HUMAN ANATOMY & PHYSIOLOGY-II- BP201T

UNIT: 4 (ENDOCRINE SYSTEM)

CLASS: 6

TOPIC: Parathyroid Glands

Human beings have four parathyroid glands, which are situated on the posterior surface of upper and lower poles of thyroid gland. Each parathyroid gland is made up of chief cells and oxyphil cells. Chief cells secrete parathormone. Oxyphil cells are the degenerated chief cells and their function is known. However, these cells may secrete parathormone during pathological condition called
parathyroid adenoma. The number of oxyphil cells increases after puberty.

PARATHORMONE

Parathormone secreted by parathyroid gland is essential for the maintenance of blood calcium level within a very narrow critical level. Maintenance of blood calcium level is necessary because calcium is an important inorganic ion for many physiological functions.

Parathormone (PTH) is secreted by the chief cells of the parathyroid glands. Parathormone is protein in nature, having 84 amino acids. Parathormone has a half-life of 10 minutes.

Synthesis

Parathormone is synthesized from the precursor called prepro-PTH containing 115 amino acids. First, the prepro-PTH enters the endoplasmic reticulum of chief cells of parathyroid glands. There it is converted into a prohormone called pro-PTH, which contains 96 amino acids. Pro-PTH enters the
Golgi apparatus, where it is converted into PTH.

ACTIONS OF PARATHORMONE

PTH plays an important role in maintaining blood calcium level. It also controls blood phosphate level.

ACTIONS OF PARATHORMONE ON BLOOD CALCIUM LEVEL

PTH maintains blood calcium level by acting on:

1. Bones

2. Kidney

3. Gastrointestinal tract.

1. On Bone Parathormone enhances the resorption of calcium from the bones (osteoclastic activity) by acting on osteoblasts and osteoclasts of the bone. Resorption of calcium from bones occurs in two phases:

i. Rapid phase

ii. Slow
phase.

Rapid phase

Rapid phase occurs within minutes after the release of PTH from parathyroid glands. Immediately after reaching the bone, PTH gets attached with the receptors on the cell membrane of osteoblasts and osteocytes. The hormone-receptor complex increases the permeability of membranes of these
cells for calcium ions. It accelerates the calcium pump mechanism, so that calcium ions move out of these bone cells and enter the blood at a faster rate.

Slow phase

Slow phase of calcium resorption from bone is due to the activation of osteoclasts by PTH. When osteoclasts are activated, some substances such as proteolytic enzymes, citric acid and lactic acid are released from lysosomes of these cells. All these substances digest or dissolve the organic matrix of
the bone, releasing the calcium ions. The calcium ions slowly enter the blood. PTH increases calcium resorption from bone by stimulating the proliferation of osteoclasts also.

2. On Kidney

PTH increases the reabsorption of calcium from the renal tubules along with magnesium ions and hydrogen ions. It increases calcium reabsorption mainly from distal convoluted tubule and proximal part of collecting duct. PTH also increases the formation of 1,25-dihydroxycholecalciferol (activated form of vitamin D) from 25-hydroxycholecalciferol in kidneys.

3. On Gastrointestinal Tract

PTH increases the absorption of calcium ions from the GI tract indirectly. It increases the formation of 1,25- dihydroxycholecalciferol in the kidneys. This vitamin, in turn increases the absorption of
calcium from GI tract. Thus, the activated vitamin D is very essential for the absorption of calcium from the GI tract. And PTH is essential for the formation of activated vitamin D.

ACTIONS OF PARATHORMONE ON BLOOD PHOSPHATE LEVEL

PTH decreases blood level of phosphate by increasing its urinary excretion. It also acts on bone and GI tract.

1. On Bone

Along with calcium resorption, PTH also increases phosphate absorption from the bones.

2. On Kidney

Phosphaturic action It is the effect of PTH by which phosphate is excreted through urine. PTH increases phosphate excretion by inhibiting reabsorption of phosphate from renal tubules. It acts mainly on proximal convoluted tubule.

3. On Gastrointestinal Tract

Parathormone increases the absorption of phosphate from GI tract through calcitriol.

MODE OF ACTION OF PARATHORMONE

Parathormone Receptors Parathormone receptors (PTH receptors) are of three types, PTHR1, PTHR2 and PTHR3, which are G protein-coupled receptors. PTHR1 is physiologically more important than the other two types. PTHR1 mediates the actions of PTH and PTH-related protein.

REGULATION OF PARATHORMONE SECRETION

Blood level of calcium is the main factor regulating the secretion of PTH. Blood phosphate level also regulates PTH secretion.

Parathormone secretion is inversely proportional to blood calcium level. Increase in blood calcium level decreases PTH secretion.

PTH secretion is directly proportional to blood phosphate level.

APPLIED PHYSIOLOGY – DISORDERS OF PARATHYROID GLANDS

Disorders of parathyroid glands are of two types:

I. Hypoparathyroidism

II. Hyperparathyroidism

HYPOPARATHYROIDISM – HYPOCALCEMIA

Hyposecretion of PTH is called hypoparathyroidism. It leads to hypocalcemia.

HYPERPARATHYROIDISM – HYPERCALCEMIA

Hypersecretion of PTH is called hyperparathyroidism. It results in hypercalcemia.

Hyperparathyroidism is of three types:

1. Primary hyperparathyroidism Primary hyperparathyroidism is due to the development of tumor in one or more parathyroid glands. Sometimes, tumor may develop in all the four glands.

2. Secondary hyperparathyroidism Secondary hyperparathyroidism is due to the physiological compensatory hypertrophy of parathyroid glands, in response to hypocalcemia which occurs due to other pathological conditions such as: i. Chronic renal failure ii. Vitamin D deficiency iii. Rickets.

3. Tertiary hyperparathyroidism Tertiary hyperparathyroidism is due to hyperplasia (abnormal increase in the number of cells) of all the parathyroid glands that develops due to chronic secondary hyperparathyroidism.

CALCITONIN

Calcitonin is secreted by the parafollicular cells or clear cells (C cells), situated amongst the follicles in thyroid gland. Calcitonin is a polypeptide chain with 32 amino acids. It has a half-life of 5 to 10 minutes.

ACTIONS OF CALCITONIN

1. On Blood Calcium Level

Calcitonin plays an important role in controlling the blood calcium level. It decreases the blood calcium level and thereby counteracts parathormone.

i. On bones

Calcitonin stimulates osteoblastic activity and facilitates the deposition of calcium on bones. At the same time, it suppresses the activity of osteoclasts and inhibits the resorption of calcium from bones. It inhibits even the development of new osteoclasts in bones.

ii. On kidney

Calcitonin increases excretion of calcium through urine, by inhibiting the reabsorption from the renal tubules.

iii. On intestine

Calcitonin prevents the absorption of calcium from intestine into the blood.

2. On Blood Phosphate Level

With respect to calcium, calcitonin is an antagonist to PTH. But it has similar actions of PTH, with respect to phosphate.

i. On bones

Calcitonin inhibits the resorption of phosphate from bone and stimulates the deposition of phosphate on bones.

ii. On kidney

Calcitonin increases the excretion of phosphate through urine, by inhibiting the reabsorption from renal tubules.

TYPES OF CALCIUM

Calcium in Plasma

Calcium is present in three forms in plasma:

i. Ionized or diffusible calcium: Found freely in plasma and forms about 50% of plasma calcium. It is essential for vital functions such as neuronal activity, muscle contraction, cardiac activity, secretions in the glands, blood coagulation, etc.

ii. Non-ionized or non-diffusible calcium: Present in non-ionic form such as calcium bicarbonate. It is about 8% to 10% of plasma calcium

iii. Calcium bound to albumin: Forms about 40% to 42% of plasma calcium. Calcium in Bones

Calcium is constantly removed from bone and deposited in bone. Bone calcium is present in two forms:

i. Rapidly exchangeable calcium or exchangeable calcium: Available in small quantity in bone and helps to maintain the plasma calcium level

ii. Slowly exchangeable calcium or stable calcium: Available in large quantity in bones and helps in bone remodeling.

REGULATION OF BLOOD CALCIUM LEVEL

Blood calcium level is regulated mainly by three hormones

1. Parathormone
2. 1,25-dihydroxycholecalciferol (calcitriol)
3. Calcitonin.