Endocrine System With Special Reference to Thyroid Gland

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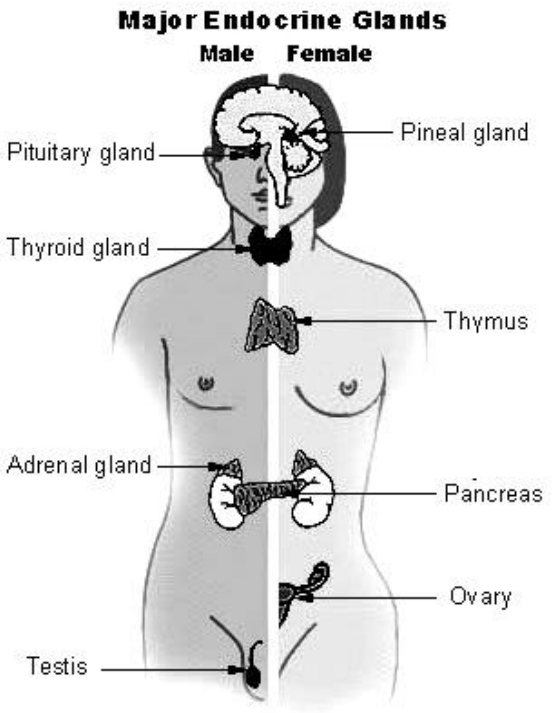
Endocrine system consisting of a group of ductless glands viz. pituitary, thyroid, parathyroid, pineal, thymus, gonads, pancreas, adrenal etc. plays a very vital role in governing human behavior. Thyroid is one of the most important glands that control body's metabolism and calcium level. It secretes iodothyronines that are (tri-iodothyronine, thyroxine) and calcitonin. Its secretion is mainly regulated by TRH (thyrotropin releasing hormone) and TSH (thyroid stimulating hormone). It helps in growth (physical, sexual, mental) – development- metamorphosis and calorigenesis-metabolism. The status of thyroid gland may be Euthyroid or Hypothyroid or Hyperthyroid. Hypothyroidism includes cretinism in children and myxoedema in adults. Common causes of hyperthyroid state are Grave's disease, multinodular goiter, thyroiditis, etc. Any enlargement of thyroid gland, regardless of cause, is called goiter. Some common investigations for thyroid diseases are estimation of serum T3, T4 and TSH, cholesterol, radioiodine uptake, thyroid imaging, etc. Common drug used in hypothyroidism is eltroxin, hyperthyroidism is carbimazole and iodine supplementation in goiter. This paper presents a full picture of thyroid gland, its functioning, disorders, and treatments which is very significant for human survival.



Introduction

The endocrine system or hormonal system is a complex system composed of a group of ductless glands known as endocrine glands that pour their secretions i.e. hormones directly into blood for passage to different body organs known as target organs in order to control their functioning, metabolism, cell permeability, growth, differentiation and stress conditions.

The endocrine system includes the pituitary gland, thyroid gland, parathyroid glands, adrenal gland, pancreas, ovaries and testes. The thymus, pineal gland, certain portions of the gastrointestinal tract, the placenta, and kidney are also considered endocrine organs. Lack of any one of the hormones produced by these glands causes serious disorders, many of them are now produced synthetically and used in treatment where a deficiency exists.

The regulation of body functions by the endocrine system depends on the existence of specific receptor cells in target organs that respond in specialized ways to the minute quantities of the hormonal messengers. The amounts of hormones are maintained by feedback mechanisms that depend on interactions between the endocrine glands, the blood levels of the various hormones, and activities of the target organ.

Pituitary control

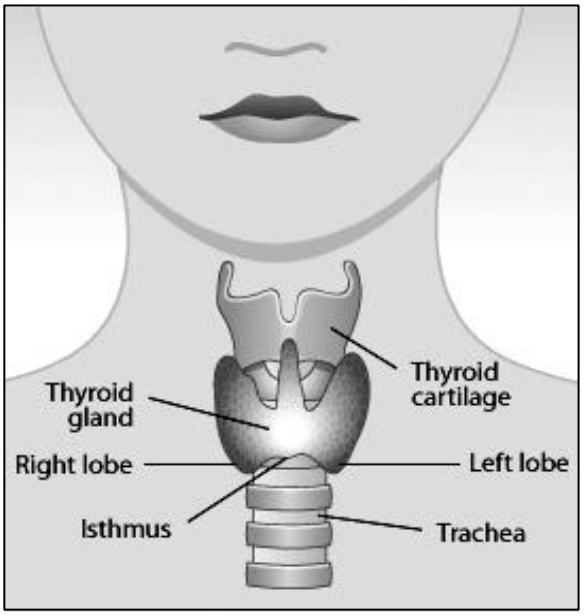
The pituitary gland otherwise known as the master gland regulates many of the other endocrine glands. It is located at the base of the brain, nestled in a bony structure called the sellaturcica. It is also called the hypophysis. It controls the adrenal gland, the sex hormones and the thyroid gland.

Other endocrine glands

The other endocrine glands are not directly controlled by the pituitary like the parathyroid glands, the endocrine portion of the pancreas, the thymus, the kidney and the pineal gland.

The endocrine system serves an essential integrative function. Humans are beset by the variety of insults, such as trauma, infection, tumor formation, genetic defects and emotional damage. The endocrine gland plays a key role in responding to these stressful stimuli.

Diseases of the endocrine system result from too much or too little hormone secretion or from the inability of the body to utilize a hormone effectively.



Thyroid Gland:

Origin: It is endodermal in origin and in human embryo, it develops from the primitive fore gut.

History: the thyroid was first identified by the anatomist Thomas Wharton in 1656. Thyroid hormone was only identified in the 19th century.

Position: it is located in front part of the larynx and upper part of trachea in the neck region.

Structure: it is the longest endocrine gland with weight of about 25 grams. However, is influenced by age, sex, reproductive state and diet of the person. It is bi-lobed in human beings. It is 'H'-shaped having two fairly symmetrical lateral lobes lying on each side of the thyroid cartilage otherwise known as Adam's apple, each about 5x2x2 cm connected by a narrow band of tissue called isthmus. It forms a crossing in front of 2nd, 3rd and 4th tracheal rings. Gland is highly vascular,

composed of approximately 3 million rounded follicles arranged in lobules each lobule having about 40 follicles and held together by connective tissue.

Follicle wall is lined by cuboidal epithelium and encloses hormone rich colloid secreted by the epithelium. Under the stimulation of thyroid stimulating hormone, low cuboidal epithelium is converted into a tall columnar epithelium.

Blood flow in thyroid gland is about 3.5 to 6.0 ml/gm/minute. Sympathetic fibers from the superior, middle and inferior cervical ganglia and the parasympathetic fibers from superior and inferior recurrent laryngeal branches of vagus cranial nerves supply thyroid gland.

Hormones:

Hormones released from thyroid gland are,

1. Thyroxine or T4
2. Triiodothyronine or T3
3. Calcitonin

Except these three hormones there is another hormone Reversed T3 or RT3 which is biologically inert. T3, T4 are iodinated derivatives of amino acid tyrosine secreted by the follicles. Calcitonin is non-iodinated hormone secreted by parafollicular cells or C-cells. Thyroid gland is stimulated to secrete hormones by TSH or thyrotropin from the anterior lobe of pituitary gland.

Biochemistry:

The thyroid hormones are modifications, called thyronines, of an amino acid, tyrosine. Thyroid hormones are heavily laden with iodine. The major active thyroid hormones are thyroxine(T4) and triiodothyronine(T3). Thyroxine and T3 are formed by the molecular addition of iodine to the amino acid tyrosine while the later is bound to the protein thyroglobulin. Most of the iodothyronine released from thyroid is T4 but ultimately an enzyme called deiodinase removes one iodine atom from T4 and produce T3.

Regulation of Hormone Secretion:

The major regulators of T3, T4 secretions are TSH, TRH, feedback, auto regulation, exposure to cold and somatostatin (of hypothalamus). Hypothalamus secretes TRH (Thyrotropin Releasing Hormone) which stimulates TSH secretion of the anterior pituitary that finally leads to secretion of T3 and T4. Elevated levels of serum T3 and T4 inhibits primarily the thyrotropes of anterior pituitary and only to little extent the hypothalamus. Daily iodine requirement for proper functioning of thyroid is 200 micrograms. If food contains excess iodine, the iodine trapping mechanism becomes inefficient so that not much of iodine is trapped, whereas if food iodine uptake is very low, the iodine trapping mechanism becomes super efficient so that the entire amount of available iodine is trapped by follicular cells. Cold stimulates production of TRH and serum T3, T4 is increased and somatostatin of hypothalamus inhibits thyroid secretion.

Role of Iodothyronines:

The thyroid plays an important role in regulating the body's metabolism and calcium balance.

- T3 increases blood sugar level. On the other hand, T3 increases peripheral utilization of glucose due to T3 induced calorigenesis. On the whole in hyperthyroidism, blood sugar level increases. But according to some recent findings, in hyperthyroidism, resistance of target cells to insulin rises.
- T3 decreases serum cholesterol level. Also the free fatty acid level is raised by thyroid hormones.

- T3 enhances both anabolism (synthesis) and catabolism (breaking down) of protein. However, under physiological condition anabolism supervenes.
- T3 causes loss of calcium via urine. Osteoporosis can develop in hyperthyroidism.
- Thyroxine controls the BMR (Basal Metabolic Rate) by regulating oxidation and production of energy.
- It regulates urine output by controlling the working of the kidney.
- It maintains the muscular and nervous toning.
- Physical as well as mental growth is regulated by thyroxine.
- It is must for the development of skeletal system.

It is required for tissue differentiation as well as metamorphosis in amphibians.

It is must for reproduction.

Role of Calcitonin or Thyrocalitonin:

It is a peptide hormone, released from extrafollicular or parafollicular cells of thyroid gland. It is non-iodinated thyroid hormone, which checks the concentration of calcium and phosphate in blood plasma by decreasing mobilization from bones. Bones, therefore, remain strong and solid. It also checks absorption of calcium and phosphate from gastrointestinal tract and increases excretion of calcium and phosphate. It is under the feedback control of plasma calcium concentration and is secreted when concentration of calcium rises in the blood. Calcitonin is antagonistic to parathormones secreted by parathyroid gland. It is hypocalcemic and hypophosphatemic.

Diseases Related to Thyroid Gland:

The state of normal thyroid function is called Euthyroidism. Diseases of the thyroid gland result from too much or too little secretion of thyroid hormones.

Hypothyroidism:

It is the condition in which the thyroid is underactive. It is producing an insufficient amount of thyroid hormones. It is the most common thyroid disorder in which the body's metabolism became slow.

Causes of Hypothyroidism:

On the basis of cause hypothyroidism can be classified under two groups-

(a) Primary hypothyroidism and
(b) Secondary hypothyroidism

In primary hypothyroidism, fault is primarily in the thyroid gland, for some reasons, thyroid is failing to produce adequate amount of iodothyronines. It can be due to (1) iodine deficiency in the food or in maternal blood (for the fetus), (2) destruction of thyroid due to surgical removal, radioiodine therapy, Hashimoto's disease (in which the body produces antibodies against the thyroid gland). Secondary hypothyroidism fault lies in the pituitary or the hypothalamus, poor amounts of TSH or TRH secretion is the cause. Secondary hypothyroidism is rare.

Types of Hypothyroidism:

Hypothyroidism is classified according to the age of onset. Thus (1) when the hypothyroidism is present since birth the condition is called cretinism but (2) when appears after the attainment of adulthood; it is adult hypothyroidism, myxoedema or Gull's disease.

(1) Cretinism

Also called congenital myxoedema or cretinoid dysplasia, is a disease of infants, which does not appear until the age of six months

because till that age, mother's milk provides enough iodine.

It is characterized by dwarfism, physical and mental deficiencies or under development with a peculiar infantile facial expression, big nose, scanty hair, low body temperature, low heart beat, low blood pressure, large head, thick legs, pot belly, pigeon chest, protruding tongue, swollen eyelids, short neck, dry skin, deformed bones and teeth and uncoordinated gait, retarded sexual development, which includes delayed development of sex glands, sex organs and secondary sexual characters. If it is treated early with thyroid hormones and trace iodine supplementation of the diet, significant improvement can be seen.

(2) Myxoedema (Gull's Disease)

It is a disease of adults which is 7-8 times more common in females than in males. It is characterized by puffy appearance due to subcutaneous accumulation of hyaluronic acid – protein – chondroitin sulphate complex which attracts water and leads to edema, low basal metabolism, retarded oxidation, lack of alertness, intelligence, failure to take initiative, retarded sexual power, high blood cholesterol level. There is swelling of tongue and larynx causing hoarseness and slow and slurring speech, hair fallout from axilla, pubis, head and eyebrows. It can be treated with oral administration of thyroid hormones.

Hyperthyroidism:

Hyperthyroidism means over activity of the thyroid gland, resulting in too much of thyroid hormones in the bloodstream. The oversecretion of thyroid hormones leads to over activity of the body's metabolism.

Causes of Hyperthyroidism:

Graves' disease is the most common cause of hyperthyroidism.

Graves' disease or Exopthalmic Goiter:

It is due to enlargement of thyroid gland and oversecretion of thyroxine probably due to an antibody which stimulates the thyroid too much in turn causing the excess production of thyroid hormone. It is characterized by bulging of eyes (i.e. exopthalmia), high BMR, increased oxidation of food, emaciation, increased heartbeat, higher body temperature, excessive sweating, restlessness, nervousness, dizziness, little sleep and fine tremors in stretched hands. Graves' disease is categorized as an autoimmune disorder. The disease is most common in young to middle-aged women and tends to run in families. It can be rectified by removal of inflamed part of thyroid gland.

Hyperthyroidism caused by multinodular goiter in which one or more nodules of the thyroid become over active. The over active nodules actually act as benign thyroid tumors. Another cause is thyroiditis but it causes temporary hyperthyroidism, usually followed with hypothyroidism. It is an inflammation of the thyroid gland. In addition, if a person takes too many thyroid hormone tablets, hyperthyroidism may occur.

Treatment of Thyroid Disorders:

The goal of treatment for any disorder is to restore the thyroid gland to normal function, producing normal levels of thyroid hormones. Specific treatment for any thyroid disorder will be determined by the physician based on:-

- Patient's overall health and medical history
- Extent of the disease
- Patient's tolerance for specific medications, procedures, or therapies
- Expectations for the course of the disease

- Patient's opinion or preference

Treatment for Hypothyroidism:

Treatment may include prescription of thyroid hormones to replace the deficient hormones. Dosage of thyroid hormone may need to be increased over the years. Yearly or biyearly checkups are usually required to ensure the proper dosage of thyroid hormones is taken. A patient usually takes thyroid hormones for the rest of his/ her life.

Laevothyroxine, Eltroxin, is popularly used by oral route in hypothyroidism.

Treatment for Hyperthyroidism:

Specific treatment for hyperthyroidism will be based on type of hyperthyroidism.

Treatment may include use of anti thyroid drugs such as carbimazole (Neomarkazole) that help lower the level of thyroid hormones in the blood, use of radioactive iodine, in the form of a pill or liquid, which damages thyroid cells so that production of thyroid hormones is slowed down, surgery to remove part of the thyroid (the overactive nodule), use of beta blocking agents, which block the action of thyroid hormone on the body.

Goiter:

Any enlargement of the thyroid, regardless of cause, is called goiter. It is a non-inflammatory and non-neoplastic enlargement of thyroid gland. Goiter is of several types, like

a) Simple goiter: - It is also called iodine deficiency goiter.

b) Endemic goiter: - It occurs in certain areas in northern hilly areas where soil and ground water are deficient in iodine.

c) Colloidal goiter: - A greatly enlarged thyroid in which the follicles are distended with colloids.

d) Toxic goiter: - Enlargement of thyroid gland due to some toxic material and also associated with exopthalmic and systemic disease. Very high concentration of iodine may also cause hypothyroidism by inhibiting iodine organification. It is known as Wolff-Chaikoff Effect. Such goiter is called Hokkihodo goiter. It is very common among Japanese, as they take in about 8-25 micrograms iodine per day in the form of sea weeds.

Goiter can be treated by taking iodinated tablets and consumption of iodinated salt in the daily diet.

Hashimoto Goiter:-

It is an autoimmune disease which occurs in middle aged females due to sensitization of their own thyroid protein called thyroglobulin.

Thyroid Function Tests:

Thyroid function tests are common procedures performed to determine how well the thyroid is functioning. Some of the most common thyroid function tests include the following: -

1) Blood Tests: - To measure the levels of T3, T4, TSH and a protein called thyroxine binding globulin (TBG) in the blood which helps determine thyroid function.

2) Ultrasound of the thyroid gland: - To detect signs of growth and other irregularities.

3) Thyroid Scans: - Using radioactive iodine or technetium, a radioactive metallic element to reveal any physical abnormalities of the thyroid.

4) Functional stimulation test: - Tests that help differentiate whether the problem lies with the pituitary gland or the thyroid gland. One such test includes injecting thyrotropin releasing hormone (TRH) and measuring the pituitary's response.

Other tests are Thyroid Antibodies' Test, Thyroid Needle Biopsy, and measurement of serum thyroid hormones (T3, T4) by RIA (radioimmunoassay).

CONCLUSION

Thyroid plays very vital role in human beings. It is associated with physical, mental and sexual functioning of our body. Thyroid gland and memory are very much related so also it is related to many other important functions of our body. Many findings prove that proper functioning of thyroid is very much necessary as it controls the body's metabolism and maintains proper calcium level. People should be aware of diseases related to thyroid gland and should take utmost precautions to avoid them by taking iodized salt, sea food in their daily diet. As we all know "prevention is better than cure".

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