



## THYMUS GLAND- ANATOMY, PHYSIOLOGY AND APPLIED ASPECT

### Ayurveda

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### KEYWORDS

Thymus is present in all vertebrates except cyclostomes i.e. lampreys and hagfish. In humans thymus is situated in superior mediastinum dorsal to the sternum and anterior to great vessels that emerge from heart. It is bilobed , encapsulated lymphoid organ. In mammals it is only primary lymphoid organ and is the first organ of embryo to become lymphoid. It is well developed and relatively larger at birth unlike spleen and lymph nodes. At puberty it has greatest weight i.e. 30 to 40 gms after that it undergoes progressive involution and then partially replaced by fat and connective tissue.

The word thymus originates from the Greek word thymos which has dual meaning. Although it is synonymous with heroic character characterized by soul, spirit, courage, power, will, heart and anger, it is also related to herb thyme and the thyme flower. Rufus (98-117 CE) who lived in Ephesus, a major port city and a centre of learning on the western shore of Turkey today, is acknowledged as the first person to refer to the thymus gland in humans.

The thymus gland gained clinical importance once it was linked by the Swiss physician platter in 1614 to the sudden death of a 5 month old boy from suffocation.

#### Structure

It has two lobes which are joined by connective tissue. Each lobe is surrounded by loosely woven connective tissue and it provides septa that extends into thymus, subdividing each lobe into number of irregular lobules. Each lobule consist of cortex and medulla.

Cortex is densely packed with immature T cells called thymocytes Medulla where there are fewer lymphoid cells.

It is essential for production of T-cells, lymphocytes that are involved in cell mediated immune response such as rejection of foreign grafts and immunologic responses to fungi, viruses and certain bacteria. T cells do cooperate with B cells in producing antibodies against antigen such as foreign red cells. There is marked decrease in the number of circulating small lymphocytes, and the deep cortex of lymph nodes and the periarterial lymphatic sheaths of the spleen fail to develop. The hagfish has no thymus and appears to be non immunocompetent.

#### Function

Thymus has lymphoid function and endocrine function. It plays an important role in development of immunity in the body.

It has two functions

1. Processing the T lymphocytes
2. Endocrine function

#### Processing The T Lymphocytes-

Thymus plays a vital role in the development of immunity by processing T lymphocytes. The lymphocytes which are produced in bone marrow are processed in thymus into T lymphocytes. It occurs during the period between 3 months before birth and 3 months after birth. So the removal of thymus after birth will not affect the cell mediated immunity.

#### Endocrine Function Of Thymus

It secretes two hormones

#### Thymosin-

It is peptide which accelerates lymphopoiesis and proliferation of T lymphocytes

#### Thymin-

It is also called as thymopietin. It suppresses the neuromuscular activity by inhibiting acetylcholinerelease. Hyperactivity of thymus causes Myasthenia gravis.<sup>2</sup>

Several peptides have been isolated from thymic extracts and appear to have some regulatory and stimulating effects on thymus.

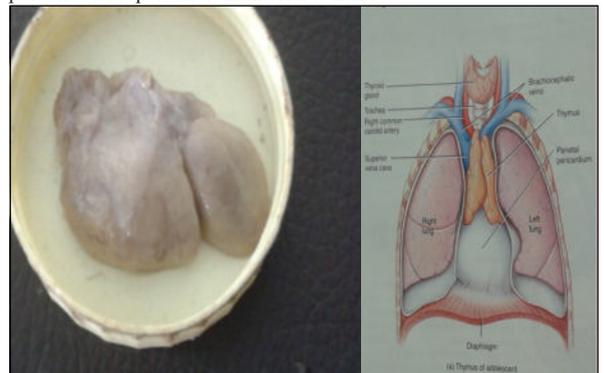
1. Thymosin- an agent that restores t cell deficiencies in thymectomized mice. It is regarded as hormone that induces t cell differentiation
2. Thymopietin- induces T cell maturation
3. Thymic humoral factor- induces development of surface markers on t cells.

The agents appear to be produced locally in thymus, possibly by the reticular epithelial cells and to have local effects on the lymphocyte population in thymus.

In the newborn, thymus weighs 10 to 12gm and continue to grow until puberty. At puberty gland reaches its maximum weight of 20 to 50 g. Thereafter it enters in gradual state of involution. Decreasing in mass to only 5 to 15 g in the elderly. At this time parenchyma is mostly replaced by fibrofatty tissue.

The thymus is a bilobed glandular structure however its two lobes are rarely symmetrical.

It is located in anterior superior mediastinum where it anteriorly covers the great vessels, pericardium and the base of the heart. It is also in close proximity with the anterior surface of the innominate vein as it runs obliquely across the superior mediastinum to join the right brachiocephalic vein to form superior vena cava. The thymus may sometimes lie adjacent to either superior vena cava on the right or pulmonary artery on the left. One or both lobes may also lie behind the left innominate vein instead of in front of it. The two thymic lobes are fused in the midline, giving the gland its H shaped configuration. The upper poles of each lobe reach into the neck where they join the thyroid gland by the thyrothymic ligaments on both sides. The lower poles lie on the pericardium anterior to heart.



#### Vascular Supply And Lymphatic Drainage

##### Arterial Supply

Internal thoracic and inferior thyroid arteries which also supply to surrounding mediastinal connective tissue. A branch from superior thyroid artery is sometimes present.

### Venous Drainage

Thymic veins drain to left brachiocephalic vein, internal thoracic and inferior thyroid vein and occasionally into the superior vena cava. One or more veins often emerge medially from each lobe of the thymus to form common trunk opening into the left brachiocephalic vein.

### Lymphatic Drainage

It has no afferent lymphatics. Efferent lymphatics arise from the medulla and corticomedullary junction and drain through extravascular spaces in company with the arteries and veins that supply the thymus.

### Nerve Supply

It is innervated from sympathetic chain via the cervicothoracic (stellate) ganglion or ansa subclavia and from the vagus.

Branches from the phrenic and descending cervical nerves are distributed mainly to capsule. The two lobes are innervated separately through their dorsal, lateral and medial aspects. During development and before its descent in thorax, the thymus is innervated by the vagus in the neck. After its descent, the thymus receives a sympathetic innervation via fibres that travel along the vessels post ganglionic sympathetic termination branch radially and form a plexus with the vagal fibres at the corticomedullary junction. Innervation is complete by the onset of thymic function. Many of the autonomic nerves are doubtless vasomotor but other terminal branches ramify among the cells of the thymus particularly the medulla suggesting that they may have other roles. The medulla contains a number of different types of non lymphoid cells including cells positive for vasoactive intestinal polypeptide and acetylcholinesterase. Large non myoid cells and cells containing oxytocin, vasopressin and neurophysin of possible neural crest origin. The roles of the nervous system and other neuroendocrine elements in the overall biology of the thymus are little understood.

### Microstructure.

It is responsible for the thymus processed (T) lymphocytes to the entire body and provides a unique microenvironment in which T cell precursors (thymocytes) undergo development, differentiation and clonal expansion to deliver the exquisitely specific T cell response simultaneously acquiring immune tolerance to the body's own components. These steps involve intimate interactions between thymocytes and other cells (mainly epithelial cells and antigen presenting cells) and chemical factors in the Thymic environment. The thymus is also part of neuroimmunological and neuroendocrine axes of the body. And is both influences and is influenced by the products of these axes. Its activity therefore varies throughout life under the influence of different physiological states, disease conditions and chemical insults such as hormones drugs and pollutants.<sup>3</sup>

### Development Of Thymus

The thymus develops from the endoderm of the third pharyngeal pouch. It also gives rise to the inferior parathyroid gland. Early in development, this pouch is cut off, both from the pharyngeal wall and from the surface ectoderm. After separation from inferior parathyroid rudiment, each thymic rudiment has a thinner cranial part and a broader caudal part. The thinner portion forms the cervical part of the thymus. The broader parts, of the two sides, enter the thorax and become united to each other by connective tissue.

The endodermal cells of the thymus are invaded by vascular mesoderm which contains numerous lymphoblasts. This invading mesenchyme partially breaks up the thymic tissue into isolated masses and thus gives the organ its lobulated appearance.

Fragmentation of the cervical part of the thymus may give rise to accessory thymic tissue. Such tissue present in relation to the superior parathyroid glands, is believed to arise from fourth pouch.

The thymus is relatively large at birth. It continues to increase in weight till puberty. Thereafter, it gradually undergoes atrophy.<sup>4</sup>

### Applied Aspect Of Thymus Gland Thymic Changes During Postnatal Life

At birth- bilobar, 2.5-5 cm wide and 1cm thick. Thickest part it lies above the base of heart.

At childhood- narrows and lengthens and cervical portion becomes less noticeable.

At Adult- after age of 20 years, it decreases to 5-6 mm in thickness.

The thymus is largest relative to the body at birth with a mass of 10-15 g. It rapidly increases to 20 g and subsequently remains at that mass. After 1<sup>st</sup> year of life till sixth decade mean mass is fairly constant at 20 g. However although the mass of the thymus may be fairly constant, it becomes increasingly infiltrated by adipose tissue and so the total amount of active lymphoid tissue becomes progressively smaller with time.

In children the gland is more pyramidal in shape and firmer than in later life when the amount of lymphoid tissue is greatly reduced. In the fresh state it is deep red, reflecting its rich blood supply. With age it becomes thinner and greyer and infiltrated by yellow adipose tissue. Each of two lobes is partially divided by the ingrowth of shallow septa, so that, superficially, the gland appears lobulated. As fatty atrophy proceeds, this lobulation becomes more distinct. The older thymus can be distinguished from the surrounding mediastinal fat only by the presence of its capsule. However, even within greatly atrophied glands there are usually greyer areas around blood vessels formed by persistent lymphoid tissue. Thymocyte production and differentiation persist throughout life. T cells from the thymus continue to populate the peripheral lymphoid tissue, blood and lymph.

### Congenital Anomalies Of The Thymus

Undescended thymus, accessory thymic bodies and rare cysts of the third branchial pouch are of no clinical significance.

Patients with thymic agenesis aplasia and hypoplasia, as in severe combined immune deficiency disease, have reduced lymphocyte numbers and early death from infection is common. Most cases are familial with autosomal recessive genes. In young children, a large normal thymus may press on the trachea, causing attacks of ventilator stridor.

### Congenital Mediastinal Cyst

Bronchogenic cysts, thymic cysts, meningoceles and thoracic duct cyst. Overall just over one third become symptomatic, either directly as a result of pressure effects on surrounding structures (especially oesophageal and thymic cysts) or indirectly as a result of secondary infection (bronchogenic cyst)

### Thymoma And Myasthenia Gravis

Thymic tumours may compress the trachea, oesophagus and large veins in the neck, causing hoarseness, cough, dysphagia and venous engorgement of head and neck. Thymomas tend to have an inhomogenous signal intensity on MRI. They may develop in one lobe of the thymus without affecting the other.

Myasthenia gravis is a chronic autoimmune disease of adults, presents as a diminution in power of repetitive contraction in certain voluntary muscles. In this disease acetyl choline receptor proteins of neuromuscular junctions are attacked by autoantibodies. Muscles commonly involved are levator palpebrae superioris (leading to ptosis) and the extraocular muscles (leading to diplopia) in severe cases ventilator muscles are compromised.<sup>3</sup>

### Thymic Carcinoma –

These are unlike encapsulated or invasive thymomas in that they are unequivocally malignant at the microscopic level. Suster and Rosai classified thymic carcinomas into low grade and high grade tumours. Low grade tumours are well differentiated with squamous cell, mucoepithelioid or basaloid features. High grade thymic carcinomas include those with cell and undifferentiated with squamous cell neuroendocrine, sarcomatoid, clear cell, and undifferentiated or anaplastic features.

### Thymolipoma -

These are benign tumours that may grow to a very large size before being diagnosed. Thymolipomas are generally well encapsulated soft, and pliable masses that do not invade surrounding structures. Resection is recommended for large masses.

### Thymic Hyperplasia

Diffuse thymic hyperplasia was first described in children after successful chemotherapy for lymphoma. It has now been described in adults and is referred to as rebound thymic hyperplasia. It is most frequently reported after chemotherapy for lymphoma or germ cell

tumours. Initially atrophy of the thymic gland is seen, latter on follow up scans, the patient is noted to have thymic gland enlargement, which can be dramatic. The usual time course for thymic hyperplasia to develop is approximately 9 months after cessation of chemotherapy but has been reported anywhere from 2 weeks to 12 months after chemotherapy.<sup>5</sup>

#### REFERENCES

1. Essentials of histology Text/Atlas/Review by William J. Krause, J. Harry Cutts first edition. Library of Congress Cataloging in Publication data. USA. pg no. 374-379
2. Essentials of Medical physiology, K Sembulingam and Prema Sembulingam. 7<sup>th</sup> edition 2016. Jaypee Brothers Medical Publishers (P) Ltd. New Delhi. Pg. no. 462
3. Susan Standring, Gray's Anatomy, The Anatomical Basis of Clinical Practice, Churchill Livingstone Elsevier: UK, Reprint 2011. Page no. 945-949
4. Inderbir Singh, G. P. Pal, Human embryology, Macmillan Publishers India Limited: New Delhi, Ninth edition, pg. no. 119-120.
5. F. Charles Brunicaudi, Schwartz's Principles of Surgery, The McGraw-Hill Companies, Inc: United States of America, Ninth edition, Page no. 572.