

Embryology and Histology of The Parathyroid Glands

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Abstract

The parathyroid glands are endocrine organs that regulate serum calcium and bone metabolism. These glands are endodermal in origin. They develop from the third and fourth pharyngeal sacs between the fifth and 12th weeks of gestation. Chief (principal) cells and oxyphil (eosinophilic) cells are two parenchymal epithelial cells. Chief cells secrete parathormone which are the predominant and abundant cells in the parathyroid glands. Oxyphil cells are thought to be degenerating chief cells. Except these cells, there are many fat cells in the stroma and parenchyma that appears in adolescent period and increase with age.

Keywords: chief cells, oxyphil cells, parathyroid.

1. Introduction

The parathyroid glands are endocrine organs that regulate serum calcium and bone metabolism [1]. They are called the parathyroid glands because of their close relationship with the thyroid gland. They consist of four glands in two pairs located in the upper and lower regions of the posterior side of the lateral lobes. Most people have four parathyroid glands. However, 5-13% of people have five or more parathyroid glands, while 2% have fewer than four parathyroid glands. Adipose tissue is not observed in the parathyroid glands in newborns. It begins to appear in adolescence and increases until the age of 40. After the age of 40 it is permanent in the parathyroid glands [2].

2. Embryology of The Parathyroid Glands

The parathyroid glands are endocrine organ that develops between the fifth and 12th weeks of gestation. They are endodermal in origin. They develop from the third and fourth pharyngeal sacs [3]. The inferior parathyroid glands originate from the posterior surface of the third pharyngeal sac. They are called parathyroid III (PIII) depending on their origin. From the anterior side of the same sac, the thymus gland originates. Their common origin allows PIII to be defined as thymic parathyroid. The inferior parathyroid glands descend by being pulled down by the thymus gland in the caudal direction with the thymus gland. This association is also called the parathymus complex [4]. The

connection of the parathymus complex formed by the inferior parathyroid glands and the thymus with the pharyngeal wall is lost. At the level of the thyroid gland, the inferior parathyroid glands separate from the thymus tissue and integrate into the posterior lower surfaces of the thyroid gland. The thymus gland migrates downward to the superior and anterior mediastinum.

The superior parathyroid glands originate from the posterior aspect of the fourth pharyngeal sac and are also called parathyroid IV (PIV) [5]. The fate of PIV and its derivatives originating from the fourth pharyngeal sac depends on those from the fifth pharyngeal sac. The primitive and blunt fifth pharyngeal sac participates in the formation of the fourth pharyngeal sac and the ultimobranchial bodies (lateral thyroids). The fourth pharyngeal sac and the fifth pharyngeal blind sac are also called the caudal pharyngeal complex. This complex includes the primordium PIV, the ventral diverticulum (a small part of the thymus gland that comes from the anterior surface of the third pharyngeal sac), and ultimobranchial bodies originating from the fifth pharyngeal sac. Although the fate of this ventral diverticulum in humans is unknown that would later disappear. Fatty lobules, which are rarely seen with PIV in their normal regions, may form incomplete remnants of this thymic tissue. The superior parathyroid glands lose their connection with the pharyngeal wall and integrate downwards into the posterior and upper parts of the thyroid gland at the level of the isthmus [4].

The formation of the nodular primordia of the parathyroid formation from the pharyngeal sacs, descending towards the neck, and taking their general

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position on the posterior surface of the thyroid results are completed at approximately seven weeks of gestation [6].

The epithelium of the dorsal surface of the fourth and fifth pharyngeal sacs proliferates, forming a small nodule on the dorsal aspect of each of the sacs during the fifth week. In these nodules, the proliferation of vascular mesoderm begins and a capillary network is produced [4]. During embryological development, differentiation of parenchymal chief cells take place, and they are functionally active in the regulation of fetal calcium metabolism. The differentiation of parenchymal oxyphil cells occurs a few years before puberty [1].

Parathyroid tissue is usually embedded within the thyroid tissue as the thyroid tissue is forming and maturing. The superior parathyroid glands are mostly intrathyroidal, on the other hand the inferior parathyroids are mostly intrathyroidal in the ectopic locations of the thyroid gland. When the parathyroid tissue is intrathyroidal, it preserves its vascular structure [4].

3. Histology of The Parathyroid Glands

In the macroscopic examination, it is seen that a parathyroid gland is an average size of 3-6 mm, around 20-40 mg, soft, oval-shaped, and yellow-brown gland [7]. It appears to be flattened in the adipose tissue envelope that surrounds it and has a very prominent capsule that separates it from this adipose tissue. Even if the biochemically functioning is normal, parathyroid glands vary in appearance. There are morphological differences in size, shape, tissue, and solidity in diseased parathyroid glands. Abnormal parathyroid tissues usually have a fuller, dark brown or reddish-brown structure in all sizes that cannot be easily compressed. These tissues are usually irregular, nodular, and have prominent vascular networks [4].

When the parathyroid glands are examined microscopically, there is a connective tissue capsule that surrounds them and separates them from the thyroid glands. The capsule forms thin septa that transmit nerves, blood and lymph vessels through the tissue. Septa divide the gland into incomplete lobules and separate cords of tightly packed cells. Inside the gland, a reticular fiber network supports the cells [8]. Connective tissue is more prominent in adults. There are many fat cells in the stroma and parenchyma of the parathyroid tissue. The fat cell ratio in the stroma constitutes approximately 25% of the gland [9]. Epithelial cells forming the parenchyma of the parathyroid glands; chief (principal) cells and oxyphil (eosinophilic) cells.

Chief cells are the predominant and abundant cells in the parathyroid glands. These numerous cells come together and anastomose with each other, forming irregular cords supported by thin connective tissue. The cords are surrounded by a rich capillary network containing many fenestrated blood capillaries [10]. Chief cells are largely responsible for the synthesis,

storage, and secretion of parathormone. They are smaller in size than oxyphil cells. These cells, with slightly acidophilic staining in their cytoplasm, are polygonal in shape [11]. They have circular and small nuclei in the center. Chief cells stain with hematoxylin and eosin lighter because of glycogen and lipid granules in the cytoplasm. In electron microscopic examinations, mitochondria, rough endoplasmic reticulum, Golgi apparatus and irregularly shaped electron-dense secretory granules of 200-400 nanometers are observed. There are two types of chief cells. These are inactive, and active chief cells. [12]. The number of inactive chief cells in the parathyroid gland is higher than the number of active chief cells. In a healthy adult with a normal calcium level, the amount of inactive chief cells is approximately 80% [13]. It is observed that the active chief cells have a large amount of rough endoplasmic reticulum and developed Golgi apparatus. Calcium and phosphorus levels in the blood are regulated by parathormone secreted by chief cells. Chief cells increase the calcium level in three ways when there is a decrease in the calcium level [14]. First, they act directly on bone tissue by increasing osteoclastic activity. Osteoclasts, which are multinucleated cells, are the main cells involved in bone resorption. These cells dissolve bone minerals and matrix through various organic and lysosomal proteolytic enzymes. Calcium is released from dissolved bone minerals and matrix. The number and activity of osteoclast cells increase with parathormone. Accordingly, the level of calcium that transmits into the blood increases. The second way is the direct effect of parathormone on the kidneys. It increases calcium reabsorption from the kidneys and inhibits phosphorus reabsorption from the glomerular tubules. The third way calcium absorption from the small intestines is increased. This effect also includes vitamin D [14].

Oxyphil cells are cells that appear in the first decade of life, a few years before puberty. They are cells that are irregularly distributed in the parenchyma tissue, either singly or in groups. In light microscopic examination, they appear larger than chief cells. The cytoplasm of these cells, which are oval or circular in shape, is stained acidophilic [10]. The nuclei of these cells are centrally located, and they are smaller and stained darker than the nuclei of chief cells. Electron microscopic examination reveals an excessive number of mitochondria. This is a factor in the acidophilic staining of the cytoplasm of these cells. Spread between mitochondria are lysosomes, oil droplets, and glycogen. Secretory granules are either absent or very few if they have a rough endoplasmic reticulum [1]. The lack of secretory granules suggests that these cells are non-secretory cells [15]. Glycogens dispersed between lysosomes, lipid drops, and mitochondria form cytoplasmic inclusions. Oxyphil cells are thought to be degenerating chief cells.

4. Conclusion

Parathyroid glands are particularly important and essential for human. Because they secrete parathormon that regulates calcium and bone metabolism. Chief cells are responsible for synthesis, storage, and secretion of parathormone. These cells have secretory granules producing parathormon. Oxyphil cells are thought to be degenerating chief cells that occur in the first decade of life. Secretory granules are either absent or very few in these cells.

Conflict of Interest

The authors declare no conflict of interest.

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