THEME: THE THYMUS GLAND AS AN ORGAN OF THE ENDOCRINE SYSTEM. PHYSIOLOGY OF THE THYMUS

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Annotation:

Views on the hormonal role of the thymus gland in the body have undergone significant changes depending on the level of our knowledge about its structure and functions. At first, it was attributed entirely to the endocrine system, then to the lymphoid system. With the development of immunology and the emergence of evidence of the primary regulatory function of the thymus in immune reactivity, the question of the hormonal mechanism of action arose again. This view was supported by the fact that neonatal thymectomy causes not only changes in immune activity, but also the development of the so-called Wasting syndrome (exhaustion syndrome), which is essentially a reflection of slowed metabolic processes and a lag in the animal's physical development and growth. The conclusion about the influence of the thymus on the growth processes was made on the basis of the fact that in newborns and young animals it is larger than in adults. This is due to the involution (reverse development) of the thymus gland, which is accompanied by a decrease in the number of thymic epithelial cells and, as a consequence, a decrease in endocrine properties. In addition, two substances isolated from the tissue of the gland have been described with an effect that stimulates and inhibits growth processes (but this is a controversial issue). In any case, the thymus gland cannot affect growth without the presence of growth hormone, on the other hand, with thymectomy, the effect of growth hormone on growth is significantly reduced.

Key word:

Physiology, embryological aspect, Gassal body, Wasting-syndrome, Adenohypophysial STH, synthes of sulfate mucopolysaccharide, thymectomy, development,secretion, humoral function

The thymus gland (thymus, thymus gland) is structurally a complex organ consisting of the stroma and regenerative lymphoid tissue. The stroma makes up about 10% of the organ; it is formed by reticular and epithelial cells. Lymphoid cells are mostly in a state of mitotic activity and are a mixture of thymocytes and bone marrow cells that migrated here.

In the embryological aspect, the thymus is one of the first endocrine organs and the first lymphoid organ. At 7-8 weeks of embryonic development, lymphoblastic cells of the bone marrow colonize the thymus gland, and it becomes the main producer of lymphocytes and thymocytes, which enter the blood and other lymphoid organs not only during the embryonic period of development, but also throughout the life of the organism.

Development features: The thymus gland appears at 6 weeks of intrauterine development in the form of a paired protrusion of 3 and 4 pairs of branchial pockets. The thymic parenchyma develops from the skin type epithelium (prechordal plate), and the stroma from the mesenchyme. The epithelial rudiments of the gland grow in the caudal direction. The distal part of them thickens, forming the body of the gland, and the proximal part is pulled into the duct, which later disappears.

The thymus gland has the appearance of massive epithelial strands, which within two months form outgrowths into the surrounding mesenchyme with blood vessels - the primordium of the gland becomes lobular.

From week 10, the epithelium of the anlages acquires a loose reticular structure. Large lymphoid cells appear in the loops of this network, the number of which is rapidly increasing.

In an 11-week-old fetus, the cortical and medulla differs in the anlage of the thymus lobules. And by the 12th week, the first layered epithelial bodies (Gassal) appear in the medulla. The thymus gland is finally formed earlier than other lymphoid organs (spleen, lymph nodes) and by the time of birth it turns out to be the largest of them.

At this point, the thymus is characterized by the predominance of the cortex over the brain and the abundance of capillaries. Each lobule contains 4-8 large epithelial bodies. The thymus gland of a 1-3-year-old child is represented by lobules with equal-sized cerebral and cortical layers, while the number of capillaries decreases and the network of large blood vessels increases.

The thymus gland reaches its maximum development by 3-4 years - it is by this time that the child's body meets with the bulk of the surrounding antigens. After 20 years, age-related involution of the thymus gland occurs: the number of lymphocytes decreases, the cortical substance gradually disappears, rare small Gassal bodies are found, the epithelial component is replaced by adipose tissue. However, the thymus gland does not completely atrophy and the areas of the cortex, surrounded by adipose and connective tissue, remain until very old age.

Until recently, it was believed that the immunoregulatory function of the thymus gland is exhausted in the perinatal and early postnatal periods. At the present time, however, it has been proven that the thymus does not lose its significance in the adult organism. Over the past 10 years, a large number of studies have been accumulated in relation to the endocrine function of the thymus gland, many of its active substances have been isolated, which have different effects and degrees of activity.

The interaction and mutual influence of the thymus and pituitary gland can be described as follows:

Adenohypophysis STG -> thymus -> T-lymphocytes

The study of the humoral functions of the thymus gland is based on facts that have indirect and direct evidence.

1. Direct evidence:

- implantation of a thymus gland in thymectomized animals, which is placed in fine-porous diffusion sacs
- transplantation of thymus cells
- introduction of biologically active extracts of the gland
- obtaining antibodies against thymosin (thymus hormone), etc.

The effect is monitored by the nature of the immune response, fast or slow flow of the Wasting syndrome.

2. Indirect evidence:

- Thymectomy effect (Wasting syndrome)
- Restoration of the immune capacity after thymectomy by implantation of a full-fledged thymus gland or its cells
- Morphological data on the secretion of Hassal's bodies by individual types of the thymus gland
- Relationship with other endocrine glands
- Changes in metabolic processes as a result of removal of the thymus gland, etc.

Direct and indirect evidence of the presence of endocrine properties of the thymus was the reason for numerous experiments on the isolation of the humoral factor from the gland. The table lists just a few of these factors.

The main method for studying the endocrine functions of the thymus is thymectomy. Removal of the gland in young animals is invariably accompanied by growth retardation and generalized disorders of skeletal development. Bones become soft, bent and lose strength, teething becomes difficult, the maxillofacial skeleton is deformed, in addition, the animal becomes more susceptible to commonplace infections. The influence of a number of hormonal factors of the thymus gland on the secretion and content of STH, TSH, ACTH and testosterone in the blood was established, as well as the fact that the thymus activates the processes of myelopoiesis and lymphopoiesis, acting on the class of progenitor cells.

Microscopic data on the secretion of the thymus gland.

The first microscopic data indicating the presence of a secretory function of the thymus gland were published in 1963-1966. Subsequent studies have shown that the medullary cells of the gland have the characteristic of glandular cells. In the cortical part of the gland, epithelial cells form a tight septum between infiltrating lymphocytes and contain a small number of cytoplasmic organelles. In the medullary part, which contains fewer lymphocytes, large epithelial cells form islets and have a number of secretion signs. With age, cysts and foci of cystic degeneration-Hassel's little body are formed.

There are three types of cytoplasmic inclusions in medullary epithelial cells that can be mistaken for secretory products.

1. The most obvious of these is an amorphous PIC-positive substance that can be detected both intercellularly and extracellularly.
2. The second type of formations are vacuoles containing an amorphous substance with the characteristics of mucoid particles, similar to that which can be found in the mucoid cells of lower-standing vertebrates.
3. The third type of formations are small dense granules, which can be considered secretory.

Each granule has its own membrane, like other secretory granules; they are usually located around the lamellar complex (Golgi apparatus); the centrally located granules have a lower density than the peripheral ones.

Autoradiographic data are also considered to be evidence of the secretory function of epithelial cells of the medullary layer of the thymus gland. Studies by K. Henry (1966), S.L. Clark (1966, 1968) showed that these cells are actively involved in the synthesis of sulfate mucopolysaccharide, and the rapid incorporation of sulfate and glucosamine is considered typical for cells producing mucoid substances. In the same studies, it was found that radioactive leucine, usually found in cells that produce purely protein substances, is diffusely scattered in the thymus gland, mainly in lymphocytes of the cortical layer.

The results obtained show that there is a relationship between the PIC-positive substance in epithelial medullary cells and the number of lymphocyte mitoses. If this substance is mistaken for a thymus hormone, then it can be considered responsible for the stimulation and proliferation of lymphocytes. This assumption supports the opinion of D. Metkalf (1956, 1966) about the presence of lymphocyte-stimulating factor (LSF) in the serum of thymic origin. Studies of the thymus gland [Vetter S.J., Macadam R.F., 1973] show that epithelial cells contain cytoplasmic organelles, typical of secretory function, located around the membrane - round secretory granules.

The discovered avascular zone near Gassal's little bodies gives grounds to the authors to assume that the secretory product of epithelial cells is of a purely intrathymic nature.

Ultramicroscopic studies have shown that in the prenatal and postnatal periods, epithelial cells contain a large number of vesicles and alveoli, and one cannot exclude the possibility that these cells are morphologically and genetically associated with the production of humoral substances. The presence of signs of increased activity, lamellar complex and fenestration of the vascular walls in the thymus gland suggest that it has a glandular function.

Various studies have shown that some conditions accompanied by changes in the function of the thymus gland are manifested in an increase in the number of Gassal's bodies and the content of SHIK-positive substances in them, an increase in the number of SHIK-positive lymphocytes. These phenomena are accompanied by a significant reaction and indicate that Gassal's little bodies have an active humoral-productive function.

In the course of these studies, two types of Hassal's bodies were identified:

- In the body of the first type there are electron microscopic signs of the secretory function of epithelial cells. These cells are characterized by an enlarged ergoplasmic cistern, containing a substance of moderate electron density and a well-developed Golgi complex. In bodies of this type, degenerative changes are found only in their inner parts.
- The second type of Hassal's bodies shows signs of rooting. Cells of this type contain bundles of tonofibrils and islets of fine-grained matter that smears the picture of cell organelles.

Epithelial cells are interconnected by well-developed desomsomas in both types of Gassal cells.

Microscopic data on the secretion of medullary epithelial cells of the thymus gland are based on objective microscopic (light microscope), electron microscopic, histochemical and autoradiographic studies. Based on the results of these studies, the authors believe that the thymus gland has a secretory function, which has been studied mainly in relation to lymphopoiesis and immunogenesis.

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