prevented or treated [1].

In this article, we will consider the immunological interaction between the mother and the fetus, the cellular and humoral mechanisms of the regulation of these processes, some pathological conditions, which may appear, when one of the organisms predominates over the other, as well as methods for the prevention and treatment of such conditions.

The immune system is composed by various organs, tissues, cells, and molecules, which work together to protect the body from infections and other harmful influences. There are three main elements in the immune system:

- Cells of the immune system.

  The main cells of the immune system are leukocytes. The following populations of leukocytes are distinguished: granulocytes, monocytes and lymphocytes. Granulocytes are involved in phagocytosis and allergic reactions of the body. Monocytes are also capable of phagocytosis, but they are also capable of antigen presentation through phagocytosis, which allows the immune system to recognize various new antigens. Lymphocytes are cells of the acquired immune system, which helps fighting foreign objects using cellular and humoral immunity mechanisms.

  - Antibodies.

    Antibodies are special proteins that detect and bind to infectious agents, assisting other cells in the immune system to destroy them. Antibodies are produced by the B cells.

  - Cytokines.

    Cytokines are molecules, which are produced by immune cells and which are involved in the interaction, differentiation of cells of the immune system. They can stimulate or suppress the activity of other cells in the immune system.
Each element of the immune system plays its own assigned role in protecting the body from infections and other negative influences. The harmony of this system is ensured by a clear interaction of the cells with the help of receptors and biologically active substances (interleukins, interferons).

During pregnancy, the state of the maternal immunity changes in order to ensure normal growth and development of the fetus. However, at the same time, the fetus also needs protection from potentially harmful environmental influences. For this purpose, a number of fetal defense mechanisms develop, which are as listed below [2]:

- Placental barrier.

The placental barrier is a barrier system that separates the circulatory system of the mother and that of the fetus. It consists of several layers, which prevent the penetration of certain substances and microorganisms from the mother’s blood into the bloodstream of the fetus. This allows protecting the fetus from infections and other dangerous effects [2].

- Fetus membranes.

The membranes also play an important role in protecting the fetus. They provide an additional barrier that helps protect the fetus from external influences such as injury and infection. Specifically, the decidua is the barrier between the fetus and the mother.

- Immunological tolerance.

This state of the mother’s immune system develops during pregnancy. It prevents the mother’s immune system from reacting to the fetus. This is achieved through mechanisms, which suppress the activity of certain cells and molecules of the immune system.

- Passive transport of antibodies.

During pregnancy, antibodies, which are produced by the mother’s immune system in response to infections and other hazards, can be transferred across the placenta from the mother to the fetus. This is called the passive antibody transport, and it helps protect the fetus from infections during the first months of life.

In general, these fetal defense mechanisms are formed and interact with each other, providing the reliable protection of the fetus from dangerous influences and exposures. However, sometimes the mother’s immune system can attack the fetus, which can lead to various pregnancy complications such as premature birth, oligohydramnios, fetal growth retardation and other problems.

Also, one of the main mechanisms responsible for protecting the fetus is the hematoplacental barrier, which prevents the penetration of certain substances and microorganisms from the mother’s blood into the bloodstream of the fetus. For a more detailed consideration of this mechanism, the structure and function of the placenta should be considered. The placenta is an organ which develops during pregnancy and connects the circulatory systems of the mother and the fetus. It is an extra-embryonic organ, which has a fetal part and a maternal part, the contact between which is provided through a developed vascular network. Between the blood systems of the mother and the fetus there is a hematoplacental barrier, which is represented by the endothelium of the fetal vessels, the connective tissue of the villi, cytotrophoblast and sympathotrophoblast, as well as Langhans’ fibrinoid. The main function of this barrier is to prevent the mixing of blood of the fetus and that of the mother.

The placenta has two parts: the fetal part and the maternal part. The fetal part is represented by the amniotic membrane, chorionic villi and the mucous connective tissue. The maternal part is represented by lacunae filled with blood and the connective tissue septa between them. Thus, maternal blood washes the chorionic villi, thereby transporting nutrients to the fetus, and the presence of a hematoplacental barrier between the two parts of the placenta allows the mother’s blood cells not to enter the fetus. The placenta plays an important role in protecting the fetus and ensuring its normal growth and development.

It is important to note that the interaction between the mother and the fetus in terms of immunology is a complex, always ambiguous, process that is not fully understood. Many questions still remain unanswered, and research in this area continues. However, understanding the defense mechanisms of the fetus, what changes occur in the mother’s immune system during pregnancy, and what factors can affect maternal-fetal interactions may help develop new strategies for the prevention and treatment of various complications in pregnancy.

The maternal immune system plays an important role in maintaining the life of the fetus.

As the fetus begins to develop, its cells produce various molecules, which can initiate an immune response by the maternal immune system. However, since the unborn child contains genetic material from two parents, its cells will have an individual genotype, which allows the synthesis of antigens unique only for this organism.
To prevent rejection of the fetus, the mother's immune system can suppress its own immune response to the fetus by reducing production of certain types of proteins and cells, which can attack the fetus. Also, the maternal immune system can produce special cells: the regulatory T-cells, which reduce the immune response to the fetus.

However, in some cases, the mother's immune system may not recognize the fetus as its own and attack the latter. This can take place, for example, in case of pathology of the uterus and the placenta that will result in deformation of the hematoplacental barrier.

Also, the maternal immune system can provoke negative reactions to the fetus if it encounters some foreign antigens from the fetal cells. The Rh-conflict is a condition when a reaction occurs between the Rh-factor and an antibody to the Rh-factor that is accompanied by a response by the body, characteristic of the vascular hemolysis. In the presence of the Rh-conflict, the mother is able to bear only the first child, since the immune reactions will not be applicable to the fetus due to the sensitization of the mother's body. However, in subsequent pregnancies, the fetal rejection will occur due to the reaction of the maternal anti-Rh antibodies with the fetal Rh antigens.

In general, the maternal immune system demonstrates a complex relationship with the fetus and can respond to its presence in many ways. It is important that its reaction is adequate and does not lead to negative consequences for the fetus and the mother. To do this, it is important to conduct regular medical examinations during pregnancy in order to identify possible problems and take measures to prevent or treat them in advance.

Let us consider some more problems which can negatively affect the health of the fetus:
- Autoimmune diseases. Women with autoimmune diseases, such as rheumatoid arthritis or systemic lupus erythematosus, are at increased risk of preterm labor and pregnancy complications. In such cases, careful monitoring and treatment by an immunologist is required.
- Immunodeficiencies. Women with immunodeficiencies, such as HIV infection, also have an increased risk of pregnancy complications. Such women need to take drugs of immunity stimulants, plasma transfusion.
- Antiphospholipid syndrome. This is a disease, in which antibodies against phospholipids are formed in the mother's blood, which can lead to an increased risk of thrombosis and preterm delivery. For the prevention and treatment of this syndrome, anticoagulants and hormonal drugs are used.
- Preeclampsia. This is a disease that will manifest itself in the form of generalized endotheliosis, systemic vasoconstriction and is characterized by an increase in blood pressure in combination with proteinuria. Preeclampsia can lead to complications both for the mother and the fetus, including preterm delivery and fetal growth retardation. In preeclampsia, there may also be an immunological factor associated with an imbalance between the immune system of the mother and that of the fetus. Some research suggests that preeclampsia may be associated with maternal T-cell dysfunction, which can induce an increased immune system activation and inflammation in the mother's body [3].

Another possible problem related to immunity during pregnancy is the risk of infection of the fetus with various infections, such as cytomegalovirus, herpes simplex virus, rubella virus, human immunodeficiency virus (HIV), hepatitis B and C, and others. All of these infections can initiate serious pregnancy complications, including miscarriage, premature birth, and fetal damage [4].

Various methods can be used to prevent and treat immunological problems during pregnancy. For example, in case of the Rh-incompatibility, the administration of anti-Rh antibodies to the mother can prevent the immune system from attacking the fetal red blood cells. Immunomodulators and hormonal drugs can be administered to prevent autoimmune diseases and preeclampsia. Also, women suffering from immunodeficiencies may require special treatment and follow-up by immunologists [5-7].

In general, the immunological problems during pregnancy can have serious consequences for the health of the mother and the fetus, so it is important to visit specialists and undergo regular medical examinations to identify and prevent possible problems in advance [8].

Finally, it can be concluded that the interaction between the immune system of the mother and that of the fetus is an important aspect of pregnancy. Although immunological problems can occur during pregnancy and cause complications, there are methods capable of successfully treating and preventing these conditions.
However, despite the existing research in this area, many aspects remain unknown. Further research may focus on elucidating the mechanisms of the interaction between the immune systems of the mother and the fetus, as well as on the development of new methods of treatment and prevention of immunological problems during pregnancy. This can help improve the maternal and fetal health and reduce pregnancy-related complications.

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