= Parathyroid gland =

The parathyroid glands are small endocrine glands in the neck of humans and other tetrapods that produce parathyroid hormone . Humans usually have four parathyroid glands , variably located on the back of the thyroid gland , although considerable variation exists . Parathyroid hormone and calcitonin (one of the hormones made by the thyroid gland) have key roles in regulating the amount of calcium in the blood and within the bones .

The parathyroid glands share a similar blood supply , venous drainage , and lymphatic drainage to the thyroid glands . The parathyroid glands are derived from the epithelial lining of the third and fourth branchial pouches , with the superior glands arising from the fourth pouch , and the inferior glands arising from the higher third pouch . The relative position of the inferior and superior glands , which are named according to their final location , changes because of the migration of embryological tissues .

Hyperparathyroidism and hypoparathyroidism , characterised by alterations in the blood calcium levels and bone metabolism , are states of surplus or insufficient parathyroid function .

= = Structure = =

The parathyroid glands are two pairs of glands usually positioned behind the left and right lobes of the thyroid . Each gland is a yellowish @-@ brown flat ovoid that resembles a lentil seed , usually about 6 mm long and 3 to 4 mm wide , and 1 to 2 mm anteroposteriorly . There are typically four parathyroid glands . The two parathyroid glands on each side which are positioned higher are called the superior parathyroid glands , while the lower two are called the inferior parathyroid glands . Healthy parathyroid glands generally weigh about 30 mg in men and 35 mg in women . These glands are not visible or able to be felt during examination of the neck .

= = = Blood supply = = =

The blood supply , drainage , and lymphatic drainage of the parathyroid glands correspond to the thyroid overlying gland .

The superior parathyroid glands receive their blood from the inferior thyroid arteries . The inferior parathyroid glands receive a variable blood supply , from either the ascending branch of the inferior thyroid arteries or the thyroid ima artery . The inferior thyroid artery arises from the subclavian arteries .

Each parathyroid vein drains into the superior , middle and inferior thyroid veins . The superior and middle thyroid veins drain into the internal jugular vein , and the inferior thyroid vein drains into the brachiocephalic vein .

= = = Lymphatic drainage = = =

Lymphatic vessels from the parathyroid glands drain into deep cervical lymph nodes and paratracheal lymph nodes .

= = = Variation = = =

The parathyroid glands are variable in number : three or more small glands , and can usually be located on the posterior surface of the thyroid gland . Occasionally , some individuals may have six , eight , or even more parathyroid glands . Rarely , the parathyroid glands may be within the thyroid gland itself , the chest , or even the thymus .

= = = Histology = = =

The parathyroid glands are named for their proximity to the thyroid but serve a completely different

role than the thyroid gland . The parathyroid glands are quite easily recognizable from the thyroid as they have densely packed cells , in contrast with the follicular structure of the thyroid . Two unique types of cells are present in the parathyroid gland :

Chief cells , which synthesize and release parathyroid hormone . These cells are small , and appear dark when loaded with parathyroid hormone , and clear when the hormone has been secreted , or in their resting state .

Oxyphil cells , which are lighter in appearance and increase in number with age , have an unknown function .

= = = Development = = =

In early human embryonic life , a series of six branchial pouches form that give rise to the human face , neck , and surrounding structures . The pouches are numbered such that the first pouch is the closest to the top of the embryo 's head and the sixth is the furthest from it . The parathyroid glands originate from the interaction of the endoderm of the third and fourth pouch and neural crest mesenchyme . The position of the glands reverses during embryological life . The pair of glands which is ultimately inferior develops from the third pouch with the thymus , whereas the pair of glands which is ultimately superior develops from the fourth pouch . During embryological development , the thymus migrates downwards , dragging the inferior glands with it . The superior pair are not dragged downwards by the fourth pouch to the same degree . The glands are named after their final , not embryological , positions . Since the thymus 's ultimate destination is in the mediastinum of the chest , it is occasionally possible to have ectopic parathyroids derived from the third pouch within the chest cavity if they fail to detach in the neck .

Parathyroid development is regulated by a number of genes , including those coding for several transcription factors .

= = Function = =

The major function of the parathyroid glands is to maintain the body 's calcium and phosphate levels within a very narrow range , so that the nervous and muscular systems can function properly . The parathyroid glands do this by secreting parathyroid hormone .

Parathyroid hormone (PTH , also known as parathormone) is a small protein that takes part in the control of calcium and phosphate homeostasis , as well as bone physiology . Parathyroid hormone has effects antagonistic to those of calcitonin .

Calcium . PTH increases blood calcium levels by directly stimulating osteoblasts and thereby indirectly stimulating osteoclasts (through RANK / RANKL mechanism) to break down bone and release calcium . PTH also increases gastrointestinal calcium absorption by activating vitamin D , and promotes calcium conservation (reabsorption) by the kidneys .

Phosphate . PTH is the major regulator of serum phosphate concentrations via actions on the kidney . It is an inhibitor of proximal tubular reabsorption of phosphorus . Through activation of vitamin D the absorption of Phosphate is increased .

= = Clinical significance = =

Parathyroid disease is conventionally divided into states where the parathyroid is overactive (hyperparathyroidism) , and states where the parathyroid is under- or hypoactive (hypoparathyroidism) . Both states are characterised by their symptoms , which relate to the excess or deficiency of parathyroid hormone in the blood .

= = = Hyperparathyroidism = = =

Hyperparathyroidism is the state in which there is excess parathyroid hormone circulating . This may cause bone pain and tenderness , due to increased bone resorption . Due to increased

circulating calcium , there may be other symptoms associated with hypercalcemia , most commonly dehydration . Hyperparathyroidism is most commonly caused by a benign proliferation of chief cells in single gland , and rarely MEN syndrome . This is known as primary hyperparathyroidism , which is generally managed by surgical removal of the abnormal parathyroid gland .

Renal disease may also lead to hyperparathyroidism . When too much calcium is lost , there is a compensation by the parathyroid , and parathyroid hormone is released . The glands hypertrophy to synthesise more parathyroid hormone . This is also known as secondary hyperparathyroidism . If this situation exists for a prolonged period of time , the parathyroid tissue may become unresponsive to the blood calcium levels , and begin to autonomously release parathyroid hormone . This is known as tertiary hyperparathyroidism .

= = = Hypoparathyroidism = = =

The state of decreased parathyroid activity is known as hypoparathyroidism . This is most commonly associated with damage to the glands or their blood supply during thyroid surgery , although it may also be associated with rarer genetic syndromes such as DiGeorge syndrome , which is inherited as an autosomal dominant syndrome . Hypoparathyroidism will also occur after surgical removal of the parathyroid glands .

Occasionally , an individual 's tissues are resistant to the effects of parathyroid hormone . This is known as pseudohypoparathyroidism , as although the parathyroid glands are fully functional , the hormone itself is not able to function , resulting in a decrease in blood calcium levels . Pseudohypoparathyroidism is often associated with the genetic condition Albright 's hereditary osteodystrophy . Pseudopseudohypoparathyroidism , one of the longest words in the English language , is used to describe an individual with Albright 's hereditary osteodystrophy but with normal parathyroid hormone and serum calcium levels .

Hypoparathyroidism may present with symptoms associated with decreased calcium , and is generally treated with Vitamin D analogues .

= = History = =

The parathyroid glands were first discovered in the Indian Rhinoceros by Richard Owen in 1852 . In his description of the neck anatomy , Owen referred to the glands as " a small compact yellow glandular body attached to the thyroid at the point where the veins emerged " . The glands were first discovered in humans by Ivar Viktor Sandström (1852 ? 1889) , a Swedish medical student , in 1880 at Uppsala University . Unaware of Owen 's description , he described the glands in his monograph " On a New Gland in Man and Fellow Animals " as the " glandulae parathyroidae " , noting its existence in dogs , cats , rabbits , oxen , horses and humans . For several years , Sandström 's description received little attention .

Physiologist Eugene Gley first documented the putative function of the glands in 1891 , noting the connection between their removal and the development of muscular tetani . William G. MacCallum in 1908 , investigating tumours of the parathyroid , proposed their role in calcium metabolism . He noted that " Tetany occurs spontaneously in many forms and may also be produced by the destruction of the parathyroid glands " .

The first successful removal of the parathyroid may have been carried out in 1928 by medical doctor Isaac Y Olch , whose intern had noticed elevated calcium levels in an elderly patient with muscle weakness . Prior to this surgery , patients with removed parathyroid glands typically died from muscular tetani .

Parathyroid hormone was isolated in 1923 by Adolph M. Hanson and 1925 by James B. Collip . Studies of parathyroid hormone levels by Roger Guillemin , Andrew Schally and Rosalyn Sussman Yalow led to the development of immunoassays capable of measuring body substances and a Nobel Prize in 1977 .

= = In other animals = =

Parathyroid glands are found in all adult tetrapods , although they vary in their number and position . Mammals typically have four parathyroid glands , while other types of animals typically have six . The removal of parathyroid glands in animals produces a condition resembling acute poisoning with irregular muscle contractions .

Fish do not possess parathyroid glands , however several species have been found to express parathyroid hormone . Developmental genes and calcium @-@ sensing receptors in fish gills are similar to those within the parathyroid glands of birds and mammals . It has been suggested that the tetrapod glands may have been evolutionarily derived from these fish gills .

= = Additional images = =